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The Natural Resources of Illinois

Introduction and Guide

Illinois Natural History Survey Special Publication 6

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R. Dan Neely and Carla G. Heister, Compilers

Special Publication 6

Illinois Natural History Survey
Department of Energy and Natural Resources
State of Illinois

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And last, to the many contributors of the text is extended sincere appreciation for their help in producing excellent and informative discussions.

R. Dan Neely and Carla G. Heister,
Illinois Natural History Survey

Introduction

Illinois is a vibrant State with nearly 12 million inhabitants who represent a rich variety of cultural interests and backgrounds. An important part of each person's heritage is defined by his or her physical surroundings, and by the natural resources available for fashioning a life-style. Fortunately for its citizens, the State of Illinois supports a plethora of biological resources, offers a diverse and interesting climate, and contains a rich array of geological materials. While the diversity and abundance of these natural resources contribute to the economic vitality of the State, they also challenge us to understand their nature and the extent of their interrelationships.

The purpose of this book is to help its readers more fully understand and appreciate the natural resources of Illinois. Our enjoyment of the State is enhanced when we understand where its various resources are found, their extent, and the historical patterns of their use. When we contemplate the harvest or development of a natural resource, similar information is required. The contributors to this book, therefore, have sought to provide a compendium of information about the natural resources of Illinois that is accessible to the general reader as well as useful to more specialized audiences.

Since a book on the natural resources of Illinois could contain a vast number of topics, the compilers relied on several guidelines in making their selections. First, all topics are related to natural processes that occur in the soil, geological materials, water, atmosphere, or biota of the State. Second, these natural processes predominate over human activities in their impact on the selected topics. Agricultural systems, for example, are managed by people, but the fundamental natural processes of plant growth determine crop yield. Finally, topics were included only if sufficient data were available to describe the status and trends of the resource.

Before becoming acquainted with the structure of the book, we should pause to consider the genesis of the information in its many tables, graphs, and maps. Data for various crops are provided by farmers and agricultural researchers who measure yields throughout the State and then carefully summarize these numbers. Trends in the number of ducks and geese migrating through Illinois each year can be determined because biologists use boats and airplanes, through good and bad weather, to count waterfowl on numerous lakes and rivers. This same variable weather is measured every day by a number of instruments distributed in hundreds of locations throughout Illinois. The State's geology has been painstakingly interpreted by scientists who examined, layer by layer, thousands of cores extracted during drilling operations and highway excavations. Because of these efforts, an enormous amount of data exists from which to describe the natural resources of Illinois.

Although the scientific community relies on the metric system for collecting and reporting data, much of the general public has had only limited and sporadic exposure to the metric equivalents of English units of measurement. In addition, even the specialists in some areas of investigation have not yet formally agreed upon metric equivalents for certain measurements. For these reasons, English units are used in *The Natural Resources of Illinois*. Future editions will no doubt reflect the growing metric awareness of the general reader.

The book is divided into six sections: General Characteristics of Illinois, Agriculture, Fish and Wildlife, Climate, Water Resources, and Geological Resources. Each section along with its individual entries is listed in the contents. Although entries are written to be understood independently of each other, readers may discover greater coherence in the material if they begin by previewing the introductory section, General Characteristics of Illinois. Comprehending how the soils of Illinois developed, for example, prepares us to understand the impressive agricultural resources of the State.

Readers will use this book in various ways. Some may read it from beginning to end, surveying all the resources of the State. Others will need information about a specific topic and will turn directly to that entry. For each entry, readers will find a general description of the resource along with numeric descriptions, usually in the form of tables, maps, or graphs. Since information is often shown on maps that include county outlines but not county names, a map that identifies the counties of Illinois by name has been printed on the foldout cover. Readers who follow the text with a particular county in mind will find this foldout a convenient reference since it can be used with any map in the book.

For those who want further information, a numbered bibliography of over 450 citations is appended. To simplify the research task, references are cited by number at the end of each entry. Preceding this citation bibliography is a list of serial publications related to the natural resources of Illinois. Readers interested in the present and future status of the State's resources will want to review these publications on an ongoing basis. Those who are interested in an historical perspective will find past issues, some dating back into the nineteenth century, invaluable.

Although the staff of the Illinois Natural History Survey conceived and designed this book, its material comes from many sources. Indeed, scientific information cannot easily be separated from the experts who collect and interpret it. An appendix, therefore, lists agencies in Illinois to which readers can turn for more information and for assistance in the interpretation of data.

A final note to readers concerns the dynamic nature of natural resource data. Often a chart or graph depicts how a certain resource varies over time (the number of bobwhite quail harvested each year) or space (the amount of precipitation in each county of the State). In most instances, however, these values vary over both time and space. Moreover, these variables are interrelated. The amount and seasonal distribution of precipitation, for example, affect the number of bobwhite quail that are produced and can be hunted. These spatial and temporal variations and the interrelatedness of natural resources make the contents of this book interesting and challenging. But most important, the complexity and the changing nature of the State's natural resources demand continuing study. From these investigations comes the information necessary to understand, to protect, and to utilize the natural resources of Illinois.

Paul G. Risser, Chief, Illinois Natural History Survey

General Characteristics of Illinois

Illinois is 11,426,518 people living on 55,645 square miles in the center of the United States. For those who enjoy four distinct seasons of the year, Illinois is an ideal location. It is far enough north to offer winter sports and insect control and far enough south to offer summer sports and a growing season of 160 to 210 days. It is far enough east to receive summer rainfall from the Gulf of Mexico and far enough west to enjoy prairie vistas and the open sky. Together, the land and its residents have made the State first in the production of soybeans, second in the production of corn and hogs, third in commercial bank assets, and fifth in the production of coal.

The topography and soils of the State have largely been determined by its glacial history and underlying bedrock structure. An extensive central lowland characterized the preglacial landscape, with uplands to the north, south, and west. The combined effects of successive glacial advances and retreats were to plane off prominent relief features and deposit a thick layer of unconsolidated drift material and windblown silt (loess) over most of Illinois. These deposits account for the fertile soils of the central and east-central parts of the State, soils that are rich in organic material and lime and able to hold large amounts of water for long periods of time.

When the young naturalist John Wesley Powell traveled the Illinois waterways in the 1850s, he observed how the glacial drift and rock formations were reflected in the soils and the natural vegetation. It occurred to him that the fundamental geology of a region profoundly influenced its flora and fauna. He observed changes in the composition of plant species that correlated with soil texture and topography. Sand from glacial outwash supported biota distinct from that on developed loess, and thin soils that formed on bedrock sharply limited plant life. He also noted that the limitation of plant species by the environment in turn altered the habitats of fish and wildlife and thus influenced the distribution of animal species.

Based on bedrock, topography, soils, and the distribution of flora and fauna, Illinois has been divided into fourteen geographic regions. Representative of these are the glacial landforms, beaches, lakes, and bogs of the Northeastern Morainal Division, the fertile soils of the Grand Prairie Division, and the forest hill country and high sandstone cliffs of the Shawnee Hills Division to the south. Eight natural communities have also been defined: forests, prairies, savannas, wetlands, lakes and ponds, streams, caves, and primary successional units.

In addition to these natural or environmentally determined divisions, Illinois is divided in ways defined by its citizens and their social institutions. Among these divisions are county boundaries and demarcations based on land ownership. Some areas have been declared unique and irreplaceable and are protected in perpetuity as nature preserves. Others which document the history of the State or are representative of its natural features have become parks and memorials that guarantee accessibility to all.

R. Dan Neely, Illinois Natural History Survey

Photograph: Larry Kanfer

Surface Features

Some of the present-day surface features of Illinois have been defined over millions of years; others reflect changes wrought in little more than a century. The preglacial landscape, for example, remains discernible beneath a topography and river network largely laid down during the Ice Age. On the other hand, the presence or absence of forests, the acres of cropland brought into production through clearing and extensive tiling, and the numerous artificial lakes and reservoirs that dot the southern half of the State are relatively recent surface features defined by human activity. Together and in radically different time frames, natural processes and human actions have created and continue to alter the face of Illinois.

Bedrock

During the Quarternary Period, often referred to as the Pleistocene or Ice Age, most of Illinois was repeatedly invaded by glaciers, some more than a mile high, that carried ground-up rock materials they had gouged out of the bedrock. Nearly 80 percent of the State was covered by one or more sheets of glacial ice. When the last of the glaciers melted from Illinois, about 14,000 years ago, the country that emerged looked far different from the preglacial landscape. Old hills and valleys had vanished, new ones had formed, and a mantle of unconsolidated glacial drift dropped by the melting ice lay over most of the region. These deposits contained a variety of rocks, some carried from regions to the north and others scoured from the native rock of Illinois.

Beneath the glacial drift, many layers of rocks overlie a base of ancient crystalline rocks that in Illinois occur at depths of 2,000 to as much as 15,000 feet below the surface. The bedrock map (Fig. 1) is drawn as if the mantle of glacial drift had been removed to expose the layers of bedrock, which chiefly consist of limestone, dolomite, shale, and sandstone. The names that geologists have assigned to the various systems of rocks are given on Figure 1, with the youngest rock system, Tertiary, listed first. Each system consists of rocks that were deposited over a long period of time. The complete sequence of rock systems can be thought of as a book of earth history, with each system a chapter in that story.

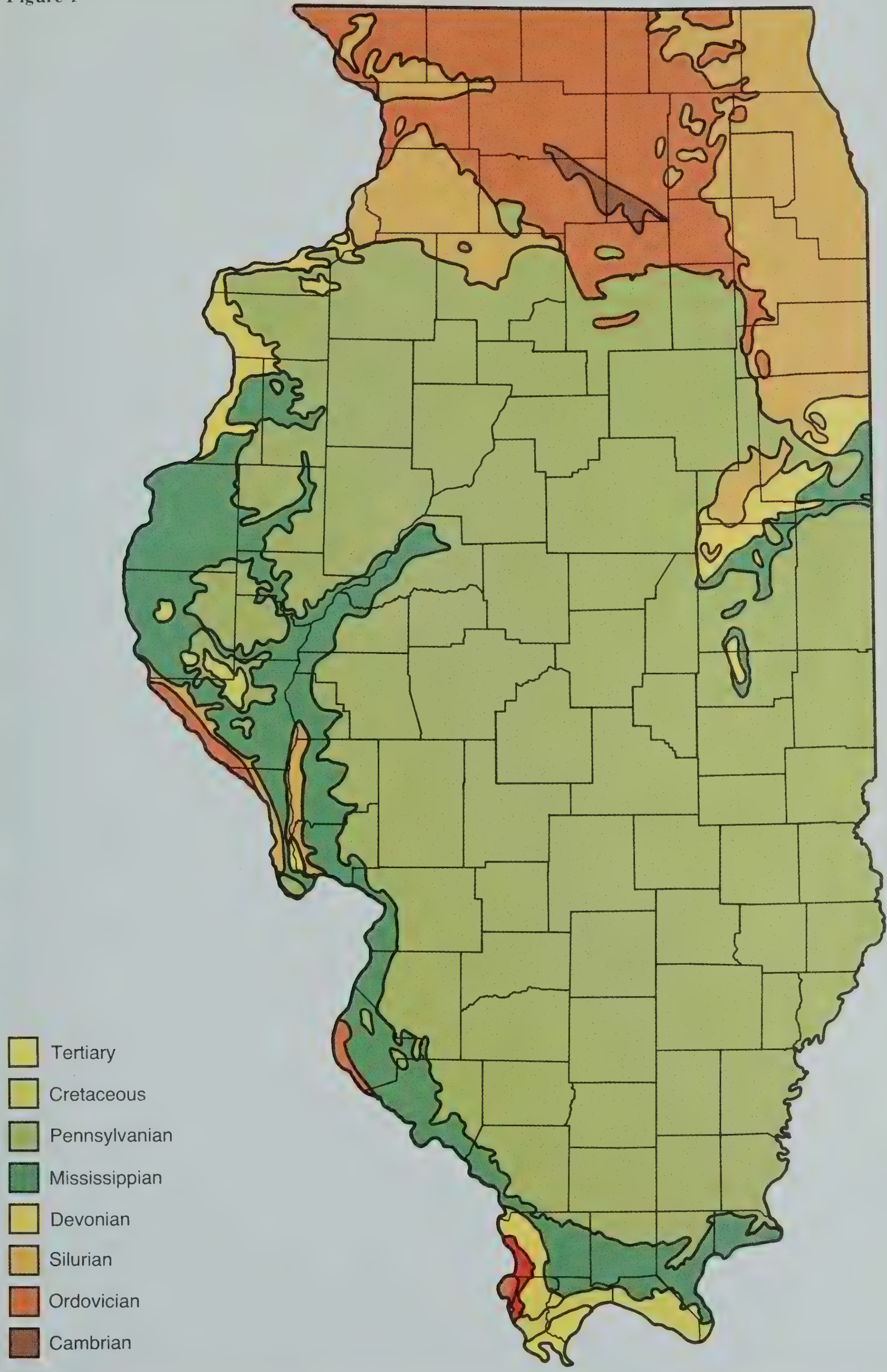
The youngest rocks in Illinois (older than the glacial drift) are the Tertiary and Cretaceous sands, gravels, and clays, mostly unconsolidated. They occur at the surface only in extreme southern Illinois and in a restricted portion of west-central Illinois.

The next (much) older rocks are Pennsylvanian in age, named for the state of Pennsylvania, where they are well exposed and were first studied. The Pennsylvanian System contains many different kinds of rocks, including the minable coals in Illinois. It also contains important deposits of limestone, shale, clay, and in places oil and gas. In Illinois, the thickness of Pennsylvanian rocks ranges from a few feet to 3,000 feet. Strata of this system make up the bedrock for about two-thirds of the area of Illinois and underlie all or parts of 86 of the 102 counties.

Below the Pennsylvanian are rocks of the Mississippian System, named for their excellent exposures along the Mississippi River Valley in western Illinois, southern Iowa, and eastern Missouri. Lower and middle Mississippian rocks are largely limestone in the western portion of the system. In

▶ **Figure 1.** Bedrock geology of Illinois. Source: Modified from Willman et al. 1967; Treworgy 1983.

Figure 1



Tertiary
Cretaceous
Pennsylvanian
Mississippian
Devonian
Silurian
Ordovician
Cambrian

the central and eastern part of the State, however, they are buried under Pennsylvanian rocks and contain much siltstone and cherty limestone. Upper Mississippian rocks–primarily the southern portion of the system–consist of a succession of sandstone, shale, and limestone formations. Mississippian rocks are a source of limestone, fluorspar, and zinc; they are of greatest economic significance in southeastern Illinois, where they are the most important oil-producing rocks.

The Devonian, Silurian, Ordovician, and Cambrian rocks, in the order named, are successively older than the Mississippian strata and consist mostly of dolomite, limestone, shale, and sandstone. Except for small areas along the Mississippi and Illinois river valleys, these older rocks are found at the surface only in the northern third of the State and locally in several counties of Illinois. They are nevertheless economically important because they yield limestone, dolomite, silica sand, oil, zinc, and tripoli. Minerals found in these and in younger rock systems are listed in Table 1. Ground water, our most essential mineral resource, is produced from all bedrock systems as well as from Pleistocene-age glacial deposits.

The rocks of the Cambrian through the Pennsylvanian systems overlie crystalline rocks, such as granites, that extend to unknown depths in the earth's crust. These rocks are not exposed in Illinois but are encountered when deep wells are drilled. Crystalline rocks, however, may be seen at the surface in the Missouri Ozarks and in central Wisconsin.

A vertical view of the bedrock in Illinois offers a perspective that differs markedly from the horizontal presentation in Figure 1. Three cross sections along with their locations in the State are shown in Figure 2. The effects of faulting can be seen as well as the outline of the spoon-shaped Illinois Basin in the north-south cross section. *188, 189, 220, 242, 273, 397, 447, 448, 450*

Richard C. Berg, Illinois State Geological Survey

Table 1. Source rocks of the mineral resources of Illinois.

Pleistocene	Gravel, common sand, peat, molding sand, clay products
Tertiary	Fuller's earth, gravel
Cretaceous	Gravel
Pennsylvanian	Coal, crude oil, gas, clay and shale products, stone, building stone, portland cement
Mississippian	Crude oil, gas, stone, clay and shale products, building stone, fluorspar, zinc, lead, lime, whiting, rock wool*
Devonian	Crude oil, gas, stone, tripoli, ganister*, novaculite gravel*
Silurian	Crude oil, gas, stone, building stone, lime, deadburned dolomite, rock wool*
Ordovician	Crude oil, gas, stone, silica sand, portland cement, building stone, zinc, lead, natural cement*
Cambrian	Stone

*Not produced at present.

Source: Willman et al. 1975

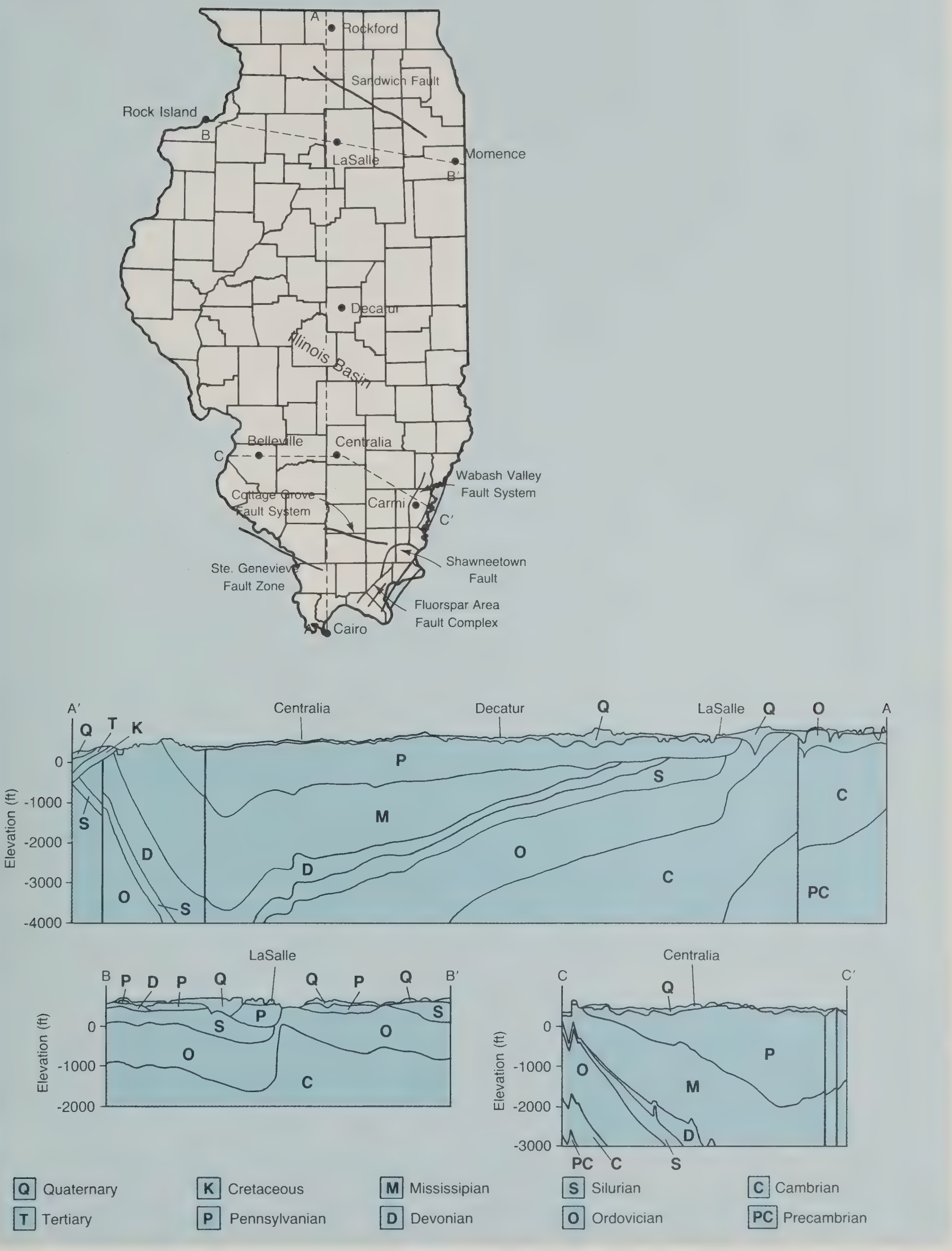
Topography

The borders of Illinois for the most part are defined by the irregular configuration of water bodies. The entire western border follows the Mississippi River, the southern and much of the eastern borders are formed by the Ohio and Wabash rivers, and the northeastern boundary is demarcated by the shoreline of Lake Michigan. Illinois has a total land area of approximately 55,645 square miles. The north-south dimension of the State is about 385 miles and the maximum east-west dimension is approximately 220 miles.

Situated near the confluence of major lines of drainage, Illinois has the lowest overall elevation of the north-central states. Its average elevation

▶
Figure 2. Cross sections of the bedrock of Illinois: A-A′ north-south cross section, Rockford to Cairo; B-B′ east-west cross section, Rock Island to Momence; C-C′ east-west cross section Belleville to Carmi. Source: Modified from Willman et al. 1975.

Figure 2


A
Rockford
Sandwich Fault
Rock Island
B
LaSalle
Momence
B′
Decatur
Illinois Basin
Belleville
Centralia
C
Wabash Valley
Fault System
Cottage Grove
Fault System
Carmi
C′
Shawneetown
Fault
Ste. Genevieve
Fault Zone
Fluorspar Area
Fault Complex
A′
Cairo
A′
Centralia
Decatur
Q
LaSalle
Q
O
A
Q
T
K
0
-1000
-2000
-3000
-4000
Elevation (ft)
S
P
S
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D
O
D
O
S
C
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LaSalle
B
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Q
B′
0
-1000
-2000
Elevation (ft)
S
P
S
O
O
C
Centralia
C
C′
Q
0
-1000
-2000
-3000
Elevation (ft)
O
M
P
D
PC
C
S
Q Quaternary
T Tertiary
K Cretaceous
P Pennsylvanian
M Mississipian
D Devonian
S Silurian
O Ordovician
C Cambrian
PC Precambrian

of 600 feet above sea level compares to 1,050 for Wisconsin, 1,100 for Iowa, 800 for Missouri, and 700 for Indiana. Local relief is less than 200 feet over most of the State. Charles Mound, located in Jo Daviess County in extreme northwestern Illinois, is the highest point in the State, 1,241 feet above sea level. The lowest elevation, 268 feet above sea level, occurs at the confluence of the Mississippi and Ohio rivers in extreme southern Illinois.

Four of the major physiographic divisions of the United States are represented in Illinois (Fig. 3). Over 90 percent of the State lies within the Central Lowland Province, and all of this portion of the State is glaciated except for a small corner in the extreme northwest. Three physiographic provinces make up the remaining tenth of the State–Ozark Plateaus, Coastal Plain, and Interior Low Plateaus. Almost all of this area lies outside the glacial boundaries.

The physiographic provinces, in turn, are subdivided into sections, seven of which are represented in Illinois. Although most of the State belongs to the Till Plains Section, the northeast corner falls within the Great Lake Section and the northwest corner within the Wisconsin Driftless Section. The far western portion of Illinois lies in the Dissected Till Plains, the Lincoln Hills, and the Salem Plateau sections. The far south belongs to the Shawnee Hills Section.

Before the glaciers advanced over the State, the landscape of central Illinois consisted of an extensive lowland eroded from the soft Pennsylvanian rocks of the Illinois Basin; deep valleys, however, were incised into the bedrock surface. To the north, south, and west, uplands had developed on the more resistant dolomitic and limestone formations of the Paleozoic Era. Although the glaciers brought major changes to the landscape, their effects were modified by the preglacial landscape. The widespread lowland of central Illinois permitted thick accumulations of glacial deposits (filling in deep

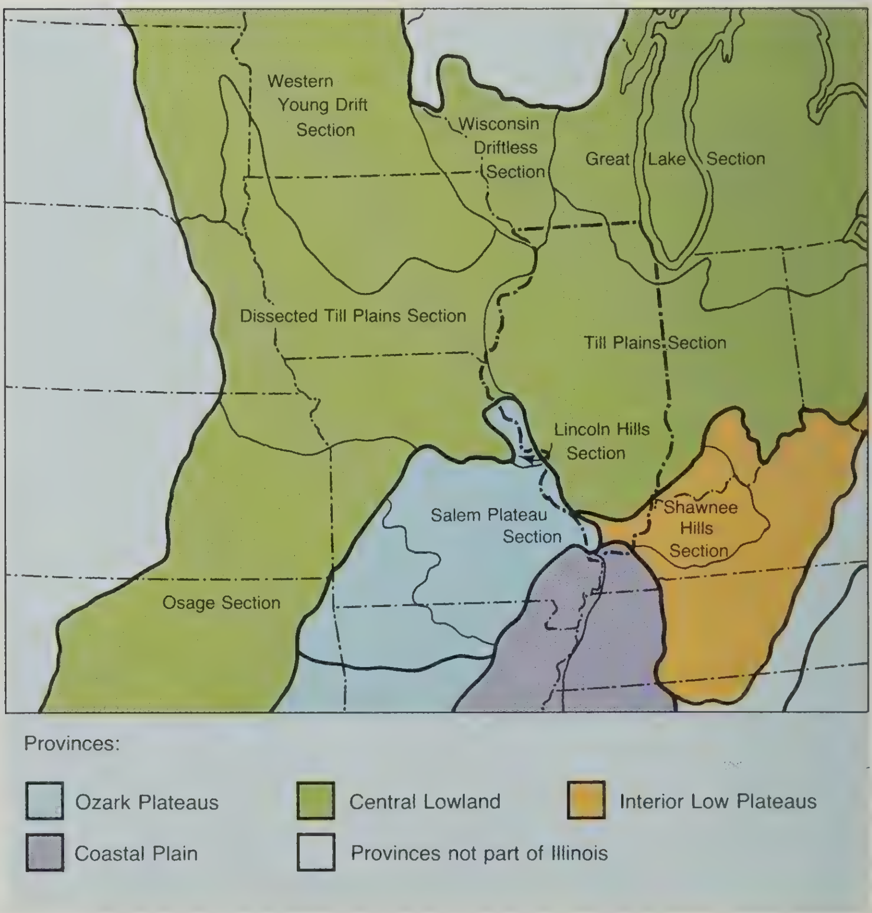


Figure 3. Physiographic provinces and sections of Illinois. Source: Leighton et al. 1948.

bedrock valleys) and the subsequent development of the prairie plains. The higher uplands to the northwest and south, however, restricted glacial movement, resulting in a physiography that contrasts sharply with that of the broad central lowland. Despite the moderating influence of the preglacial landscape, the Pleistocene glacial advances, which began over one million years ago and ended about 14,000 years ago, brought radical change. The combined effects of numerous glacial advances and retreats (Fig. 4) were to plane off prominent relief features and to deposit over most of the State a thick blanket of unconsolidated materials–glacial till (pebbly clay), outwash sands and gravels, lake-bed silts and sands, and windblown silt (loess). The glacial advances over Illinois also radically realigned drainage patterns.

Although the effect of the glaciers is most apparent in the topographic contrasts between glaciated and nonglaciated areas, more subtle differences are reflected in more detailed physiographic divisions within the Till Plains Section of Illinois (Fig. 5). The Mount Vernon Hill Country and the Rock River Hill Country, for example, had fewer glacial advances and perhaps

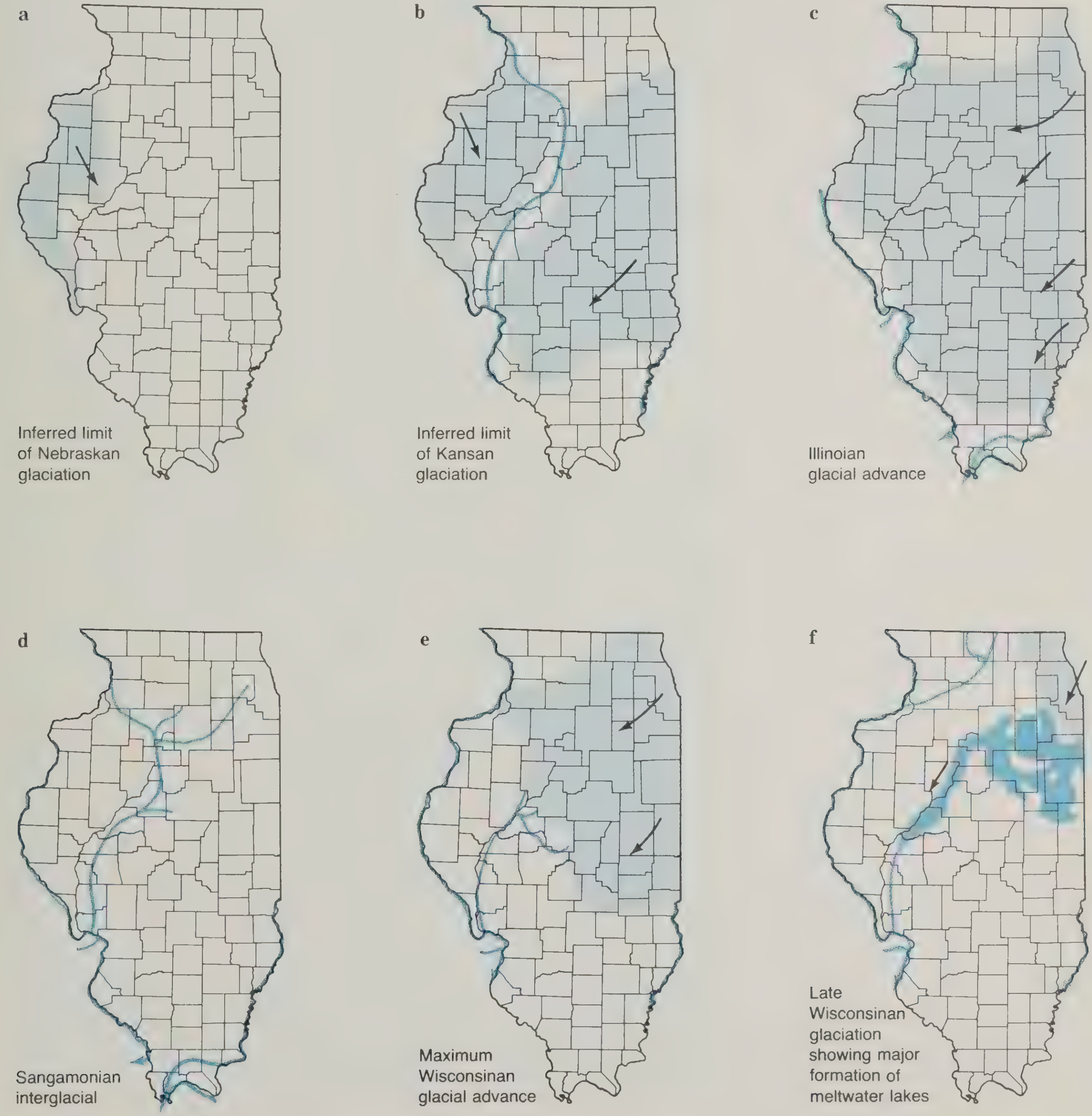


Figure 4. Extent of main glacial advances, beginning with the Nebraskan (the oldest) and ending with the late Wisconsinan. Major stream development between the Illinoian and the Wisconsinan glaciers is also shown (map d). Heavy lines indicate major stream valleys present at particular times. Source: Illinois State Geological Survey 1965.

were subject to more episodes of erosion than the Bloomington Ridged Plain, which was buried beneath numerous drift-sheets. When the Wheaton Morainal Country was formed, the ice was confined to the deep Lake Michigan Basin; as a result, moraines there are closely huddled together. When the Bloomington Ridged Plain was formed, however, the glacier was more extensive and during its receding and advancing stages formed more widely spaced moraines. The Chicago Lake Plain, on the other hand, is characterized by a flat surface (the former bed of an ancient Lake Michigan) broken by low beach ridges, headlands, spits, bars, and islands.

Seven of these physiographic subdivisions or districts fall within the Till Plains Section, which covers about 80 percent of the State. Broad, relatively uneroded till plains characterize this section, a marked contrast to the older, eroded Dissected Till Plains to the west. The Kankakee Plain is level to gently undulating and the glacial drift varies in thickness, sometimes barely concealing the bedrock surface. The Bloomington Ridged Plain,

Figure 5. Physiographic provinces, sections, and districts of Illinois. Source: Leighton et al. 1948.

perhaps more than any other district in this section, typifies the grass-covered stretches of rolling prairie and the far-reaching swamps described by early settlers and later extensively developed for farming. Glacial deposits are thick and conceal the bedrock virtually throughout the district. The present-day level topography of the Bloomington Ridged Plain is due primarily to successive drift-sheets that filled in and concealed the irregularities of the bedrock. Drift from Illinoian glaciation is found beneath the Wisconsinan drift (Figs. 4c and 4e) in the Bloomington Ridged Plain. Illinoian drift is at the surface throughout most of western and southern Illinois. The period between the deposition of the Wisconsinan and Illinoian drifts is called the Sangamonian Interglacial (Fig. 4d). The Green River Lowland is a relatively poorly drained plain. The present lowland was occupied by the Mississippi River up to the time of the Wisconsinan glaciation (Figs. 4d and 4e). In the Galesburg Plain, the Illinoian drift (Fig. 4c) is generally thick and underlain by pre-Illinoian deposits (Figs. 4a and 4b), classically referred to as Nebraskan and Kansan. As a result, the irregularities of the preglacial surface are hidden so that, in contrast to the Rock River Hill Country, only the largest features of the bedrock topography are discernible in the present landscape. The western boundary of the Springfield Plain follows the edge of the Illinoian drift (Fig. 4c), and the greater part of the district is characterized by flatness. Its valleys are relatively shallow and the streams have low gradients, especially in contrast to the steeper, walled valleys of the Galesburg Plain.

The relatively flat topography of Illinois and glacial deposits rich in nutrients have contributed to the rich soil and high agricultural productivity of the State. The present soils are fertile partly because they are high in nitrogen, phosphorous, and potassium–all elements that occur naturally in glacial materials. These soils stretching out over miles of level terrain have made Illinois the nation's leading producer of soybeans and the second-largest producer of corn. Almost 81 percent of the State is farmland.

In general, the more rugged the topography of an area, the greater the diversity of habitats, and so the topography of Illinois has influenced its biota by limiting the diversity of habitats. In the glaciated regions that cover so much of the State, forests were restricted mainly to moraines and to sloping hillsides adjacent to streams. Prairies occupied most of the level uplands and some of the broad floodplains. Parts of Illinois once had abundant aquatic habitats, but ditching and draining for agricultural purposes have reduced or eliminated many of these. *30, 221, 222, 273, 320, 418, 448*

Richard C. Berg, Illinois State Geological Survey

Soils

Practically no soils on earth are more suited to food production than those of Illinois cropland. The 1982 National Resources Inventory (U.S. Department of Agriculture, Soil Conservation Service 1984b) reported that 24.73 million of the 35.66 million acres of land in the State were in cropland, 3.16 in pastureland, 3.43 in forestland, 0.87 in rural transportation, 0.76 in other rural uses, and 1.85 in urban and built-up land. Clearly, Illinois utilizes an incredibly high proportion of its land for agricultural purposes, especially since it has an average density of over 200 persons per square mile and is the fifth most populated state in the nation.

The best land for farming is referred to as prime farmland. To receive that designation, soils must meet such criteria as high available water capacity, depth of soil in excess of 40 inches, moderate permeability, minimal rock fragments at the surface, reasonably deep water table (with drainage), and slope less than 7 percent (U.S. Department of Agriculture, Soil Conservation Service 1983a). Nearly 22 million acres of land in the State qualify as prime farmland. An additional 6 million acres are considered farmland of statewide importance, although they do not meet all of the prime-land criteria (U.S. Department of Agriculture, Soil Conservation Service 1984a).

▶ **Figure 6.** Major soil regions of Illinois based on parent materials. Source: University of Illinois at Urbana-Champaign, College of Agriculture, Agricultural Experiment Station 1982.

Key

1 Thick loess (>60 inches)

2 Moderately thick to thin loess (10-60 inches) on Illinoian drift with or without paleosols

3 Moderately thick to thin loess (20-60 inches) on Aeolian or Wisconsinan materials (loamy sands or sands)

4 Moderately thick loess (40-60 inches) on Wisconsinan till or lacustrine sediments (medium- to fine-textured)

5 Moderately thick to thin loess or silty material (24-60 inches) on medium-textured Wisconsinan outwash

6 Thin loess (10-40 inches) on Wisconsinan till (loam or sandy loam)

7 Thin loess (<20 inches) on Wisconsinan till or lacustrine sediments (silty clay loam)

8 Thin loess (<20 inches) on Wisconsinan till or lacustrine sediments (silty clay or clay)

9 Loamy, silty, and clayey Wisconsinan lacustrine sediments

10 Thin loamy or silty materials on gravelly Wisconsinan outwash

11 Thin silty or loamy materials on sandy and loamy Wisconsinan outwash

12 Thick, sandy Wisconsinan outwash and Aeolian materials

13 Thin to thick loess or loamy materials with or without residuum on limestone

14 Thin to thick loess or loamy materials with or without residuum on interbedded sandstone, siltstone, and shale

15 Sandy to clayey alluvial sediments on bottomlands

16 Deposits of organic materials (peats and mucks) are too small to be shown.

The soils of Illinois have been classified into over 600 soil series based on the parent materials from which a given soil developed, the slope on which it is found, its color and texture, and other factors. Series with similar characteristics, in turn, have been grouped into larger categories called soil associations. All of the soils in the State have been placed into 50 soil associations designated on the General Soils Map of Illinois (Fehrenbacher et al. 1984). This map is available from the College of Agriculture at the University of Illinois at Urbana-Champaign. A generalized version that identifies only the major soil regions of the State has been included here (Fig. 6).

The development of soil is chiefly determined by its parent materials, by climate, by plants and animals, by topographic relief, and by time. For much of Illinois, these factors have favored the development of highly productive agricultural soils.

Parent materials for the soil in most of the State are windblown silt (loess) at various thicknesses over glacial till. The loess was deposited primarily during periods of glacial retreat. Tremendous floods of meltwater poured down major river valleys and deposited massive amounts of sediment on the floodplain. During periods of low flow, winds picked up this sediment and deposited it on the uplands. Some areas of the State have as much as 50 feet of loess on the surface. Loess soils, which account for about 63 percent of the State's land area, are typically friable, medium-textured silt loams with high available water-holding capacity. Generally well supplied with plant nutrients (except nitrogen), they make excellent soils for agricultural purposes (Fehrenbacher et al. 1984). Other important parent materials of Illinois soil include glacial till (glacial drift deposits, 12 percent of the State), outwash (glacial meltwater deposits, 8 percent of the State), and alluvium (recent stream deposits, 12 percent of the State). Although these parent materials vary in quality, many soils developed from them are agriculturally highly productive. Figure 6 shows 16 major soil regions of Illinois by parent materials.

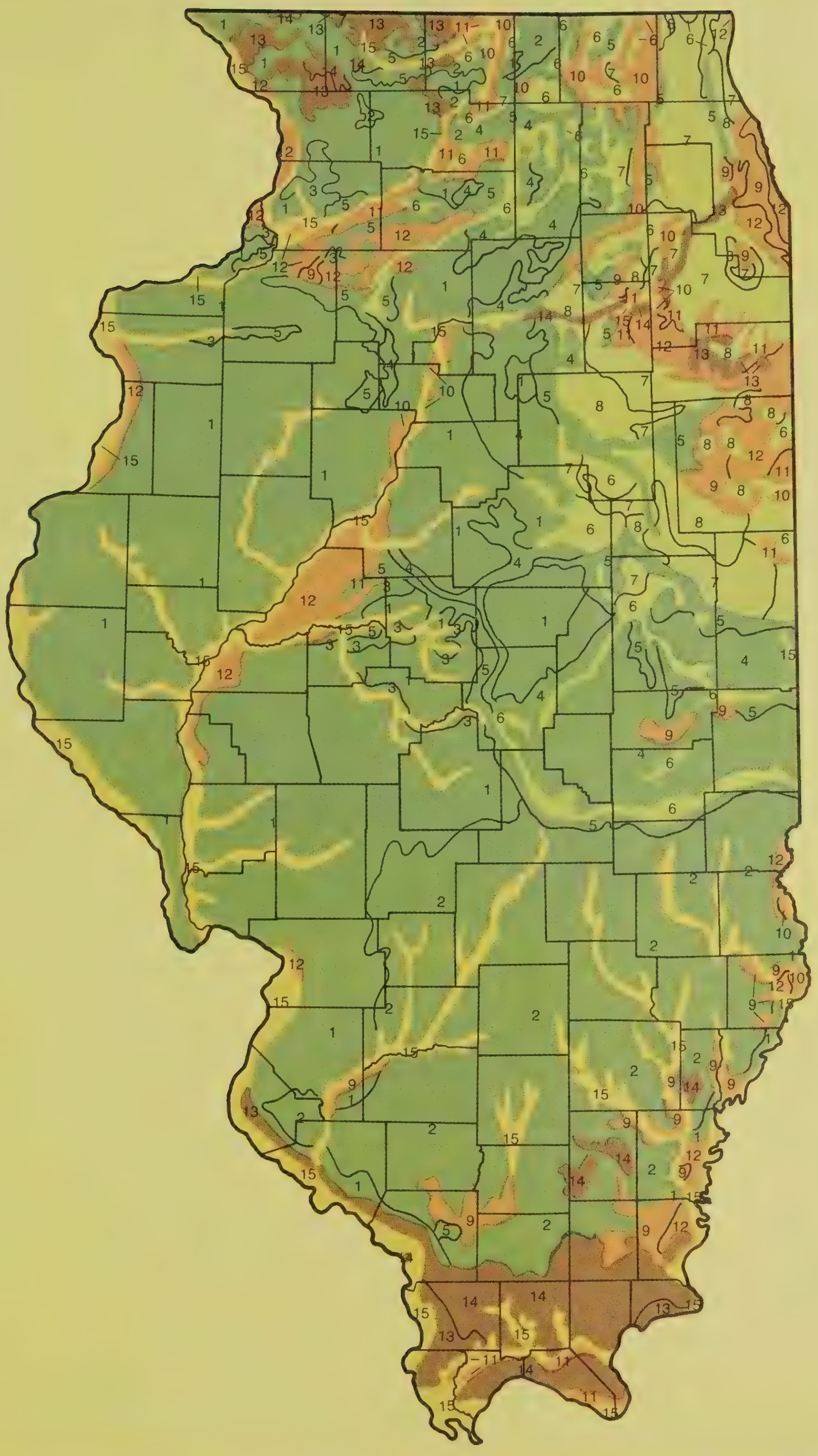
Climate is important in the development of soil because it determines the type and rate of weathering and influences the nature of vegetation. The humid, temperate climate of Illinois is conducive to the breakdown of soil minerals, the formation of clay, and the movement of these materials downward in the soil profile.

Plants and animals also contribute to the development of soil. The native vegetation under which soils form helps to determine soil color and the percentage of organic matter. Compared to forest vegetation, prairie grasses have extensive fibrous root systems. Illinois soil that developed under prairie, therefore, generally had a high accumulation of the organic materials so valuable for agriculture because of their capacity to store water and nutrients. Microbial organisms are also involved in soil development because they break down organic materials and make them available to plants. Leaf decay is an example of microbial action. Burrowing animals like earthworms and gophers churn the soil, moving surface organic materials deeper into the soil.

Topographic relief helps to determine the moisture of a soil under a given climatic regime because it influences the amount of water infiltration versus runoff as well as the angle of incidence of solar irradiation (south-facing slopes, for example, are drier than north-facing slopes). Many soils in Illinois are naturally poorly drained soils that developed under nearly level, wet prairie vegetation. With artificial drainage, however, these soils have become highly productive.

The length of time under which soil has developed is also important. In Illinois most of the soils except those in southern Illinois developed on materials deposited as a result of Wisconsinan glaciation, which receded from Illinois about 12,000 years ago. The relatively youthful nature of these

Figure 6



soils is responsible for their high fertility, since leaching and weathering have not yet removed their nutrients and clay minerals to lower soil zones. In southern Illinois, where no glaciers reached or where glaciation occurred much earlier (about 60,000 years ago), extensive weathering has reduced the fertility of the soil.

Two major problems are associated with the great soil resource of Illinois: the rapid conversion of prime agricultural land to nonfarm use and the erosion of soils at unacceptable rates.

Each year from 1942-1977, approximately 100,000 acres of Illinois farmland were converted to nonfarm uses (U.S. Department of Agriculture, Soil Conservation Service 1984b). Most of this conversion–10 percent of the State's total land area–occurred on prime farmlands, since many characteristics of prime farmland are also highly desirable for construction purposes. With the loss of prime farmland, agriculture often moves to less productive land, some of which is more erosive or wetter or has a lower moisture-supplying capacity. The net result is a reduction in production capability and an increase in management problems associated with farming less suitable land. In response, the Illinois Department of Agriculture and the U.S. Soil Conservation Service established the Land Evaluation and Site Assessment (LESA), a system designed to curtail the fragmentation of prime agricultural lands. Areas proposed for conversion are evaluated and rated for a stated agricultural use, after which an assessment is made of factors other than soils, such as distance from urban areas, adjacent land use, and percentage of the area in agriculture (U.S. Department of Agriculture, Soil Conservation Services 1983b). Though not yet adopted by all county governments, LESA has proven useful in evaluating alternative siting proposals. In addition, the Farmland Preservation Act of 1983 created the Interagency Committee on Farmland Protection to ensure that state agencies consider farmland preservation during the development of projects.

Soil erosion is the other serious problem facing those who would conserve the Illinois soil resource. The 1982 National Resources Inventory (U.S. Department of Agriculture, Soil Conservation Service 1984b) estimated that over 200 million tons of Illinois soil–6.3 tons per acre–were lost annually due to sheet and rill erosion on nonfederal rural land in the years preceding 1982. This loss, the third highest per acre average in the nation, is exceeded only by soil losses in Iowa and Kentucky. Law and Nolan (1981) dramatized the enormity of this loss by observing that for every bushel of corn produced in Illinois, 1.5 bushels of soil are lost. In addition to its deleterious effects on agriculture, soil erosion also causes problems related to water quality, to biological diversity, to flood control, and to recreational uses of Illinois streams and reservoirs.

Soil erosion is particularly serious in Illinois for several reasons: (1) the loess materials blanketing a large portion of the State are severely erodable by water even on the gently sloping lands that cover so much of the State (Illinois Environmental Protection Agency 1979); (2) under conventional tillage practices, corn and soybeans, the primary crops grown in the State, leave little residue on the surface for much of the year; and (3) rainfall in Illinois is fairly high in the spring when little vegetative cover exists on cropland. According to the National Resources Inventory (U.S. Department of Agriculture, Soil Conservation Service 1984b), over 11.6 million acres of the State are in need of conservation treatment. These lands are losing soil faster than they can be rejuvenated and long-term productivity is in jeopardy.

Management practices that leave residue on the surface or slow the flow of water down slopes help to reduce erosion. These include no-till planting, strip rotary tillage, till planting, chiseling, disking, contour farming, contour strip cropping, and the creation of terraces and grass waterways. Such practices benefit not only the landowner/tenant by increased net returns but all of society by reducing sedimentation and pollution problems and by maintaining the long-term productive potential of the land. *31, 40, 41, 108, 122, 123, 133, 135, 160, 211, 212, 229, 251, 265, 287, 292, 323, 404, 405, 406, 407, 408, 417, 429, 430, 431*

Louis R. Iverson, Illinois Natural History Survey

Lakes and Streams

Illinois is surrounded by fresh-water resources: the Mississippi on the west, the Ohio and Wabash to the south and east, and Lake Michigan to the northeast. In addition, a number of large rivers flow through the State–the Illinois, Fox, Rock, Kankakee, Sangamon, Spoon, Kaskaskia, Big Muddy, Embarras, Little Wabash, and others. Numerous lakes and ponds complete the surface-water network of the State (Fig. 7).

The river borders of Illinois total 880 miles; 570 of them are accounted for by the Mississippi, 180 by the Wabash, and 130 by the Ohio. A total of 900 interior rivers and streams run for approximately 13,200 miles; however, the average width of 10,800 of those stream miles is less than 100 feet. The drainage areas of the interior rivers and streams vary from less than a few square miles to nearly 11,000 square miles for the Rock River near its mouth and almost 29,000 square miles for the Illinois River near its mouth. The estimated surface area of these rivers and streams is 256,500 acres. In addition, approximately 50,000 acres of wetlands and marshes are found in Illinois.

The Illinois shoreline of Lake Michigan extends for 63 miles, and about 7 percent of the lake (976,640 acres of water surface) lies within the jurisdiction of the State. An average of 3,200 cubic feet of water per second are diverted from Lake Michigan either for public water supplies within the metropolitan area of Chicago or for sewage dilution through the Illinois Waterway.

Of the approximately 84,300 inland lakes and ponds covering about 302,500 acres, 2,915 have surface areas of 6 or more acres and are therefore classified as lakes. Although only about 3.5 percent of the total number of standing bodies of water are lakes, those lakes account for 78 percent of the total surface acreage of standing bodies of water.

Although Illinois is endowed with sufficient surface water to meet its domestic and industrial needs, the natural distribution of this water within the State is uneven and has been altered through the construction of dams, which have created numerous artificial bodies of water. Indeed, 75 percent of the lakes (95 percent of the bodies of standing water) have been artificially created. Carlyle Lake, the largest artificial lake in Illinois, has a surface area of 26,000 acres at normal pool level. Most of the naturally occurring lakes in Illinois are backwaters along major rivers. Only 2 percent are natural glacial lakes, and these are found in the extreme northeastern part of the State.

The inland lakes of Illinois serve a variety of purposes. Nearly all of them are used for recreation. One hundred and ten of them also function as primary or reserve public water supplies. These are particularly important in the southern and western sections of the State where ground water resources are limited. The lakes of Illinois are also used as industrial and agricultural water supplies, as cooling lakes, and for flood control. The major hydroelectric project in the State is located near Hamilton at Pool 19 of the Mississippi River. Among the important cooling lakes are Clinton in DeWitt County, Sangchris in Christian County, Kinkaid in Jackson County, Lake Springfield in Sangamon County, and Lake of Egypt in Williamson and Johnson counties. Finally, because lakes trap and collect materials generated within their drainage boundaries, they also serve as an important monitoring tool in evaluating the effectiveness of various control measures taken to reduce pollution within their watersheds.

Figure 7


Fox Chain of Lakes
LAKE MICHIGAN
Rock River
Fox River
Des Plaines River
Kankakee River
Vermilion River
Spoon River
ILLINOIS RIVER
MISSISSIPPI RIVER
Mackinaw River
Clinton Lake
Sangamon River
Lake Decatur
Lake Springfield
Sangchris Lake
Lake Shelbyville
Lake Lou Yeager
Embarras River
Little Wabash River
Wabash River
Lake Carlyle
Kaskaskia River
Rend Lake
Big Muddy River
Kinkaid Lake
Crab Orchard Lake
Lake of Egypt
Ohio River

The surface waters of Illinois comprise a diverse and vital resource essential to the economic health and growth of the State. They provide valuable habitat for plants and animals and water for human consumption. They are used for recreational and industrial purposes and for the generation of hydroelectric power. They also play an important role in the commercial traffic of the Midwest. Since the opening of the St. Lawrence Seaway in 1959, Chicago has become a world export center. In 1982, approximately 26 million tons were handled by the port of Chicago. All of the Illinois River is navigable, and its eight locks and dams maintain a nine-foot navigation channel. About 60 percent of the commercial traffic on the Mississippi River is contributed by the Illinois River. Navigation locks and dams have also been constructed on the bordering stretches of the Mississippi and the Ohio and on the Kaskaskia; these provide an extremely important link in the commercial water network of Illinois and the Midwest. *96, 97, 98, 124, 174, 213, 224, 354, 355, 379, 418*

Nani G. Bhowmik, Illinois State Water Survey

Forests

The wide range of latitude between the northern and southern boundaries of Illinois, nearly 400 miles, gave rise to climatic conditions that favored a wide variety of tree species. The eastern white pine found in northern Illinois is common to the northern coniferous zone; the bald cypress and shortleaf pine found in southern Illinois are typical of the southern and coastal plain forests of the United States. Two kinds of forest, however, predominate–upland forest, which accounts for 76 percent of the forest in Illinois, and bottomland forest. The upland forests are made up primarily of two of the more than 30 forest-cover types found in Illinois: the white oak/red oak/black oak type and the white oak/black oak/hickory type. The former is often referred to as the mixed hardwood upland type and, in addition to the species mentioned above, may contain bur oak, ash, maple, elm, hickory, and black walnut. The white oak/black oak/hickory type, which is common to the hills of southern Illinois, may include such species as scarlet oak, black gum, and chinquapin oak. On moist slopes, both types may include such additional species as sugar maple, beech, and tulip poplar.

At the time of European settlement, Illinois forests occupied 13.8 million acres and accounted for 39 percent of the land area of the State (Iverson and Perry 1985; Fig. 8). Those native forests provided a number of products needed to sustain the early settlers. In addition, forests helped to create an excellent fertile soil for food crops. As the population grew and as farms began to increase in size, the abundant supply of timber for shelter and fuel began to dwindle. This diminishing timber resource greatly concerned the settlers and prompted them to plant trees near their homes and to manage their forest lands more wisely. Stands of trees that returned naturally, along with those planted by the settlers in the 1880s, now represent much of the remaining Illinois forest land.

Illinois forests currently account for approximately 4 million acres, one-tenth the land area of the State (Fig. 8). Ninety percent of that land is privately owned, and nearly two-thirds is held in conjunction with farming operations. Each of the approximately 110,000 owners of forest land in Illinois holds an average of only 40 acres. As a result, forest management is difficult to implement on a statewide basis.

In spite of federal programs that share the costs of conservation with the owners of forest land, many owners continue to convert their forest land to other uses for economic reasons. In 1983, the Illinois Forestry Development Act provided for the establishment of a commission to evaluate the forest resources of the State. Proceeds from a 4 percent harvest fee deducted from the price paid for timber were allotted to the Department of Conservation to finance a program under which landowners receive up to 40 percent of the costs they incur by following acceptable forest manage-

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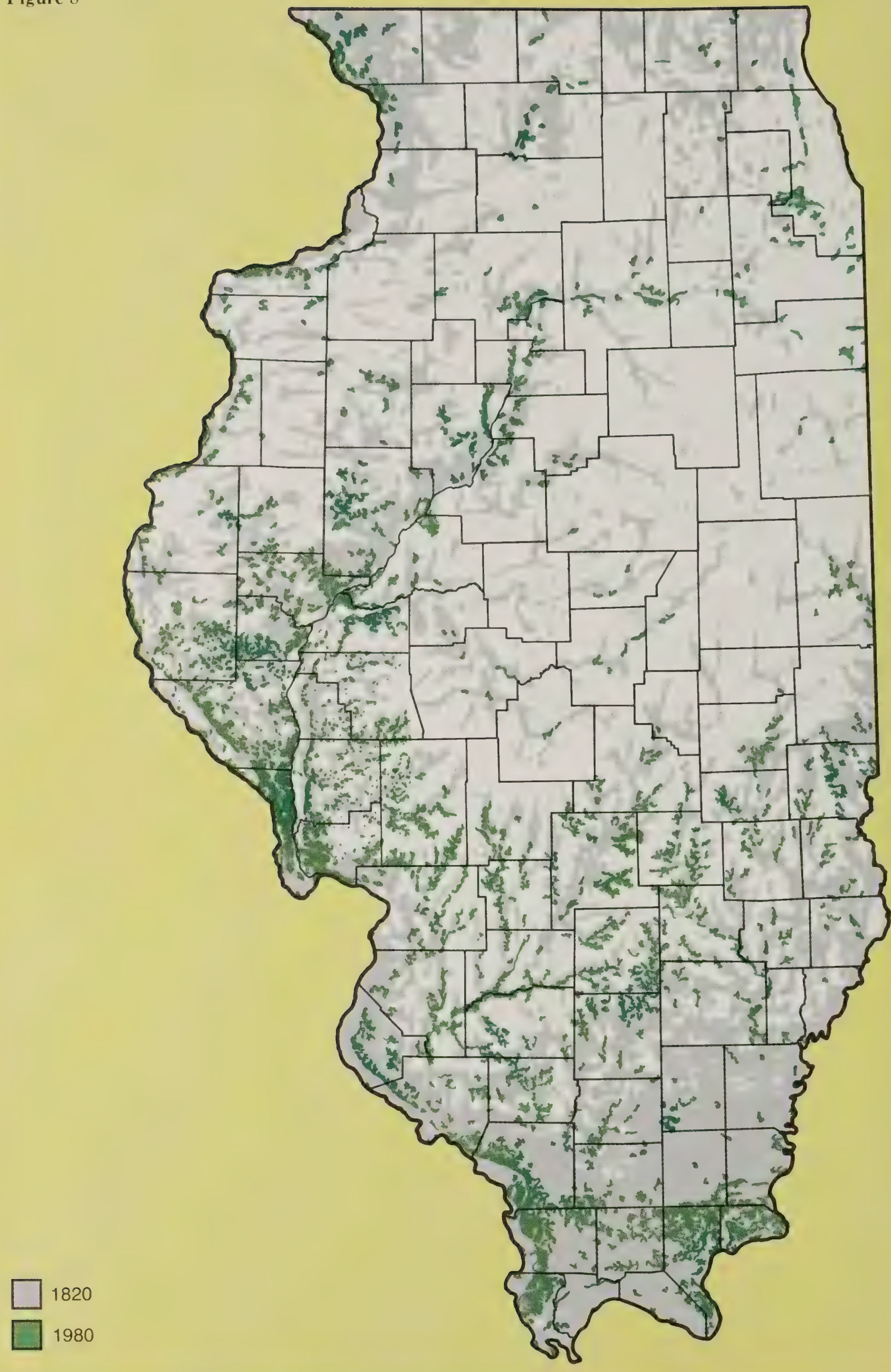
Figure 7. Rivers and lakes of Illinois. Source: U.S. Geological Survey, Topographic Quadrangle Series, 1:250,000.

Figure 8



ment practices, providing their management plans were approved by the Department of Conservation. In July 1986, the payment will increase to 60 percent and in July 1987 to 80 percent. In addition, an amendment in 1981 to the Illinois Farmland Assessment Act provided that farmland be taxed according to a productivity index. Permanent pasture, therefore, is assessed at a third of its productivity index, forest land at a sixth.

Although rehabilitation is possible for improperly managed forests, forest land converted to other uses is an even more serious problem. The clearing of forests for row crops has accelerated because of the incentive of an annual cash crop, and as communities expand, home and industrial construction further decreases forest acreage. Highway construction, although declining recently, also contributes to this loss.

The majority of forests in the State are growing at less than half of their potential due to poor management. Presently, most Illinois forests are either immature and overstocked or overmature and stagnant. Poor harvesting practices, unmanaged livestock grazing, and lack of protection have further decreased their productivity. According to the 1982 National Resources Inventory (U.S. Department of Agriculture, Soil Conservation Service 1984b), Illinois has 1.23 million acres of marginal lands that are eroding excessively. Marginal lands here include capability classes IVe, VI, VII (cropland), and VIII (pastureland). To reduce excessive erosion, much of this area should be planted in trees, shrubs, or other permanent vegetation.

For both private and public lands, the focus of forest resource management is use that is compatible with the perpetuation of forests for watershed protection and soil and water stabilization. Also important are the improvement of wildlife habitats, the protection of recreational and aesthetic areas, and the production of wood products. According to the latest edition of the *Census of Manufacturers*, 1,341 businesses in Illinois are involved in either primary (the processing of raw wood) or secondary (the manufacture of finished wood products) aspects of the wood products industry. In 1982 these businesses employed 55,000 people with an annual payroll of more than $965 million. In addition, these businesses annually bring about $2.2 billion into the economy of the State and invest an average of $145 million in capital improvements. *12, 59, 86, 99, 100, 112, 113, 130, 163, 176, 201, 204, 205, 207, 229, 243, 289, 334, 335, 381, 382, 388, 414, 416*

Dennis P. Tucker, Division of Forest Resources,
Illinois Department of Conservation

◀
Figure 8. Forest lands of Illinois, 1820 and 1980. Source: Anderson 1970; U.S. Geological Survey, digital land use and land cover maps (LUDA).

Environmental Divisions

An objective of the Illinois Nature Preserves System is to protect in perpetuity examples of all of the remaining natural features of the State. Among these are geological formations, soils, streams and lakes, and plant and animal communities–aquatic and terrestrial. To that end, the State has been divided into 14 natural divisions distinguished from each other geologically and by the distribution of flora and fauna. These divisions outline the distinctive natural communities and features of the State, allowing an accurate evaluation of the completeness of the nature preserve system. Such information helps to establish land-acquisition priorities by drawing attention to communities or restricted species that should be but are not represented in the nature preserve system.

Natural Divisions

The State of Illinois has 14 geographic or natural divisions that are distinguished from each other by bedrock, glacial history, topography, soils, and the distribution of plants and animals. These natural divisions in turn are divided into 33 sections based on differences similar to but of lesser significance than those used to delimit the divisions (Fig. 1). The 14 divisions are briefly characterized here; complete descriptions are found in part 2 of the *Comprehensive Plan for the Illinois Nature Preserves System*, a publication of the Illinois Nature Preserves Commission.

The Wisconsin Driftless Division is part of an area extending from northwestern Illinois into Wisconsin, Iowa, and Minnesota that apparently escaped glaciation. One of the most maturely developed land surfaces in Illinois, it is characterized by rugged terrain that originally was mostly forested. The division has the coldest climate in the State and is characterized by distinctive northern plants and some species that may represent relicts of preglacial flora.

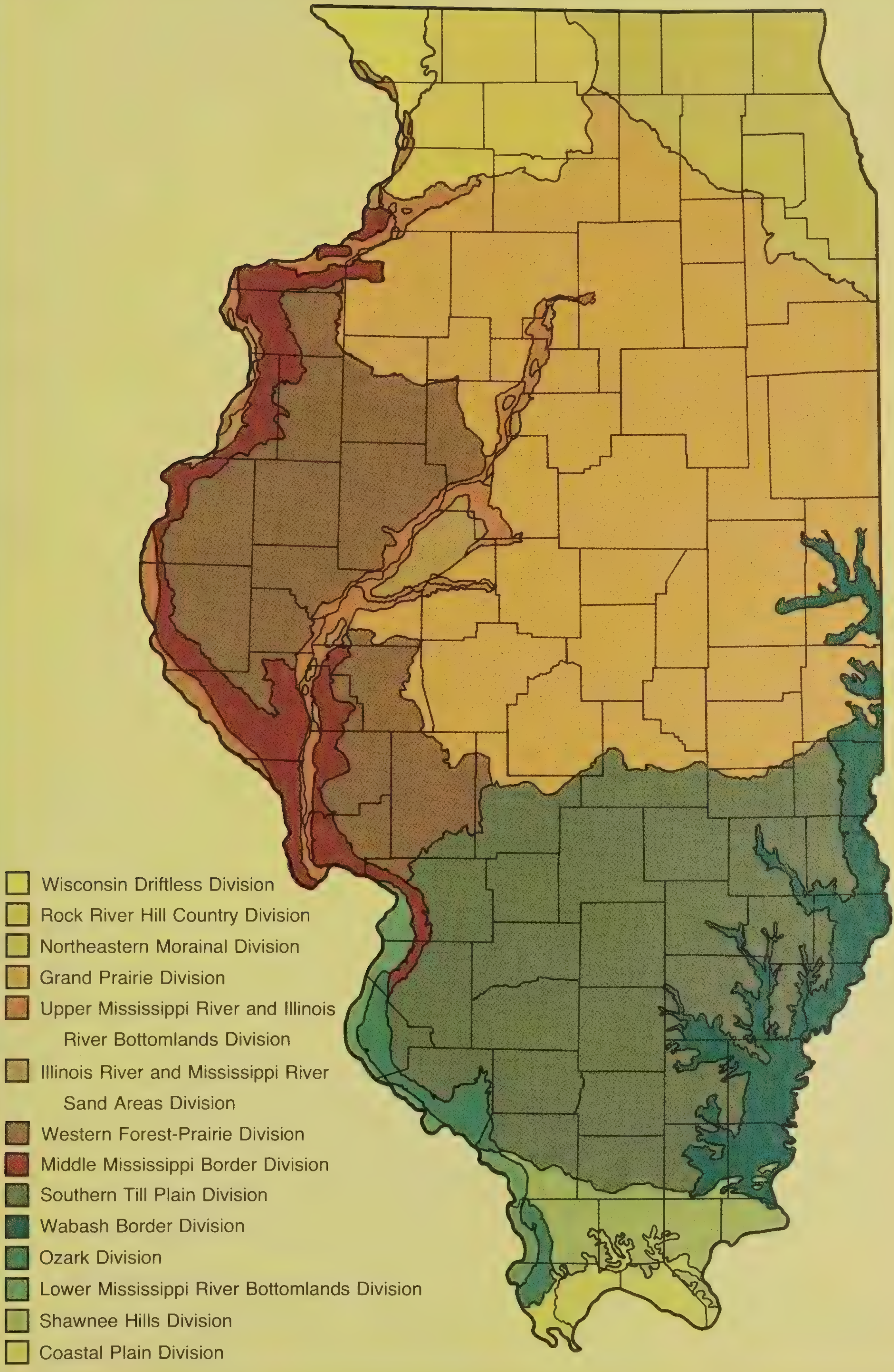
The Rock River Hill Country Division has a rolling topography drained by the Rock River. Prairie formerly occupied the larger expanses of its level uplands, but forest predominated along the water courses and the more dissected uplands. Such unique northern plants as ground pine and American wintergreen are found here.

The Northeastern Morainal Division experienced the most recent glaciation in Illinois. Glacial landforms are common and contribute to the rough topography of most of the area. Lake-bed deposits, beach sands, dunes, and bogs are common features. Unlike most of Illinois, the soils are derived from glacial drift rather than loess. Drainage is poorly developed, and many natural lakes are found. Among its distinctive floral elements are such members of the bog community as pitcher plant, winterberry, and dwarf birch. The occurrence in Illinois of several species of migrant waterbirds (the pomarine, long-tailed jaeger, and Bonaparte's gull) is limited almost entirely to Lake Michigan and its shores. Other animals restricted to this division are the pigmy shrew, the spotted turtle, and the blue-spotted salamander.

The Grand Prairie Division was formerly covered with hundreds of species of grasses and forbs that made up the tallgrass prairie. Interspersed were numerous marshes and prairie potholes. The fertile soils of this vast plain were developed from recently deposited loess, lake-bed sediments,

▶
Figure 1. Natural divisions of Illinois. Source: Schwegman 1973.

Figure 1



Wisconsin Driftless Division
Rock River Hill Country Division
Northeastern Morainal Division
Grand Prairie Division
Upper Mississippi River and Illinois River Bottomlands Division
Illinois River and Mississippi River Sand Areas Division
Western Forest-Prairie Division
Middle Mississippi Border Division
Southern Till Plain Division
Wabash Border Division
Ozark Division
Lower Mississippi River Bottomlands Division
Shawnee Hills Division
Coastal Plain Division

and outwash. Forest once bordered the rivers and occurred as groves in the prairies. The percentage of this large area occupied by prairie was greater than that of any other natural division.

The Upper Mississippi River and Illinois River Bottomlands Division encompasses the rivers, bottomlands, and associated backwater lakes of the upper Mississippi and the Illinois and its major tributaries. Originally much of this division was forested, but prairie and marsh also occurred. The more sluggish nature of the Illinois River and its distinctive backwater lakes distinguish the Illinois River Section from the Upper Mississippi River Section.

The Illinois River and Mississippi River Sand Areas Division contains sand areas and dunes in the bottomlands of the Illinois and Mississippi rivers and atop the bluffs near Hanover in Jo Daviess County. Scrub oak forest and dry sand prairie are the natural vegetation. The Illinois chorus frog is restricted to the Illinois River Section; the white-tailed jackrabbit is found in Illinois only in the northern part of the Mississippi River Section.

The Western Forest-Prairie Division is characterized by a strongly dissected glacial till plain of Illinoian and Kansan age. The predominate vegetation was forest with considerable prairie on the level uplands. The fertile prairie soils were developed from 4 to 5 feet of loess.

The Middle Mississippi Border Division contains a narrow band of river bluffs, limestone cliffs, and rugged terrain bordering the Mississippi River floodplain and the lower Illinois River floodplain. The Driftless Section was never glaciated and its topography is rougher than that of the Glaciated Section. The dark-sided salamander and the western worm snake are restricted in Illinois to this division, which also provides major roosting areas for wintering bald eagles.

The Southern Till Plain Division is an area of dissected Illinois glacial till plain. The soils are relatively poor because of their high clay content and poor drainage. Both forest and prairie were abundant at the time of settlement. Post oak flatwood forest is characteristic of the division as is the crayfish frog.

The Wabash Border Division includes the bottomlands of the Wabash and its major tributaries, the loess-covered uplands that border it, and the ravine forests of the Vermilion and Little Vermilion rivers and Crab Apple Creek. The lowland oak forests contain beech, tulip, and other species typical of forests to the east of Illinois. A number of fishes are limited in Illinois to this division, including the river chub, river redhorse, mountain madtom, and the bluebreast and greenside darters.

The Ozark Division consists of the Illinois part of the Salem Plateau of the Ozark uplift from Monroe County southward and includes the glaciated sandstone ravines in Randolph County. The division is mostly forested, but hill prairies occur in the Northern Section. Many Ozarkian, southern, and southwestern plants and animals that are rare or absent elsewhere in Illinois are found here. One of these animals is the plains scorpion. Caves and sinkholes are also distinctive features of this division.

The Lower Mississippi River Bottomlands Division includes the Mississippi River and its floodplain from Alton to Thebes Gorge. The Mississippi is muddy here because of the silt load brought in by the Missouri, and a distinctive assemblage of silt-tolerant plains fishes is present. The Northern Section of this division originally contained prairies, marshes, and forests. The Southern Section was densely forested. The spring-fed swamps of Union County provide a unique habitat for several species of fishes, including the bantam sunfish.

The Shawnee Hills Division extends across the southern tip of the State from Fountain Bluff on the Mississippi to the Shawneetown Hills near the mouth of the Wabash. Forested, unglaciated hill country characterized by a high east-west escarpment of sandstone cliffs form the Greater

Shawnee Hills; a series of lower hills underlain by limestone and sandstone form the Lesser Shawnee Hills. A number of distinctive plant species are restricted to this division, including such northern and preglacial relict plants as clubmosses, barren strawberry, and French's shooting star. The fluorspar deposits in Hardin County are world famous.

The Coastal Plain Division identifies a region of swampy forested bottomlands and low clay and gravel hills at the northernmost extension of the Gulf Coastal Plain Province of North America. Bald cypress-tupelo gum swamps and southern animals and plants are unique features. This division has the warmest climate in the State. *12, 43, 54, 92, 123, 136, 139, 189, 216, 233, 273, 293, 295, 303, 320, 334, 352, 360, 367, 370, 383, 424, 425, 427, 448, 450*

John E. Schwegman, Natural Heritage Division,
Illinois Department of Conservation

Natural Communities

Natural communities are groupings of plants and animals living together under similar environmental conditions. These communities are dependent on physical factors such as soil, slope, moisture, and climate; on biological factors such as the availability of plants and animals adapted to a site's conditions; and on cultural/natural forces such as grazing and fire.

The natural communities of Illinois are grouped under eight headings: forests, prairies, savannas, wetlands, lakes and ponds, streams, caves, and primary successional units. About two-fifths of Illinois originally was forest. About one-quarter of that forest remains, but only 13,500 acres have escaped serious disturbance from logging or grazing or have recovered from former uses of the land. Prairie once covered about 55 percent of Illinois (nearly 20 million acres), but only about 2,300 acres of these natural grasslands remain relatively undisturbed, mostly on sites unsuited for farming, in old cemeteries, or along railroad rights-of-way. The savanna is a natural transition between forest and prairie–a mixture of trees, shrubs, and prairie vegetation with its own set of plants and animals. Savannas formerly occurred in every county, but only 1,300 acres of high-quality savanna still exist. Cattail marshes, forested swamps, and peat bogs are characteristic wetlands. Common throughout Illinois in presettlement times, wetlands of high quality have been reduced to about 6,000 acres. These are lands that have proved uneconomical to drain or that have been maintained for hunting and fishing. River backwaters, deep glacial lakes, and prairie potholes form another natural community. Once characteristic of the landscape, they have for the most part been drained or seriously disturbed. Over 13,000 miles of streams make up yet another natural community. Approximately half of these streams have been dredged, dammed, or directly altered in some way, and they suffer from pollution, siltation, and the introduction of foreign fish. The 300 Illinois caves, a relatively small natural community, are found primarily along the southern and western borders of the State. Most are less than a few hundred feet long, but 30 are listed as natural areas of significance. Primary successional communities include cliffs, rocky glades, beaches, and other areas with little or no soil. They remain at an early stage of succession and often have rare plants and animals. The distributions of four high-quality natural communities in Illinois–prairies, savannas, forests, and wetlands–are shown in Figures 2 and 3.

Soil is an important determinant of natural communities. Most of the soils on uplands in Illinois are derived from wind-deposited silt called loess. This material was blown onto the uplands from sand and mud bars in the major river valleys when cold winter weather slowed glacier melting and lowered the water level. This annual cycle of wind deposition during the Ice Age built up considerable depths of loess, especially near rivers. This blanket of loess over vast areas masks the diversity of natural substrates and reduces the diversity of natural communities. Loess, however, is not a dominant community factor in recently glaciated northeastern Illinois, along major river valley bottoms, and on steep slopes where it has been eroded away.

The topography of Illinois has been greatly altered and shaped by the continental glaciers of the Ice Age. Most of the State is a plain of glacial deposits that tend to fill in old valleys and level off high knobs. Unglaciated areas in the southern, southwestern, and northwestern parts of the State are exceptions to this pattern as are bluff areas near major river valleys. Areas that were glaciated in the more distant past, such as those in western and southern Illinois, have better developed drainage patterns and ravine systems than do more recently glaciated east-central and northern Illinois. Rapid glacier advances and retreats at the close of the Ice Age created hilly terrain in the Chicago region in spite of its glaciated nature. Forest communities are generally associated with unglaciated areas and with the sloping lands of older glaciated areas; prairie communities predominated on the flatter land surfaces.

Figure 2

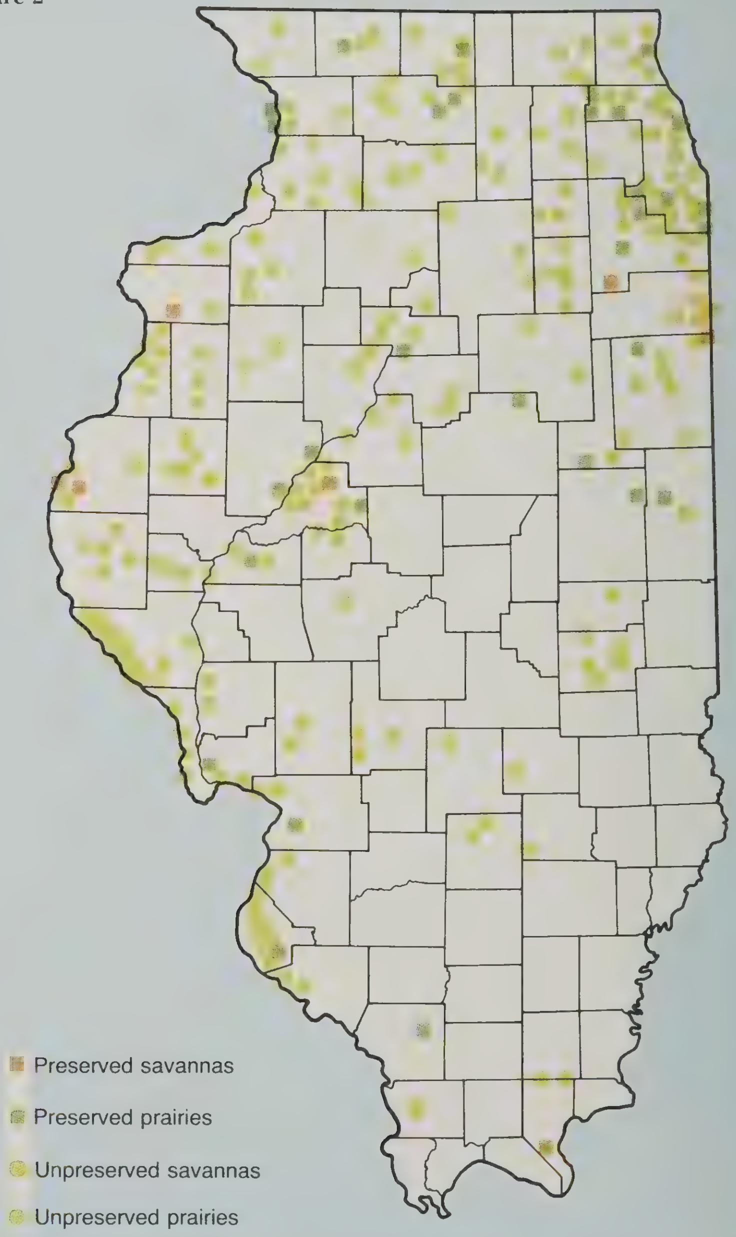


Figure 2. Distribution of preserved and unpreserved high-quality natural communities: prairies and savannas. Source: Illinois Department of Conservation, Illinois Nature Preserves Commission, and Illinois Endangered Species Protection Board 1980.

Past climatic changes also play a role in the present natural communities of Illinois. In the past 15,000 years, our climate has gone from boreal (northern, neartic) to moist temperate to dry temperate to our present medium-moist temperate. As a result, a variety of natural communities from boreal forest to moist deciduous forest to dry prairies moved across the face of Illinois during this period. Remnants of the boreal communities can be found in cool spring-fed habitats and on shaded cliffs and ledges. Relicts of the moist forest era can be found in ravine bottoms in western and southern Illinois. Remnants of the dry climate period survive in the sandy soil of areas that provide drought conditions under present climatic conditions. Dry climate communities also survive on steep southwest-facing slopes, where rapid drainage and increased exposure to sun and wind create suitable conditions for them.

The plant and animal species contributing to natural communities vary from region to region within the State. These variations reflect the effects of past and present climate, the presence of migration corridors and barriers,

Figure 3

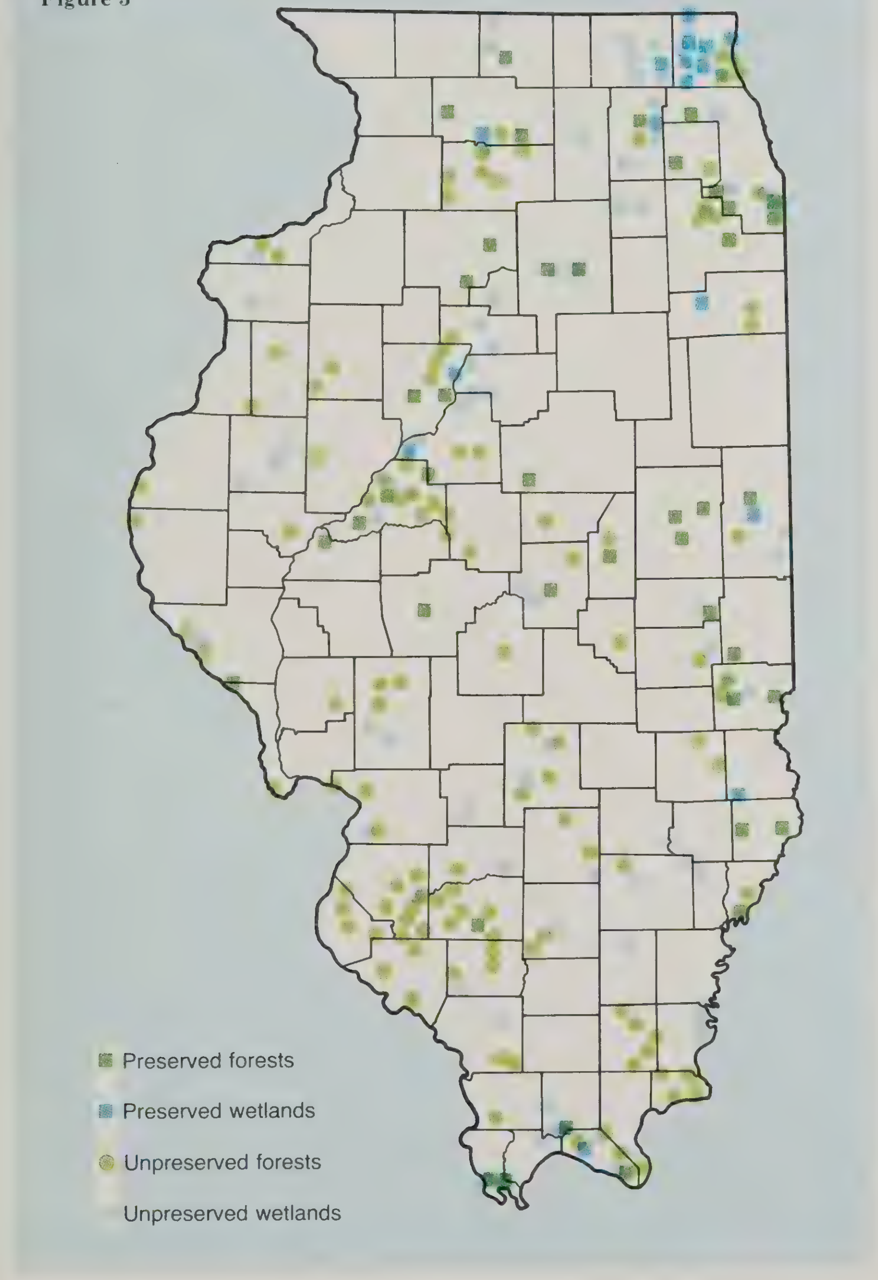


Figure 3. Distribution of preserved and unpreserved high-quality natural communities: forests and wetlands. Source: Illinois Department of Conservation, Illinois Nature Preserves Commission, and Illinois Endangered Species Protection Board 1980

and the present distribution of suitable habitat for given species. Eastern beech-maple forest, for example, is limited essentially to the southern tip of Illinois. Northern relict plants, on the other hand, are found in the extreme northwestern part of the State as well as in the far south, where deep ravines and sandstone ledges support such northern relicts as sphagnum and clubmosses.

Natural communities that have undergone little change through human activities are called natural areas. An inventory of these areas completed in 1978 revealed that only about 25,700 acres (less than seven hundredths of one percent) of the natural communities present at the time of settlement have survived in a condition of high natural quality.

Natural communities, and especially natural areas, are valuable to ecologists, who study the interaction between plants and animals and their relation to the physical environment. Undisturbed communities are examples of relatively complex, stable ecosystems, which allow the study of organisms within the environmental conditions under which they evolved and to which they are adapted. Such studies are not possible for most of our landscape, where natural communities have been disturbed. Natural areas are also the source of many species and provide genetic material of potential usefulness to man. For example, prairie, once our most common natural community, formed most of the soils that make Illinois a leading agricultural state. Prairie natural areas now provide us with benchmarks for assessing the loss of soil to erosion. They also allow us to measure changes in soil microbes and soil structure brought about by pesticides and tillage. The preservation of natural communities is an important function of state government, and the Illinois Nature Preserves System is the principal program to protect them. *12, 13, 32, 43, 50, 54, 92, 115, 116, 123, 139, 206, 207, 214, 215, 216, 217, 233, 273, 293, 295, 303, 334, 360, 370, 383, 416, 424, 425, 426, 427, 428, 445*

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Illinois Department of Conservation

Nature Preserves

The natural landscape of Illinois has changed dramatically in the 200 years since the State was settled. Only small fragments of the natural communities that existed in presettlement times remain in a relatively undisturbed condition. These natural areas are an important but vanishing resource. Pressures to farm, drain, mine, log, or otherwise alter them continue, and if examples of native prairie forests and wetlands are not set aside to be protected in perpetuity, they may be lost forever. To that end, the Illinois Nature Preserves System was created by statute in 1963 to provide a legal mechanism for permanently preserving natural areas and endangered species. Areas dedicated as nature preserves are considered to have been put to their highest, best, and most important use and cannot be taken by state or local governments or used for any other purpose.

The Illinois Natural Areas Preservation Act, the authorizing statute for the Nature Preserves System, stipulates that nature preserves be maintained as nearly as possible in their natural condition and used in a manner consistent with their continued preservation for the purpose of present and future scientific research, education, and aesthetic enjoyment and as habitats for plants, animals, and natural communities. As of January 1986, 140 nature preserves have been designated (Fig. 4). Taken together, these preserves comprise 23,022 acres. Types of areas included in the Nature Preserves System are prairie, savanna, wetland, and forest communities as well as habitats for endangered and threatened species. A major objective is to preserve representative examples of each distinct natural community found in Illinois.

Nature preserves are owned and managed by a variety of public and private landowners, including the State of Illinois, county forest preserve

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Figure 4. Nature preserves and natural areas of Illinois, 1985. Source: Illinois Department of Conservation and the Nature Preserves Commission 1982; updated data from the Illinois Department of Conservation.

Figure 4

Natural areas, most of which are privately owned, are sites in relatively pristine, presettlement condition. Those indicated by straight lines generally run along railroad tracks; those shown by wavy lines generally follow streams.

and conservation districts, schools, cemetery associations, private conservation organizations, and individual citizens. Formal dedication of a natural area as a nature preserve requires the approval of the owner of the land, the Department of Conservation, the Nature Preserves Commission, and the Governor and involves a legal document that creates a permanent encumbrance on the title to the land, thereby prohibiting in perpetuity the disturbance of the property in any manner. The Illinois Nature Preserves Commission, a nine-member body appointed by the Governor, has statutory responsibility for approving all areas dedicated into the System and for overseeing their management and use. Because so much of Illinois has been altered by human activity, natural areas are subject to a variety of internal and external stresses and merely leaving these areas alone does not guarantee their continued existence. Prescribed burning, control of nonnative plants and animals, and protection from adverse uses of the surrounding land are all part of the management of natural areas. In general, the goal of management is to protect the remaining high-quality natural areas and to restore others to their presettlement conditions to the extent possible.

The Illinois Natural Areas Inventory (University of Illinois, Department of Landscape Architecture, 1978), an extensive survey that identifies and describes lands and waters representative of the natural landscape that existed in Illinois prior to settlement, is an important data base in directing natural areas preservation, including the acquisition, dedication, and management of ecologically significant natural areas. As a follow-up to this inventory, the Department of Conservation, the Nature Preserves Commission, and the Endangered Species Protection Board developed the Illinois Natural Areas Plan (Illinois Department of Conservation et al. 1980), which establishes priorities for the protection of natural areas in Illinois. Since the completion of these documents, considerable progress has been made in permanently setting aside vulnerable and irreplaceable natural areas, but much remains to be done if these tiny fragments of our natural heritage are not to be lost forever. *12, 13, 32, 50, 54, 115, 116, 206, 207, 214, 215, 216, 217, 233, 416, 426, 427, 428*

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Social Divisions

Although many social, political, and economic divisions cut through Illinois (judicial and legislative districts, school and park districts, city and village limits), the boundaries of its 102 counties are among the most important in surveying the natural resources of the State. Coal and crude oil and stone production, for example, are reported on a county basis as are many crop and livestock statistics. Withdrawals of water for purposes of irrigation are listed by county–even the deer harvest is based on county figures. For that reason, and because many readers of this book will follow the text with a particular county in mind, a map of the counties of Illinois has been printed on the foldout cover and may conveniently be used in conjunction with maps that do not bear county labels.

Rivers, forests, and geological formations, however, do not respect county boundaries, and many of the most scenic areas of the State are defined by other perimeters–national forests, state parks, forest preserves, wildlife refuges, and conservation areas. Much of the history of Illinois also transcends county lines, and landmarks from the past are often preserved in conjunction with state parks and recreational areas that include all or parts of several counties.

Counties

The 102 counties of Illinois vary widely in size and population as well as in topography and geology. Five encompass areas of more than a thousand square miles; seven contain less than 250 square miles. Only Cook County has a population counted in the millions (5,253,190). The population of one county (DuPage) exceeds 500,000, and six counties have populations over 250,000. Fourteen Illinois counties have populations below 10,000 (Table 1).

Although we tend to think of county boundaries as static features on the map of Illinois, and so they have been for over a century and a quarter, counties were not always so clearly defined. Indeed, at some points in Illinois history county boundaries extended as far north as Canada and lapped over into Indiana. On the other hand, thirteen counties with names assigned and boundaries fixed were authorized by legislative enactment but failed to complete their organizations under the enabling acts that created them. Illinois was destined never to have Coffee or Michigan or Audubon or Lincoln County.

County government came first to Illinois with the Virginians. Their colonial charter, they always claimed, gave them all the territory north of the Ohio River and west of Pennsylvania. Virginia militia under George Rogers Clark made good that claim in the summer of 1778 when they captured Kaskaskia and accepted the surrender of Vincennes and the other French towns that had been held by the British in the West since 1763.

On December 9, 1778, the Virginia legislature created the county of Illinois, including under its jurisdiction the Wabash Valley west to the Illinois River and all the land north from the Ohio River for an indefinite distance; the act also required that the county's statutory existence be renewed each year. Three days later the governor of Virginia, Patrick Henry, appointed twenty-eight-year-old John Todd, lawyer, Indian fighter, and representative to the Virginia assembly from the county of Kentucky, to be the county lieutenant–the chief magistrate of Illinois.

Todd arrived at Kaskaskia in May of 1779 and set about establishing civil government for settlements that had largely been without government under the British. A sheriff was elected, the town courts, which Clark had set up more or less on the former French model, were continued, and some provisions of Virginia law were introduced to augment French law, which was customarily being followed.

Todd was not happy in Illinois, however, and left in August of the same year, complaining about the unwholesome air, his inability to speak or understand French, and his difficulty in obtaining "many of the conveniences of life." With Todd's departure, what government Illinois had

Table 1. Illinois county information.

County	County seat	1980 census population	Area square miles	County	County seat	1980 census population	Area square miles
Adams	Quincy	71,622	866	Lee	Dixon	36,328	729
Alexander	Cairo	12,264	224	Livingston	Pontiac	41,381	1,043
Bond	Greenville	16,224	383	Logan	Lincoln	31,802	622
Boone	Belvidere	28,630	283	Macon	Decatur	131,375	576
Brown	Mt. Sterling	5,411	307	Macoupin	Carlinville	49,384	872
Bureau	Princeton	39,114	868	Madison	Edwardsville	247,671	731
Calhoun	Hardin	5,867	259	Marion	Salem	43,523	580
Carroll	Mt. Carroll	18,779	468	Marshall	Lacon	14,479	395
Cass	Virginia	15,084	370	Mason	Havana	19,492	541
Champaign	Urbana	168,392	1,000	Massac	Metropolis	14,990	246
Christian	Taylorville	36,446	709	McDonough	Macomb	37,236	582
Clark	Marshall	16,913	505	McHenry	Woodstock	147,724	611
Clay	Louisville	15,283	464	McLean	Bloomington	119,149	1,173
Clinton	Carlyle	32,617	498	Menard	Petersburg	11,700	312
Coles	Charleston	52,992	507	Mercer	Aledo	19,286	556
Cook	Chicago	5,253,190	954	Monroe	Waterloo	20,117	380
Crawford	Robinson	20,818	442	Montgomery	Hillsboro	31,686	706
Cumberland	Toledo	10,062	346	Morgan	Jacksonville	37,502	565
DeKalb	Sycamore	74,624	636	Moultrie	Sullivan	14,546	345
DeWitt	Clinton	18,108	399	Ogle	Oregon	46,338	757
Douglas	Tuscola	19,774	420	Peoria	Peoria	200,466	624
DuPage	Wheaton	658,177	331	Perry	Pinckneyville	21,714	443
Edgar	Paris	21,725	628	Piatt	Monticello	16,581	437
Edwards	Albion	7,961	225	Pike	Pittsfield	18,896	829
Effingham	Effingham	30,944	482	Pope	Golconda	4,404	381
Fayette	Vandalia	22,167	718	Pulaski	Mound City	8,840	204
Ford	Paxton	15,265	488	Putnam	Hennepin	6,085	166
Franklin	Benton	43,201	434	Randolph	Chester	35,566	594
Fulton	Lewiston	43,687	874	Richland	Olney	17,587	364
Gallatin	Shawneetown	7,590	328	Rock Island	Rock Island	165,968	420
Greene	Carrollton	16,661	543	St. Clair	Belleville	265,469	670
Grundy	Morris	30,582	432	Saline	Harrisburg	27,360	384
Hamilton	McLeansboro	9,172	435	Sangamon	Springfield	176,089	880
Hancock	Carthage	23,877	797	Schuyler	Rushville	8,365	434
Hardin	Elizabethtown	5,383	183	Scott	Winchester	6,142	251
Henderson	Oquawka	9,114	381	Shelby	Shelbyville	23,923	772
Henry	Cambridge	57,968	826	Stark	Toulon	7,389	291
Iroquois	Watseka	32,976	1,122	Stephenson	Freeport	49,536	568
Jackson	Murphysboro	61,522	603	Tazewell	Pekin	132,078	653
Jasper	Newton	11,318	495	Union	Jonesboro	16,851	414
Jefferson	Mt. Vernon	36,354	574	Vermilion	Danville	95,222	898
Jersey	Jerseyville	20,538	374	Wabash	Mt. Carmel	13,713	221
Jo Daviess	Galena	23,520	614	Warren	Monmouth	21,943	542
Johnson	Vienna	9,624	345	Washington	Nashville	15,472	565
Kane	Geneva	278,405	516	Wayne	Fairfield	18,059	715
Kankakee	Kankakee	102,926	680	White	Carmi	17,864	501
Kendall	Yorkville	37,202	320	Whiteside	Morrison	65,970	690
Knox	Galesburg	61,607	728	Will	Joliet	324,460	845
Lake	Waukegan	440,372	457	Williamson	Marion	56,538	427
LaSalle	Ottawa	109,139	1,153	Winnebago	Rockford	250,884	520
Lawrence	Lawrenceville	17,807	374	Woodford	Eureka	33,320	537

Source: Edgar 1984

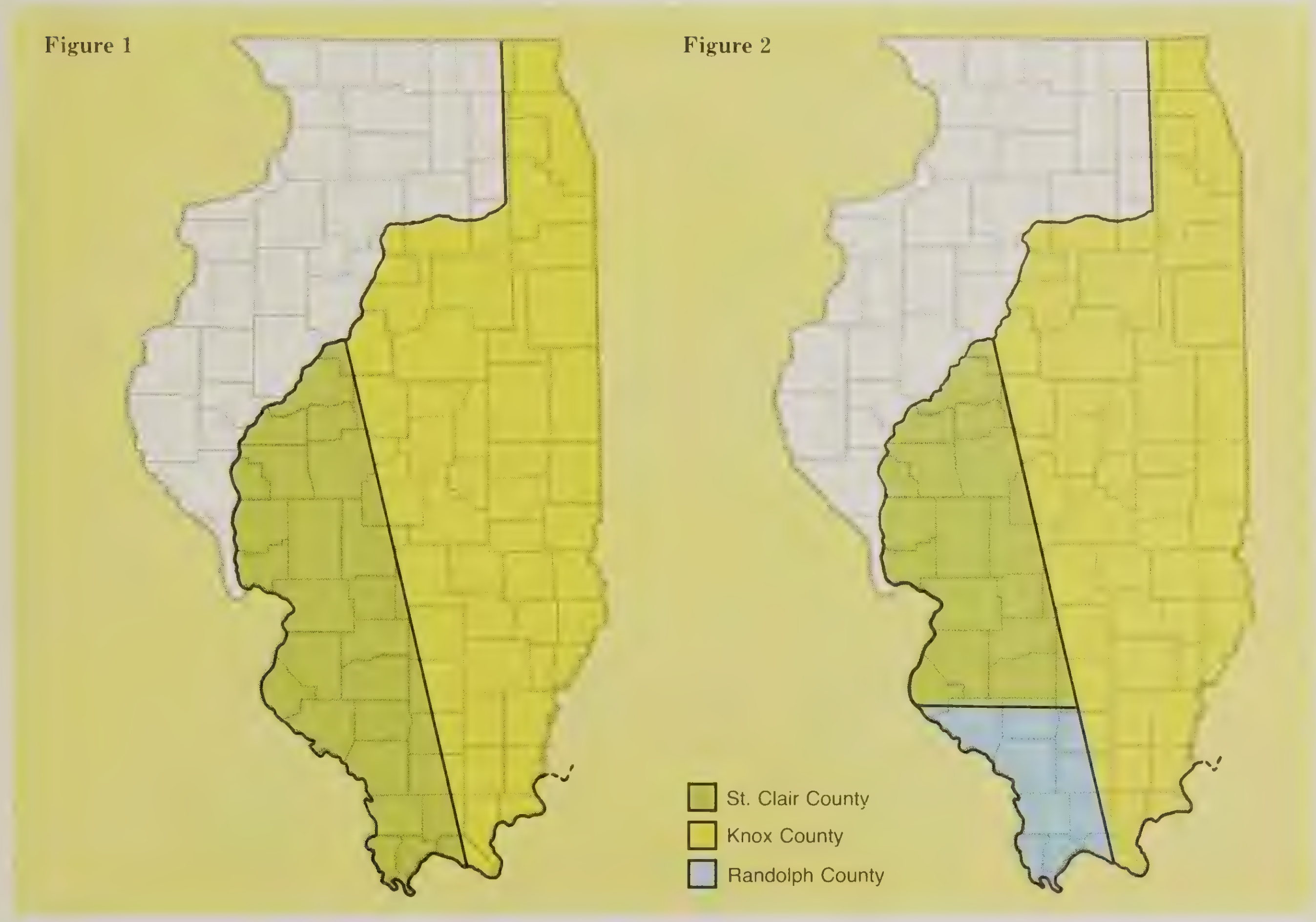
was exercised by a succession of deputy county lieutenants with doubtful authority. In January 1782, the Virginia assembly adjourned without seeing to the continuation of the county of Illinois, and land and people were left to get along as best they could.

Virginia's western claims, along with those of other states, were surrendered to the United States in 1784. Under the Ordinance of 1787, Illinois became part of the newly organized Northwest Territory. In April 1790, the first territorial governor, Arthur St. Clair, established St. Clair County and, in June, Knox County. Included within these two counties was all the country south of the Illinois River to the Ohio (Fig. 1). St. Clair County, the smaller of the two, had the larger population since the French and American settlers had located mostly in the fertile bottomlands along the Mississippi River from Kaskaskia to Cahokia. Knox was two-thirds again as large, but settlement was confined mainly to Vincennes and the lower Wabash.

When Randolph County was created in 1795, St. Clair County became even smaller, and Kaskaskia inhabitants found themselves living within the boundaries of the new county (Fig. 2). In 1801, however, St. Clair was enlarged to include most of what was later to become the State of Illinois. Randolph had its eastern boundary pushed almost to the Wabash River, and Knox became primarily a county of Indiana (Fig. 3). Although the enlargement of St. Clair was to prove temporary, it won for the county the title "Mother of Counties." In 1812, with the creation of Madison County, St. Clair was reduced to about its present size. Madison, bounded on the west by the Mississippi, on the east by Indiana, and on the south by a line drawn to the Wabash from a point ten miles above Cahokia, extended north to Canada (Fig. 4). Randolph, too, was diminished in size that year when Johnson and Gallatin counties came into existence.

Figure 1. County boundaries in 1790 (Northwest Territory). Source: Illinois, Office of the Secretary of State, 1974.

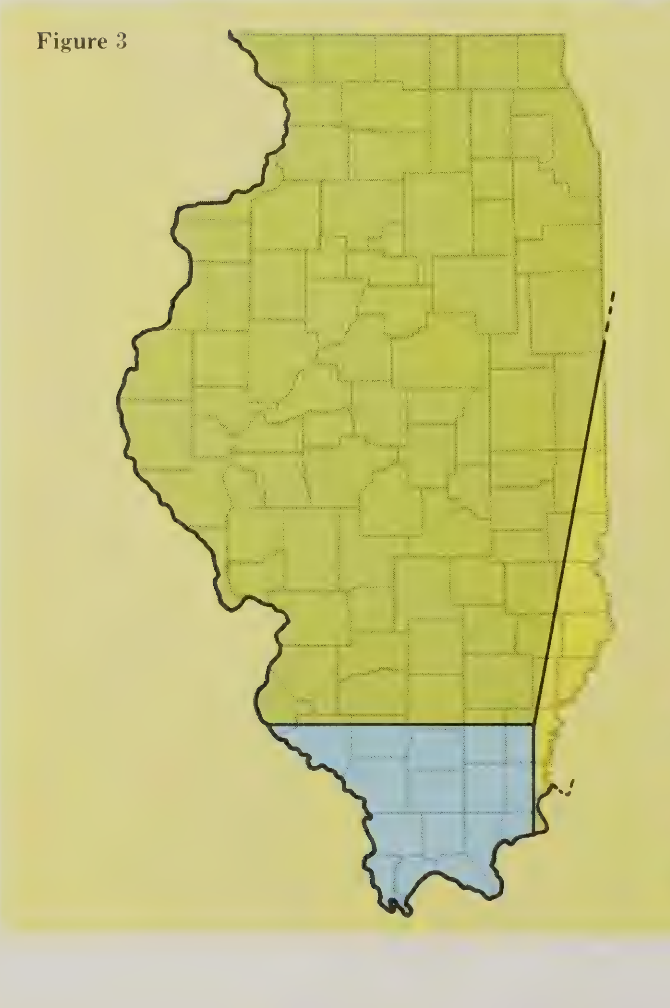
Figure 2. County boundaries in 1795 (Northwest Territory). Source: Illinois, Office of the Secretary of State, 1974.



The creation of the 102 counties of Illinois was not completed until the organization of Douglas and Ford counties in 1859. Coles lost its northern townships to Douglas, and Ford was created from unorganized territory left after the creation of Iroquois, Kankakee, and Will counties, land which had been attached as a panhandle or, as it was called, a "bootleg" to Vermilion County. Those lands by law now became Ford County, and Vermilion was reduced to its present size. Only a series of maps such as those in *Counties of Illinois: Their Origin and Evolution*, published by the Office of the Secretary of State, can make clear how counties were proclaimed or legislated into being and subsequently enlarged, cut up, and rearranged. The often curious explanations of those changes lies elsewhere, however, and can sometimes be found in county histories.

Most counties and the changes in them since Illinois became a state in 1818 resulted from the petitions of citizens to the legislature. A common complaint was that the distance from their homes to the county seat was too great; a man on horseback ought to be able to go there and back in a single day, regardless of where he lived. Sometimes the possibility of profit was behind the request. Landowners in LaSalle County in the late 1830s, realizing that the new canal would bring trade and commerce and settlers right to their doors, asked for, and got in 1841, two new counties–Kendall, north of the canal, and Grundy, south of it.

And once, the threat of civil war over the relocation of a county seat ended with the creation of a new county. Sickness flourished at Palmyra, the county seat of Edwards County since 1815. Locating the town on a forested flat in a bend of the Wabash a few miles above Vincennes had been a mistake from the first. In 1821, commissioners appointed by the general assembly designated Albion as the new seat of justice and the county clerk transferred the records and seals to his new office.



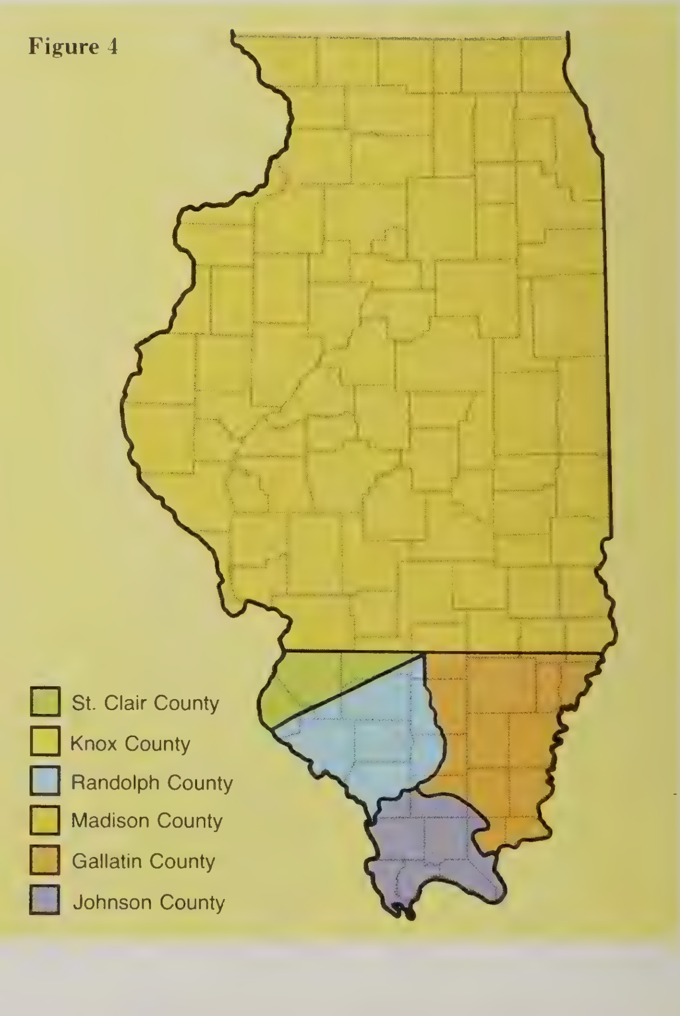


Figure 3. County boundaries in 1801 (Indiana Territory). Source: Illinois, Office of the Secretary of State, 1974.

Figure 4. County boundaries in 1812 (Illinois Territory). Source: Illinois, Office of the Secretary of State, 1974.

In response, the French Canadians and Americans living east of Bonpas Creek, a tributary of the Wabash River, called up four companies of militia, made camp on Ball Hill Prairie, and commenced drilling against the day they would march on Albion and recover the records. They hated the English living west of the Bonpas, the founders of Albion, and considered them arrogant snobs who thought they were called upon to teach Americans how to build, how to keep house, how to farm, and how to raise livestock. It was no secret that the English thought the Wabash Valley settlers lacked "industrious habits," never took a bath unless they fell into the river, and with three shots of whiskey "became madmen." According to one of the English, "Americans keep a taint of the log cabin even when they live in a brick house."

When word of troops drilling reached Albion, a delegation of the English, according to the county historian, came "under a flag of truce . . . into camp to negotiate terms of peace." What those terms were he never recorded; however, one of the negotiators, elected to the legislature in 1824, sponsored a bill that created two of the smallest counties in the State–Wabash County east of Bonpas Creek and Edwards County west of Bonpas Creek, each with about 220 square miles. *3, 106, 218*

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Parks, Forests, Conservation Areas, and Historic Sites

The recorded history of Illinois began in the 1670s with the French voyageurs who followed a river network that continues to lure canoeists and other twentieth-century explorers of the State. Each year millions of people enjoy the outdoor recreation sites of Illinois, including national, state, and county parks, forests and conservation areas, and historic sites and landmarks. Like many other states, Illinois has provided for recreational use along with resource conservation so that citizens of the State and visitors may enjoy the best of Illinois today and in the years to come.

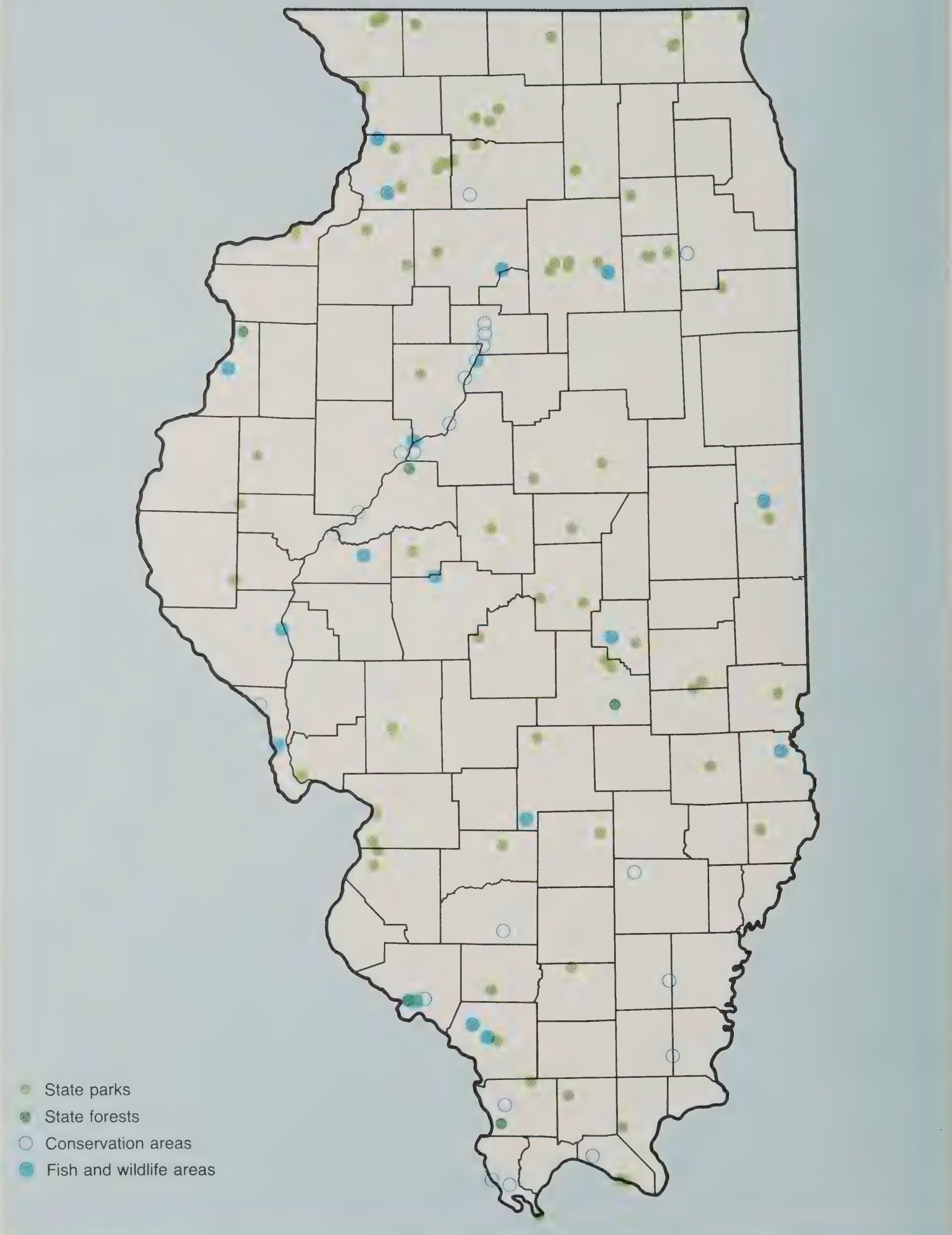
A brief regional overview of these recreational resources follows. The state parks, forests, conservation areas, and fish and wildlife areas of Illinois are shown in Figure 5, and more detailed information is available from the Illinois Office of Tourism and from other agencies listed in Appendix B.

Northern Illinois offers a variety of natural attractions–from Lake Michigan on the east to the towering rock formations along the Mississippi River on the west. Chicago's fabulous lakefront parks cover 90 percent of the length of the city's waterfront, and a three-mile stretch of beach near Zion, the only dune area in the State, has been preserved as a major feature of Illinois Beach State Park. Chain O' Lakes State Park introduces visitors to a string of ten glacier lakes with 180 miles of shoreline. The Illinois and Michigan Canal National Heritage Corridor, a 120-mile historical and environmental corridor from Chicago to LaSalle-Peru, is the newest member of the National Park System. Built between 1836-1848, the Canal played a significant role in the history of Illinois and now will provide many recreational opportunities.

The county forest preserve and conservation area systems of Lake, Cook, Will, DuPage, Kane, McHenry, Boone, Winnebago, DeKalb, and Kendall counties contain natural resources and recreational facilities not easily matched: several hundred miles of trails for all types of uses; winter sports areas for tobogganing, tubing, sledding, and skiing; access to good canoeing and water sports; and beautiful rolling countryside with quality woodlands, wetlands, and prairie remnants.

Lorado Taft's most famous statue, the 50-foot Indian sentinel positioned high on a bluff overlooking the Rock River, is a hallmark of Lowden State Park. North of Savanna, Mississippi Palisades State Park offers magnificent views of the island-dotted Mississippi River. Amateur geologists, wild-

Figure 5


State parks
State forests
Conservation areas
Fish and wildlife areas

flower lovers, and hikers of all ages come to Starved Rock State Park to stay at the fine lodge and explore the 18 canyons cut from sandstone by running water millions of years ago. Naturalists have identified 600 species of plants in the immediate area. Among the national historic sites and landmarks in northern Illinois are the courthouses of Carroll and Ogle counties, the home of John Deere at Grand Detour, and the Ulysses S. Grant home at Galena, a town in which 85 percent of the buildings are on the National Historic Register.

Located in western Illinois are some of the most interesting historic sites in the State. Nauvoo, on the great bend of the Mississippi, was the largest city in Illinois in the 1840s, and its history is inextricably bound with that of the Mormon Church. Fifteen restored nineteenth-century homes may now be visited, including the homes of John Smith and Brigham Young. Another town closely linked to the fortunes of a religious group is Bishop Hill, founded in 1840 by Swedish Utopians. Its restoration includes homes, a hotel, and a church, which houses a remarkable collection of primitive paintings by Olaf Krans. Much of the cultural history of Bishop Hill can be read in his series of portraits and in the detailed scenes of communal living. Part of the town is a state park but most of the community is an example of "living history."

Military history, too, is recorded in the parks and landmarks of this part of the State. At Creve Coeur near Peoria stands a replica of Fort Crevecoeur, LaSalle's outpost and the first European settlement in the mid-American continent. Black Hawk State Park near Rock Island marks the site of the westernmost battle of the Revolutionary War. Abraham Lincoln is remembered in Old Main on the Knox College Campus, where he and Douglas debated; in the restored courthouse at Metamora, where he practiced law while riding the Eighth Judicial Circuit; and at the Princeton homestead of his friend Owen Lovejoy, a dwelling that once served as a headquarters for the Underground Railway.

A much, much older history of Illinois, the Indian culture of about 1,000 B.C., is recorded at Dickson Mounds near Havana. An enclosed burial mound reveals the skeletons of 237 Indians in the precise positions unearthed by archeologists. An interesting interpretation of the site is told to visitors.

Waterways also contribute their share to the recreational enjoyment of the western part of the State. The 65-mile meandering Spoon River and the surrounding countryside bring to mind Edgar Lee Masters, and names still legible in the Oak Hill Cemetery are identical to those of characters in the *Spoon River Anthology*. The Spoon River Scenic Trail marks 55 miles from London Mills to Dickson Mounds for hikers and motorists. The Hennepin Canal State Park offers canoeing, hiking, and snowmobiling along the 104-mile waterway. A 72-mile trail along the old towpath is popular with cross-country skiers.

Central Illinois, more than any other section of the State, documents the Lincoln story in its parks and landmarks. The faithfully reconstructed village at New Salem State Park preserves for us the environment in which young Lincoln lived and worked for six years, including the store where he clerked and the post office he tended. In nearby Springfield we can visit Lincoln Home National Memorial, his law office, the family pew in the First Presbyterian Church, and the restored Old State Capitol, where he delivered the "House Divided" speech. Only a few miles away, in Oak Ridge Cemetery, is the Lincoln Tomb. The Bryant Cottage in Bement, now a state historic site, marks the place where Lincoln and Douglas met to plan their series of debates. Near Charleston is Lincoln Log Cabin State Park, the site of the restored and furnished last home of Lincoln's parents. Close by, in Shiloh Cemetery, his father, Thomas, and stepmother, Sarah, are buried. These and many other places in central Illinois have been touched by the shadow of Abraham Lincoln.

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Figure 5. State parks, state forests, conservation areas, and fish and wildlife areas. Source: Illinois Department of Conservation.

But not all historic buildings and parks in the central part of the State recapture Lincoln lore. Decatur has an 80-acre tract of buildings, landmarks, and memorials–all on the National Register of Historic Sites and representative of every period of architecture from the Civil War through the Depression. The nearly 3,000 acres of Kickapoo State Park, situated on reclaimed strip mine lands, offer camping, boating, fishing, hunting, and hiking. Lake Shelbyville and Clinton Lake, two of the larger bodies of water in Illinois, provide outstanding water-based facilities. People can spend a day or a whole vacation enjoying the outdoor recreational opportunities provided by the Illinois Department of Conservation at Eagle Creek and Wolf Creek State Parks, at Clinton Lake State Recreation Area, or at other areas provided by the U.S. Army Corps of Engineers. Similar facilities are provided by these agencies at Carlyle Lake and Rend Lake a bit farther south.

Four counties, Vermilion, Champaign, Piatt, and Macon, have resource-based areas that offer facilities for swimming, fishing, boating, camping, hiking, golfing, nature study, and other activities throughout the year. Specialized sites include the Early American Museum and Botanical Gardens at Lake of the Woods near Mahomet in Champaign County and the Rock Springs Environmental Center near Decatur in Macon County.

The only national forest in the State is located in southern Illinois. The over 260,000 acres of the Shawnee National Forest provide excellent recreational opportunities and some of the most spectacular scenery in the Midwest. The many state parks in this section of Illinois also provide excellent hiking trails. Cave-in-Rock State Park, on the Ohio River, with its 200-foot cave and pirate tales is a perennial favorite. Giant City State Park near Makanda, named for its structures of sandstone, is also home for over 70 varieties of trees. Ferne Clyffe State Park is known for its canyons and greenery.

Three of the state parks of southern Illinois mark important pages in the history of the United States. Fort Kaskaskia State Park is named for the British fort captured during the Revolutionary War by George Rogers Clark and his men, who marched across the frozen swamps and bottomlands of southern Illinois. This victory won the war for the colonists in the West. Lewis and Clark State Park commemorates the area where these famous explorers trained their men for the long trek across the North American continent to the Pacific Ocean. Fort Defiance State Park, at the junction of the Ohio and Mississippi, marks the site of the fort established by Ulysses S. Grant in 1861. Visitors to this park discover a marvelous view of the river junction. Nearby, in Mound City National Cemetery, are the graves of 4,800 Union and Confederate soldiers. In contrast to these large parks is Tower Rock near Grand Tower. This 60-foot rock was left standing as the base for a bridge when the Mississippi River was dredged during the Grant Administration. The bridge was never built, but Tower Rock has been federally protected ever since.

Birdwatchers and canoeing enthusiasts also visit the state-protected lands of southern Illinois. Each year over 100,000 Canada geese migrate to Horseshoe Lake Wildlife Refuge, and colonies of great blue heron can be seen nesting in Heron Pond Nature Preserve. Canoeists seek out stretches of the Cache and Embarras rivers and the 30-mile stretch of the Big Muddy River Canoe Trail from Murphysboro through the scenic Shawnee National Forest, catching sight enroute of Little Grand Canyon, Swallow Bluffs, and Horseshoe Bluff.

Among the many historic buildings found in this area of Illinois are the 700 buildings that make up the Belleville Historic District (dating from the 1830s, they offer a veritable history of Illinois); the two banks at Shawneetown; the Riverview Mansion Hotel in Golconda; and the Cahokia Courthouse, the oldest surviving building in the Midwest and the seat of government for the Northwest Territories. At Kampsville, not far from Cahokia, the center for American Archeology at Northwestern University conducts an ongoing study of the prehistoric Indians of the lower Illinois valley. Only recently, Cahokia Mounds was placed on the World Heritage Sites List of UNESCO, an honor granted to only about 120 other sites around the world. From the tiny remnants of native prairie to the massive bluffs at Pere Marquette State Park, the State of Illinois is working with other agencies to acquire, develop, and maintain its natural and historic heritage for the benefit and enjoyment of its citizens. *2, 116, 130, 198, 199, 200, 202, 214, 226, 233, 428*

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Agriculture

Figure 1. Crop-reporting districts of Illinois. Source: Illinois Cooperative Crop Reporting Service.

Agriculture, the largest business activity in the United States, is of central importance to the economic vitality of Illinois. Illinois and the surrounding midwestern states generate over half the value of the nation's agricultural products, plant over half of its cropland acres, produce over half of its agricultural exports, and account for over half of its agricultural assets. The American consumer enjoys the most bountiful table in the world, yet spends the lowest proportion of income for food.

Natural conditions in Illinois favor profitable farming. The average productivity of Illinois soils is high. Much of the land is level or gently rolling, and the climate is varied enough to make possible a wide range of products. By efficiently utilizing these natural advantages, Illinois farming has developed from a self-contained home industry to a highly commercial undertaking. Competition among regions within the State has led to increasingly specialized agricultural production.

Illinois ranks second in the nation in value of crops marketed and first in value of crops exported. It ranks eighth in livestock and livestock products marketed. (Illinois Department of Agriculture 1984). According to the 1982 Census of Agriculture (U.S. Department of Commerce 1984), 92,000 Illinois farms were responsible for this remarkable productivity.

The 1982 Census also showed that 28,726,114 acres (80.7 percent) of the 35,612,601 acres of land in Illinois are farmland. The remaining 6,886,487 acres are occupied by cities, railroads, roads, and public institutions, used for industrial purposes or recreation, or considered too rough and unproductive for farming. Farm acreage, again according to the 1982 Census, had decreased 2.5 percent since 1978, and the average size of an Illinois farm was 292 acres.

In 1982, 86.2 percent (24,748,112 acres) of the farmland in Illinois was classed as cropland. Ninety-three percent of this cropland was harvested, 4 percent was grazed, and 3 percent was idle or in cover crops or legumes for soil improvement. The remaining 13.8 percent of the farmland (3,978,002 acres) was about evenly divided between woodland and miscellaneous uses such as house lots, ponds, roads, and wasteland.

The market value of Illinois agricultural products in 1982 was $7.3 billion; $5.1 billion came from the sale of crops and $2.2 billion from the sale of livestock and poultry and their products. Corn and soybeans accounted for 87 percent of the crop sales. Hogs and pigs accounted for 48 percent of the livestock product sales, and cattle and calves accounted for 34 percent. The relative importance of the various farm enterprises differs greatly from one part of the State to another. As a result, the Illinois Cooperative Crop Reporting Service has divided the State into nine crop-reporting districts of approximately equal size based on soil composition, growing conditions, and types of farming (Fig. 1). These nine districts are used to present the data in the crop and livestock discussions that follow.
8, 15, 48, 49, 197, 251, 272, 326, 340, 410, 452

R. Dan Neely, Illinois Natural History Survey

Photograph: Larry Kanfer

Corn

Corn is the foundation of Illinois agriculture. It is grown on 82 percent of the Illinois farms that harvest crops and on 50 percent of the cropland acres (U.S. Department of Commerce 1984). Cash sales from corn provide 42 percent of the income of Illinois farmers, some of whom derive additional indirect income by feeding the corn they grow directly to the livestock on their farms.

Through human ingenuity and the genetic diversity of corn, this crop can now be grown in many soils and climates. It grows in temperate climates, in the tropics, and at elevations of 300 to 13,000 feet. With the exception of sorghum, corn uses less water to produce a pound of above-ground dry matter than any other field crop. In the early 1800s, Atlantic-coast farmers, in an effort to improve yields, mixed the white gourdseed corn of the South with the yellow flint corn of the North, a strategy that resulted in recognized dent varieties by 1850. By 1900, over 1,000 varieties of open-pollinated corn were available (Wilsie 1962). The development of hybrid corn varieties in the 1930s has been called one of the miracles of plant breeding. Prior to 1933, less than 1 percent of the corn grown in the United States was from hybrids; by 1942, however, hybrids accounted for approximately 95 percent (Newlin et al. 1949).

Corn is best adapted to a long and warm growing season with evenly distributed summer rainfall. Such characteristics apply to the U.S. Corn Belt, an area running west from Ohio to Kansas and Nebraska. This area, the most productive farmland in the United States, has fertile, well-aerated soil, is relatively level, and is well suited to the use of machinery. It has a growing season of 120 to 180 days and an annual precipitation of approximately 40 inches, with 60 to 80 percent occurring in the spring and summer months. Illinois and Iowa, the central states of this region, produce almost 50 percent of the corn in the Corn Belt (Hill et al. 1981b).

Table 1. Average yield per acre and average annual production of corn, 1933–1982.

	1933–1942		1943–1952		1953–1962		1963–1972		1973–1982	
Crop-reporting districts	Bu/A	Million bu	Bu/A	Million bu	Bu/A	Million bu	Bu/A	Million bu	Bu/A	Million bu
Northwest	51.7	59.8	60.7	82.6	73.8	107.2	95.3	154.0	112.6	219.6
Northeast	48.9	48.2	55.2	65.2	68.7	78.9	90.5	102.0	110.3	138.3
West	46.6	33.1	54.9	45.1	67.6	58.5	93.1	93.5	110.8	120.9
Central	48.2	51.9	54.9	70.0	72.8	91.1	100.0	149.7	117.0	119.8
East	46.8	51.7	52.2	68.8	69.7	86.0	100.5	147.9	115.0	185.4
West Southwest	41.1	33.5	50.5	50.3	61.9	67.3	92.3	107.5	110.8	142.8
East Southeast	36.3	31.9	44.6	43.5	57.4	58.4	87.2	98.4	105.5	136.0
Southwest	30.3	10.8	36.4	15.3	43.9	19.2	65.0	27.5	82.4	33.2
Southeast	26.8	11.5	37.4	17.4	45.3	20.3	66.8	31.3	82.6	40.8
Illinois	40.6	332.8	52.0	458.0	65.6	587.0	92.0	901.8	110.8	1216.9

Source: Illinois Cooperative Crop Reporting Service

Corn yield per acre has been increasing steadily in Illinois, as elsewhere, for the past fifty years (Table 1). The statewide average has risen from 40.6 to 110.8 bushels per acre, an increase brought about primarily through the development of higher-yielding hybrids, through more efficient fertilization practices, through the use of improved herbicides and insecticides, and through better tillage practices. Corn yields have also improved because of increased plant populations, narrow-row plantings, increased fertilizer rates (especially nitrogen), irrigation, and improved machinery (Boone et al. 1981). As a result, during the ten-year period 1973-1982, 7 of the 9 crop-reporting districts in Illinois each produced an annual average of over 100 million bushels of corn (Table 1). During the five-year period 1978-1982, the average annual corn production for half the counties in Illinois was 10 million or more bushels; most of these counties had average annual yields during this period of more than 100 bushels per acre (Figs. 1 and 2). *48, 182, 306, 410, 452*

R. Dan Neely, Illinois Natural History Survey

Figure 1. Average annual corn yield per acre by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Figure 2. Average annual corn production by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Figure 1

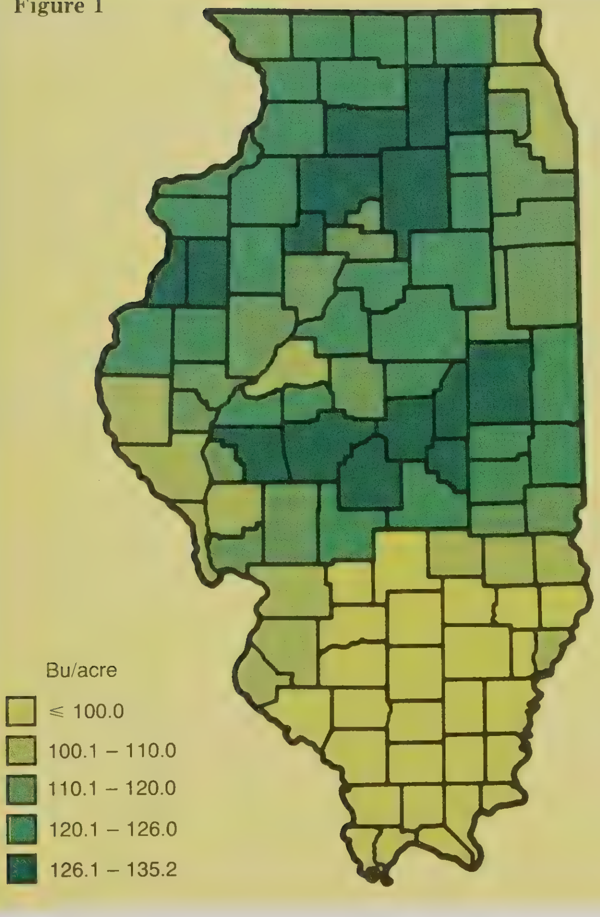
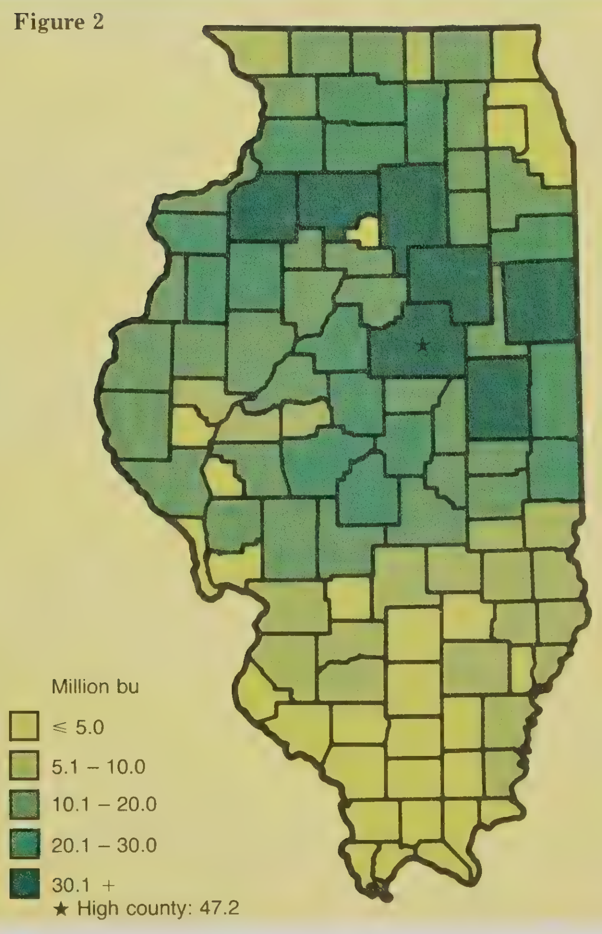


Figure 2



Soybeans

The soybean originated in Asia and is one of the oldest plants in cultivation. Although it was used in a variety of foods in that region, it was not favored as either a food or a feed grain by Europeans and was one of the last crop plants to be introduced into this country. The production of soybeans has expanded tremendously in the last forty years, and soybeans are now the most important oilseed crop in the United States. The volume of soybeans produced has exceeded that of wheat since 1978 and currently ranks second to corn in annual volume produced. As the acreage of soybeans has increased in the Corn Belt, the acreage of oats and, to a lesser extent, that of barley and hay have declined. In Illinois, the number of bushels of harvested soybeans is exceeded only by that of corn.

Soybeans, like corn, do best in fertile, well-drained soils. Soybean acreage is concentrated in the Corn Belt, where a corn-soybean rotation is common, and in the south-central region of the United States, where soybeans are double-cropped with wheat. These areas provide 65 and 20 percent, respectively, of the annual production of soybeans, with Illinois the national leader in soybean production (Leath et al. 1981c). Since production greatly exceeds domestic requirements, many Illinois soybeans are exported to other countries. With terminals on the Mississippi, Illinois, and Ohio rivers, Illinois is well situated to ship beans economically by barge to ports on the Gulf of Mexico, which handle four-fifths of the exported volume.

The soybean yield per acre has increased dramatically in Illinois over the past fifty years (Table 1). Average yields have increased from 20.2 to 34.6 bushels per acre, and yields of 50 to 60 bushels per acre from individual farms are not uncommon. New varieties developed primarily at state agricultural experiment stations during the 1940s and 1950s are responsible in part for these increased yields. The pods of shatter-resistant varieties, for example, do not open prematurely, and fewer beans are consequently dropped. Varieties with stronger stems reduce lodging and help to keep

Table 1. Average yield per acre and average annual production of soybeans, 1933–1982.

Crop-reporting districts	1933–1942 Bu/A	1933–1942 Million bu	1943–1952 Bu/A	1943–1952 Million bu	1953–1962 Bu/A	1953–1962 Million bu	1963–1972 Bu/A	1963–1972 Million bu	1973–1982 Bu/A	1973–1982 Million bu
Northwest	20.2	1.3	24.9	2.8	28.6	4.5	32.8	12.3	37.1	23.5
Northeast	19.7	2.2	24.0	4.5	27.7	8.9	29.9	17.5	34.7	29.3
West	20.5	3.3	24.8	7.0	27.1	9.3	32.5	15.2	35.7	26.0
Central	21.5	6.0	25.4	12.3	29.4	18.5	34.8	29.4	38.2	44.1
East	21.8	8.2	24.5	15.3	28.3	23.5	33.1	35.8	36.7	51.0
West Southwest	19.7	4.9	23.7	16.3	26.4	22.5	32.2	31.5	35.5	47.0
East Southeast	18.7	5.2	20.3	16.2	23.0	22.8	27.8	32.2	32.6	48.7
Southwest	12.4	0.2	18.6	3.6	19.9	7.6	25.5	12.0	29.0	20.7
Southeast	13.3	0.3	16.7	2.8	20.0	6.5	23.4	11.2	26.5	18.8
Illinois	20.2	31.6	22.8	80.8	25.6	124.1	30.6	197.3	34.6	309.1

Source: Illinois Cooperative Crop Reporting Service

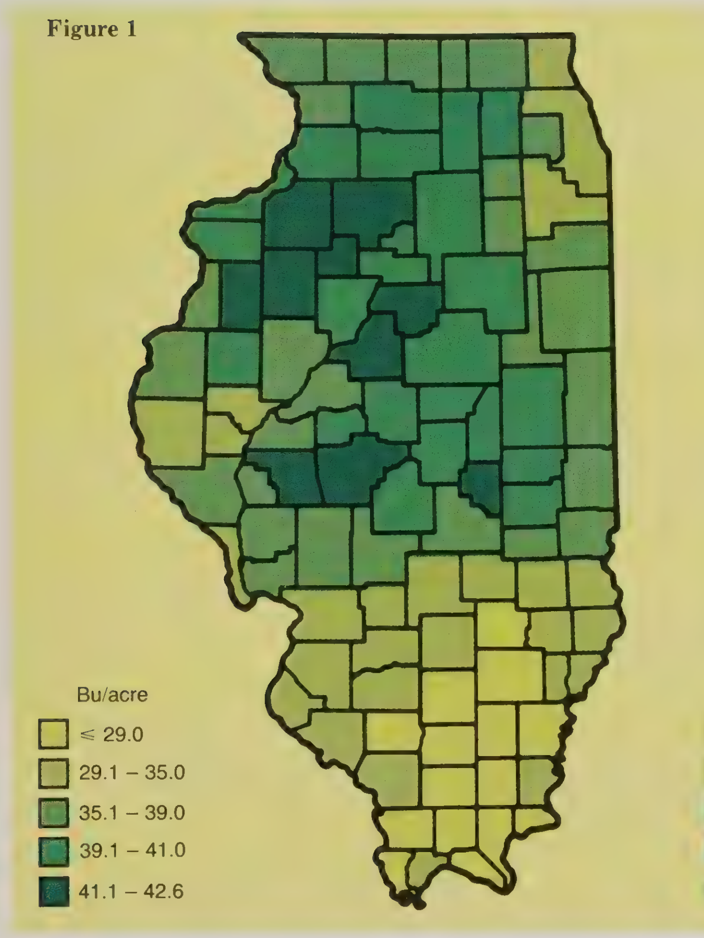
plants upright until harvest. A number of disease-resistant varieties have also been released (Pepper et al. 1982). Changes in agricultural practices such as narrow-row planting, minimum tillage, and irrigation during dry summers have also had positive effects on soybean yields.

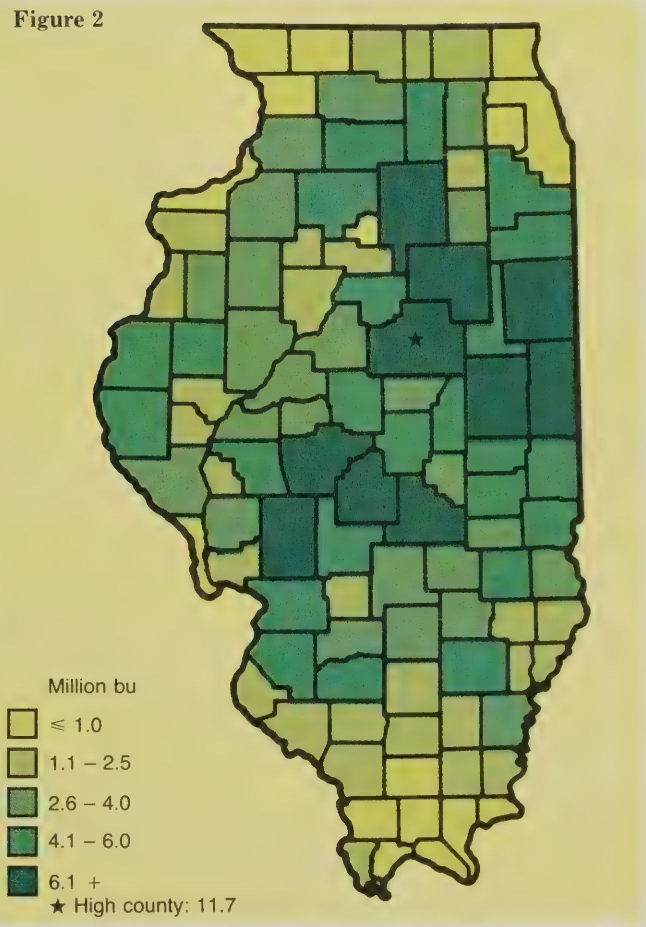
The increase in total production of soybeans in Illinois is phenomenal, with averages ranging from 31.6 million bushels in the mid-1930s to 309.1 million bushels in the mid-1970s (Table 1). Counties in the central region of Illinois produce more soybeans and a higher yield of soybeans than do northern or southern counties (Figs. 1 and 2). Although corn rightly receives first attention by Illinois farmers in the spring, soybeans represent an extremely competitive cash crop on many farms. Soybeans were grown on 67,000 of the 92,000 Illinois farms in 1982, with an annual total production value approximately 57 percent that of corn (U.S. Department of Commerce 1984). *248, 269, 315, 410*

R. Dan Neely, Illinois Natural History Survey

Figure 1. Average annual soybean yield per acre by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Figure 2. Average annual soybean production by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.





Other Crops

Although corn and soybeans account for 87 percent of crop sales in Illinois, a surprising variety of other crops are grown throughout the State. Farmers, of course, adapt production to the natural conditions of soil and climate and to the economic conditions of marketing, and some respond to the pull of traditions that have developed within a community or even within a family. Although none of these secondary crops has the statewide importance of corn and soybeans, some–like wheat–are widely grown; others–like peaches, horseradish, and onion sets–are significant enterprises in highly localized areas.

Wheat

Wheat provides nourishment for more people in the world than any other food source. It can be produced economically in a variety of climates, and it can be stored for years as grain or as flour. Wheat grows best in areas with a cool, moist growing season and a warm, dry ripening season. Much of the world's production comes from the semiarid and steppe climates. Currently, the USSR grows more wheat than any other country. Approximately 70 percent of the wheat produced in the world is used for human consumption; the remaining 30 percent is used for seed or livestock feed.

The principal varieties of wheat grown in the United States are divided into three market classes: hard red winter, hard red spring, and soft red winter. Winter wheats, which will remain prostrate unless they are exposed to low temperatures, are higher yielding than spring-sown wheats. Hard and soft red winter wheats make up most of the Illinois crop. Hard wheats are used primarily for yeast breads and hard rolls; soft wheats are used chiefly in cakes, pastries, cookies, and crackers.

Wheat production in the United States tends to be concentrated in the Great Plains, where rainfall is inadequate for corn and soybean production. The area that includes eastern Montana, North Dakota, and western Min-

Table 1. Average yield per acre and average annual production of wheat, 1933–1982.

	1933–1942		1943–1952		1953–1962		1963–1972		1973–1982	
Crop-reporting districts	Bu/A	Million bu	Bu/A	Million bu	Bu/A	Million bu	Bu/A	Million bu	Bu/A	Million bu
Northwest	22.8	0.9	25.6	0.6	32.4	0.6	37.6	0.5	44.2	1.3
Northeast	21.2	0.6	26.3	0.6	35.3	1.2	39.8	1.5	44.4	2.1
West	18.7	3.7	22.1	2.6	29.6	4.0	35.5	3.5	39.2	4.0
Central	19.7	5.0	23.2	3.9	32.9	5.2	40.1	4.5	43.1	3.0
East	20.6	1.4	24.9	1.8	34.5	4.7	43.5	4.3	46.4	2.4
West Southwest	18.9	10.5	22.1	7.8	31.7	12.6	39.8	11.8	43.1	13.6
East Southeast	15.9	3.3	18.7	4.3	28.9	10.8	41.1	14.6	40.8	14.7
Southwest	16.4	7.1	18.1	6.6	28.1	7.8	38.4	9.8	37.1	12.4
Southeast	15.2	2.3	16.2	2.6	25.6	3.9	36.9	5.9	36.9	8.5
Illinois	18.0	34.7	20.2	30.8	30.2	50.7	39.5	56.4	40.5	62.2

Source: Illinois Cooperative Crop Reporting Service

nesota and runs south to the Texas Panhandle grows about half of the nation's wheat (Leath et al. 1981d). In some southern states, winter wheat is double-cropped with soybeans. In Illinois, wheat was grown on 31 percent of the farms in 1982, but on only 6 percent of the harvested acreage (U.S. Department of Commerce 1984). In the past fifty years, the production of wheat in Illinois has almost doubled, from 34.7 to 62.2 million bushels (Table 1). Improved yields per acre rather than increased acreage account for this increased production.

Average wheat yields in Illinois have increased from 18.0 to 40.5 bushels per acre in the past fifty years (Table 1). Yields are relatively uniform throughout the State, but wheat production is greatest in the southern half of the State (Figs. 1 and 2). Increased yields per acre can be attributed in part to the selective use of herbicides and to the response of wheat to nitrogen fertilization. Since wheat is self-pollinating and since inbreeding produces no obvious reduction in yield, improvement in varieties through hybridization has not been as dramatic as it has been in corn. Straw strength (lodging resistance), however, is extremely important in keeping wheat plants upright for harvest, and shorter varieties less likely to lodge were introduced. Their foliage was more dense than that of taller varieties, and insect and disease problems increased. In recent years, disease resistance has been incorporated into many varieties of wheat. *270, 410*

Oats, Barley, and Rye

The combined value of oat, barley, and rye production in Illinois is only 10 percent of the value of wheat production (U.S. Department of Commerce 1984). Although singly or in combination these three grains were grown on 10 percent of Illinois farms in 1982, they were grown on less than 1 percent of the harvested acres.

Figure 1

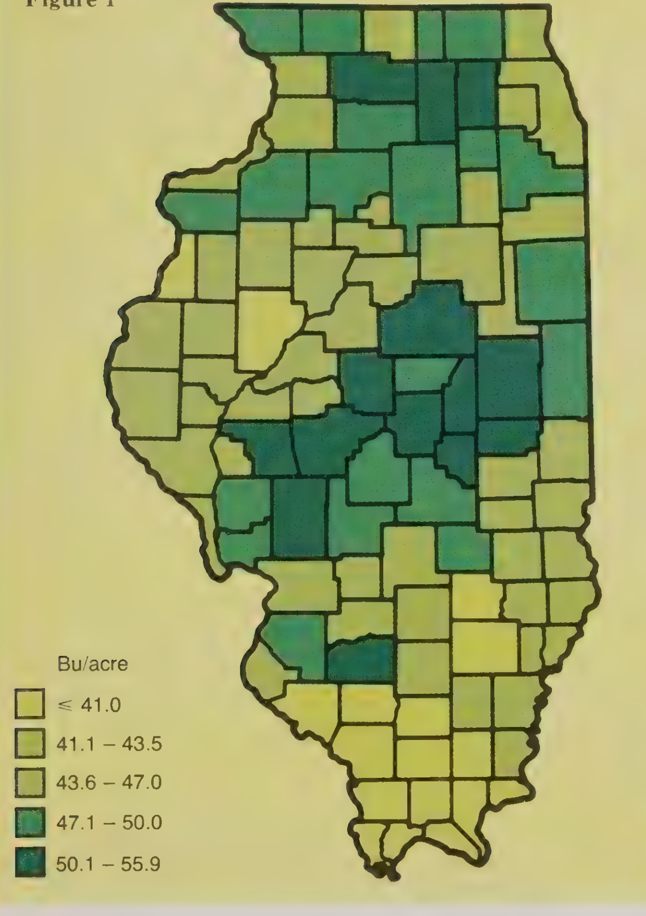


Figure 1. Average annual wheat yield per acre by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Figure 2

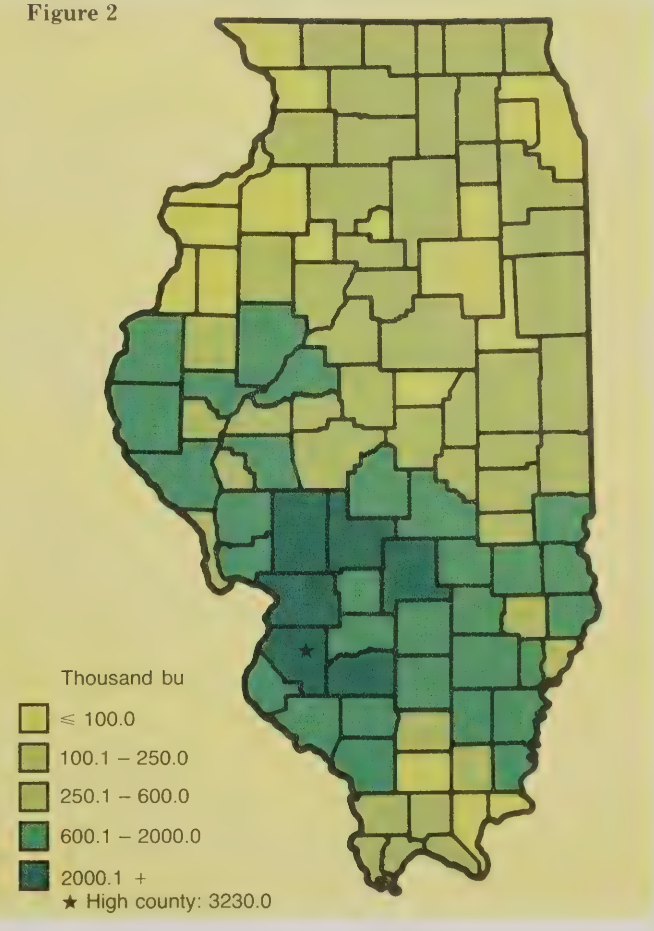


Figure 2. Average annual wheat production by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

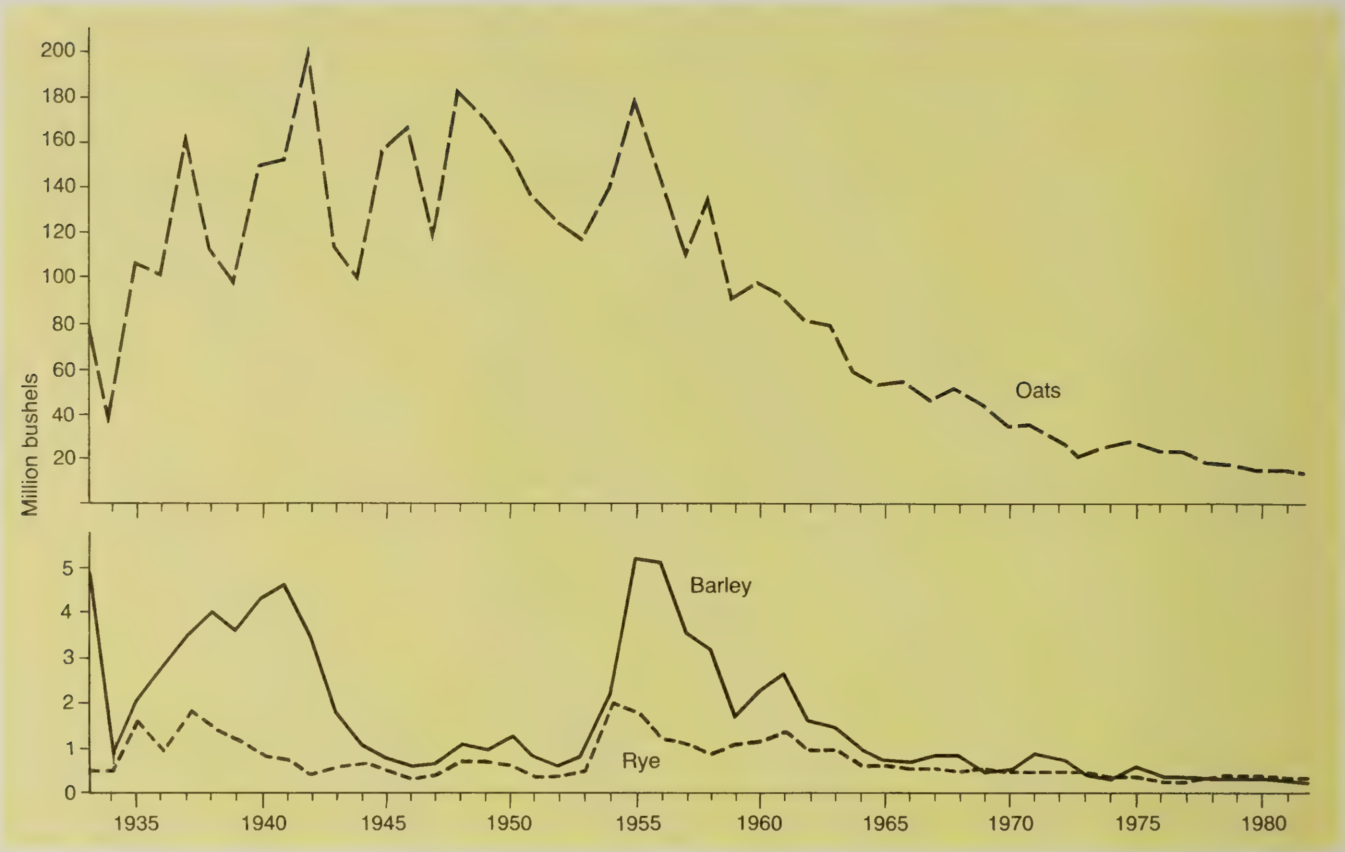


Figure 3. Annual production of oats, barley, and rye in Illinois, 1933-1982. Source: Illinois Cooperative Crop Reporting Service.

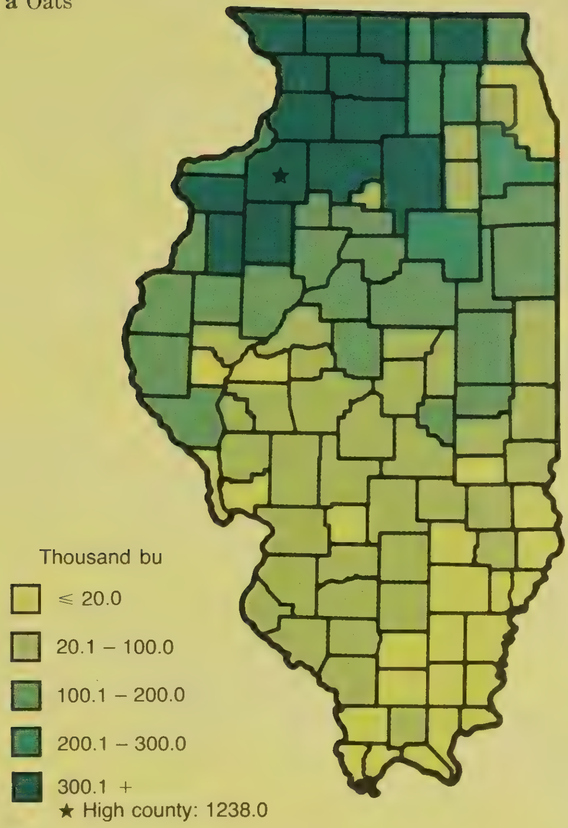
Oats do well on all productive soils in the East and Midwest, but production is concentrated in the Great Plains and the western Corn Belt. In Illinois, most oats are spring-sown on land not expected to produce a cash crop. The use of oats as a nurse crop for forage legumes is declining, and oat acreage continues to be displaced by soybeans. Over the past fifty years, oat production has declined by 85 percent (Fig. 3). Yield per acre, however, has increased by 78 percent through the use of disease-resistant varieties, selective herbicides, fertilizer, and improved machinery.

Barley is one of the oldest crops known to man. The Egyptians used it in the production of beer, and even today approximately 30 percent of the crop is sold to distillers. Barley is an excellent substitute for corn as a livestock feed, and three-fourths of the barley fed to livestock is used on the farm where it is grown (Hill et al. 1981a). In the United States, production of barley is concentrated in the northern Plains and on the Pacific Coast. Both spring and winter barley are grown in Illinois; spring barley is best adapted to the northern fourth of the State and winter barley to the southern half. Barley yield per acre is equal to that of wheat, but its value per bushel is much less. Since 1965, barley production in Illinois has been less than 2 million bushels (Fig. 3).

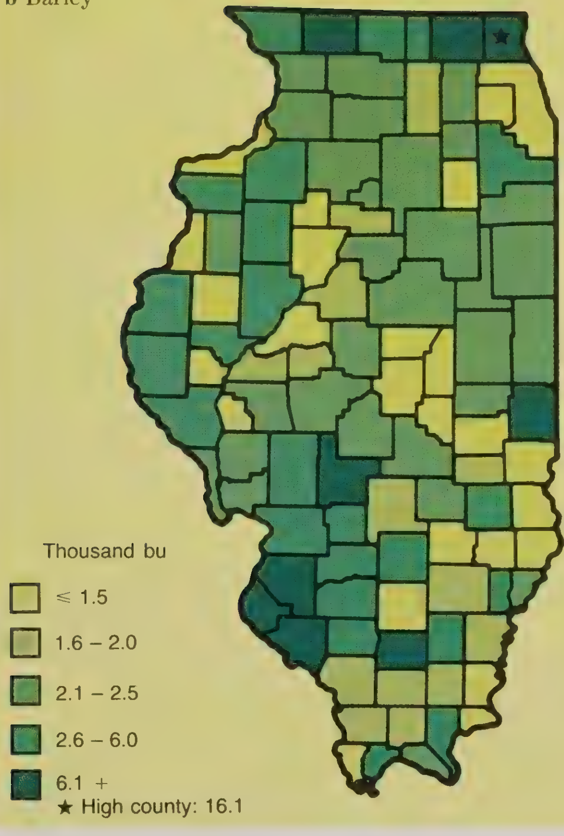
Rye is the most hardy of the small grains. It germinates and grows at lower temperatures than wheat and on sandy, more arid, less fertile soils. In the United States, production is concentrated in the north-central region (Hill et al. 1981a). Rye is used primarily for food products, alcoholic beverages, and seed; very little is used as feed on the farm. Rye has received less attention from plant breeders than the other small grains, and per-acre yields generally remain unchanged. Historically, the annual production of rye in Illinois has never exceeded 2 million bushels (Fig. 3).

▶
Figure 4. Average annual a. oat, b. barley, and c. rye production by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

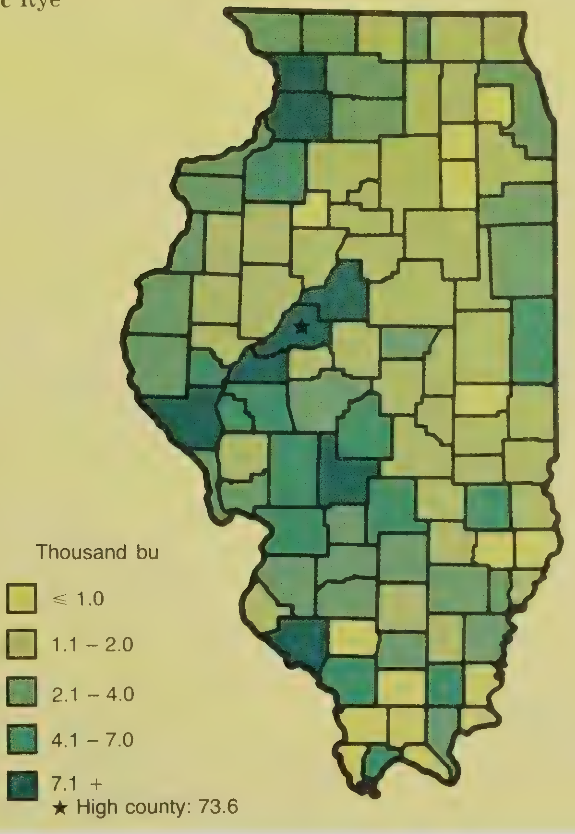
Average annual production of oats, barley, and rye for the five-year period 1978-1982 is shown in Figure 4. Average yield per acre for each of the three grains was 60.4, 44.0, and 23.2 bushels, respectively (Illinois Cooperative Crop Reporting Service). *61, 181, 267, 410* a Oats



b Barley



c Rye



Forage Crops

In recent years many Illinois farmers have moved from livestock production toward specialization in grain crops, a change that reduced the need for forage on many farms. By 1982 only 5 percent of Illinois cropland was planted to forage grasses or legumes (U.S. Department of Commerce 1984). Forage is produced from meadows–fields for hay production; from pastures–fields for grazing; and from cultivated row crops such as corn and sorghum, which may be used either for forage or for grain. Forage is harvested as hay–forage with the water removed by drying in the field; as silage–green herbage preserved through fermentation in airtight containers; and as green chop–forage chopped daily for direct feeding without storage. The Illinois production of hay, silage, and green chop in 1982 is shown in Table 2. The legumes–alfalfa, red clover, and lespedeza–are most often used as hay; members of the grass family–timothy, brome grass, and tall fescue–are most suitable for silage or green chop.

Alfalfa, a legume with high nutritional qualities, is the most important perennial forage crop in Illinois (Table 2). It can be pastured, makes an excellent hay species, and recovers rapidly after cutting. It does not grow well on acid soils but persists on fertile, well-drained neutral soil for many years. On less-suited soils it should be rotated after 3 to 5 years. Although the percentage of acres planted to forage crops is low, about one-fourth of Illinois farms grow alfalfa. Red clover, the second most important hay and pasture legume in Illinois, does not have the yield potential of alfalfa but persists under more acidic soil conditions and grows well with companion grasses. Although red clover is a perennial, disease often limits its life-span to two years. It is the forage crop most harvested for seed (Table 2). Lespedeza, a popular annual legume in the southern third of Illinois, survives on soils of low productivity where alfalfa and clovers cannot adapt. Although it has a relatively low yield, it does well in midsummer.

Timothy, smooth brome grass, and tall fescue are the most commonly grown grasses in Illinois. Timothy, a popular hay and pasture grass, is a cool-season perennial best adapted to the northern half of the State and often used as a companion with red clover. Smooth brome grass, the most widely adapted of the perennial grasses for hay and pasture in Illinois, grows well in the northern two-thirds of the State and is more tolerant to drought and less sensitive to soil acidity than timothy. Tall fescue, a high-yielding, rather rough grass, is a popular winter pasture in southern Illinois.

Table 2. Hay, silage and green chop, and forage seed harvested, 1982.

	Number of farms	Number of acres	Quantity
Hay			(dry tons)
Alfalfa	23,399	570,255	1,904,767
Small grain	2,341	40,283	82,344
Sorghum	4	55	——
Tame (other than above)	11,379	267,775	519,510
Wild	685	12,045	18,164
Silage, Green-chop			(green tons)
Corn	8,026	220,422	3,585,698
Grass	2,624	92,279	613,251
Sorghum	281	5,410	63,312
Seed			(pounds)
Alfalfa	12	98	11,223
Fescue	6	135	23,500
Red clover	540	11,074	966,925
Redtop	16	606	83,440
Timothy	9	298	26,280

Source: Illinois Cooperative Crop Reporting Service

Table 3. Average yield per acre and average annual production of hay, 1933–1982.

Crop-reporting districts	1938–1946 Tons/A	1938–1946 Thousand tons	1947–1955 Tons/A	1947–1955 Thousand tons	1956–1964 Tons/A	1956–1964 Thousand tons	1965–1973 Tons/A	1965–1973 Thousand tons	1974–1982 Tons/A	1974–1982 Thousand tons
Northwest	1.7	805.2	1.9	967.6	2.4	1169.2	3.2	1028.0	3.6	1044.4
Northeast	1.7	610.9	2.0	753.5	2.4	725.9	3.0	465.1	3.2	362.6
West	1.5	394.6	1.6	438.2	2.0	491.7	2.6	413.1	2.9	432.1
Central	1.5	387.5	1.7	467.9	2.0	498.0	2.9	283.2	3.1	235.1
East	1.5	293.2	1.6	314.0	2.0	335.2	2.7	172.5	3.2	153.5
West Southwest	1.5	509.8	1.7	454.8	2.1	453.2	2.6	375.2	2.9	410.2
East Southeast	1.1	520.6	1.2	340.5	1.6	320.7	2.2	250.0	2.5	283.2
Southwest	1.4	344.8	1.5	320.9	1.8	350.7	2.3	357.6	2.6	410.2
Southeast	1.0	266.4	1.1	195.5	1.4	188.3	1.8	192.8	2.1	223.5
Illinois	1.5	4133.1	1.6	4252.9	2.1	4532.8	2.7	3537.3	3.0	3554.8

Source: Illinois Cooperative Crop Reporting Service

Over the past forty-five years, the yield per acre of forage crops harvested as hay has doubled, but their production in Illinois has decreased 15 percent (Table 3). Many of the counties leading in production and yield are in northwestern Illinois (Figs. 5 and 6). *173, 410*

Figure 5. Average annual hay yield per acre by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Figure 6. Average annual hay production by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Figure 5

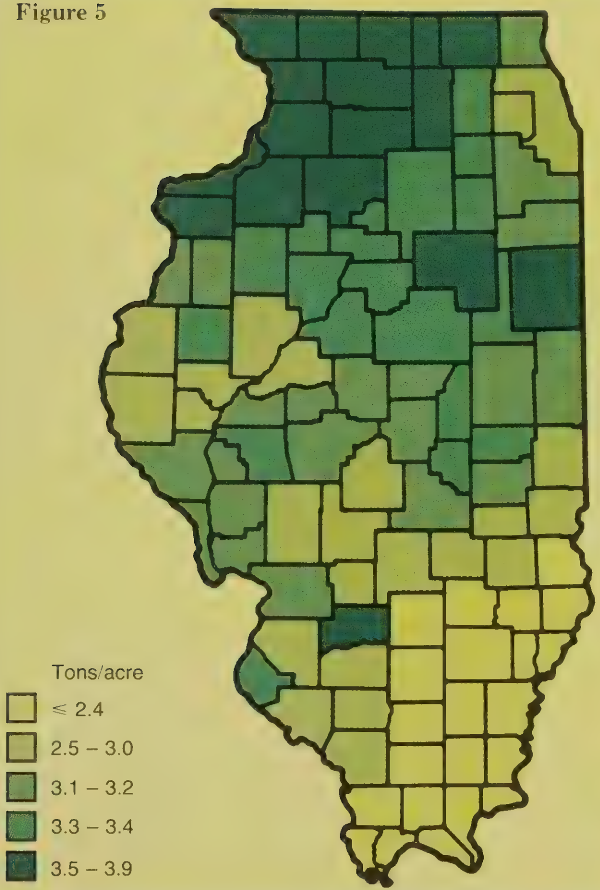
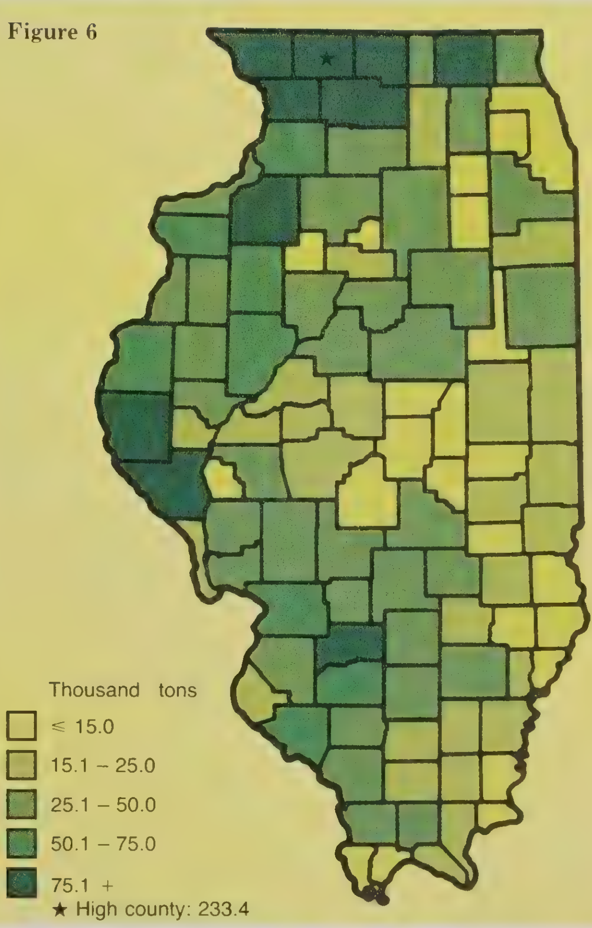


Figure 6



Sorghum

Sorghum, the second most important feed grain grown in the United States, has been called the corn crop of the dry lands. Although four types of sorghum (grain sorghum, sweet sorghum, broom corn, and Sudan grass) are grown nationally, only grain sorghum has a substantial volume of production in Illinois.

As a young plant, grain sorghum closely resembles corn; as it matures, however, it becomes distinctive. At maturity it may be 15 feet tall, but a number of dwarf varieties that grow to only 3 feet are available. The primary advantage of sorghum over other crops is that it slows its growth during periods of drought and resumes normal growth when moisture again becomes available. Sorghum leads all major crops in above-ground dry matter production per unit of water absorbed. The seed of grain sorghum is extremely nutritious as a livestock feed and parallels yellow corn as an important source for fattening cattle (Boone et al. 1981).

The production of grain sorghum is concentrated along the eastern fringe of the Great Plains where rainfall is inadequate for corn and soybean production. Sorghum is adapted to almost all soils, from sand to heavy clay. Over 85 percent of the sorghum produced in the United States is grown in Kansas, Missouri, Nebraska, and Texas (Leath et al. 1981b).

Management practices for growing sorghum are much the same as those for growing corn. Its relatively small seeds emerge more slowly than corn seeds, however, and serious weed-control problems can result (Anderson et al. 1984). The small sorghum seeds are also more difficult to dry in storage than corn seeds. Sorghum's response to fertilization with nitrogen has been erratic, but narrow-row plantings have increased yields. Hybrid dwarf varieties suitable for harvest with a combine are rapidly replacing taller, open-pollinated varieties. The sorghum head is compact, yet more exposed than that of corn, and in rainy weather the seed may sprout prior to harvest. In spite of these problems, yields per acre in Illinois have increased modestly but consistently over the past fifteen years (Table 4).

Although sorghum can be grown successfully throughout Illinois, its potential is greatest in the southern third of the State (Figs. 7 and 8). In 1982, fewer than 2,000 farmers in Illinois grew sorghum on approximately 100,000 acres (U.S. Department of Commerce 1984). *8, 48, 158, 268, 410*

Table 4. Average yield per acre and average annual production of sorghum, 1967–1982.

Crop-reporting districts	1967–1970 Bu/A	1967–1970 Thousand bu	1971–1974 Bu/A	1971–1974 Thousand bu	1975–1978 Bu/A	1975–1978 Thousand bu	1979–1982 Bu/A	1979–1982 Thousand bu
Northwest	64.5	47.5	64.6	130.4	67.2	57.6	47.5	57.2
Northeast	58.1	38.9	63.5	66.9	64.0	40.2	41.5	38.2
West	62.2	39.4	64.7	174.7	61.1	66.1	64.0	172.6
Central	60.3	37.4	63.5	64.6	66.1	44.3	66.0	51.0
East	63.5	49.0	64.2	71.4	67.9	44.8	60.5	45.4
West Southwest	56.0	217.0	63.5	915.2	67.8	577.4	71.5	690.7
East Southeast	52.5	73.7	61.3	812.3	70.0	672.6	69.7	455.0
Southwest	58.2	302.6	62.7	2026.0	64.1	1787.7	66.0	1942.8
Southeast	52.2	78.1	62.0	1237.6	65.9	939.9	65.9	1677.6
Illinois	58.0	883.5	62.7	5499.0	66.0	4224.0	67.5	5130.0

Source: Illinois Cooperative Crop Reporting Service

Fruits and Vegetables

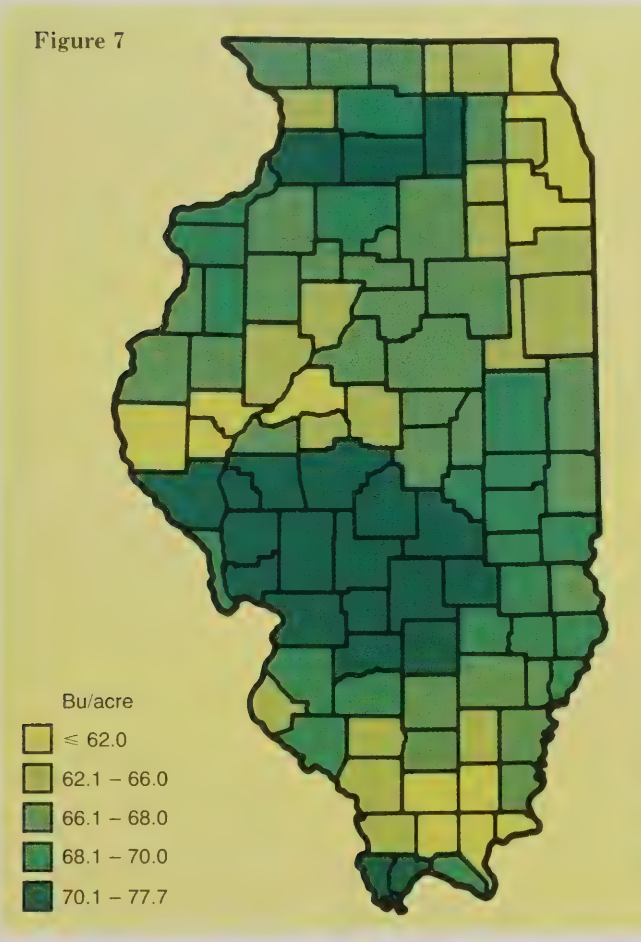
To the casual observer, Illinois appears to grow only corn and soybeans. Yet, scattered throughout the State in 1982 were almost 114,000 acres of vegetables, sunflowers, and melons (Table 5), 13,000 acres of fruits and nuts (Table 6), and 1,100 acres of berries (Table 7). More than two-thirds of our nation's annual commercial production of horseradish comes from Madison and St. Clair counties. Illinois is also the nation's leading producer of onion sets and canning pumpkins and ranks seventh as a supplier of processed vegetables (sweet corn, green beans, and peas).

Less than one-half of 1 percent of the cropland in Illinois is planted to fruits and vegetables, but even this relatively small acreage allows some farms to diversify and thus lend financial stability to their operations. To be successful, these specialty farmers must have the training and experience to grow an acceptable product efficiently, a convenient and permanent market, labor available at harvest, and sufficient capital to extend through several years–particularly with orchard crops. Although technical knowledge and favorable economic conditions are essential to successful commercial gardening or truck farming, the natural conditions of soil, site, and weather ultimately determine its success. Orchards should be located where winter temperatures, spring frosts, wind, hail, and the settling of cold air cause the least damage. Deep soil is best for trees, and fertile soil is desired for succulent annual plants. Sunshine is required for both.

All production costs for fruits and vegetables have increased in recent years, but the single largest increase has been for labor. Efforts to reduce labor costs at harvest have led to dramatic changes in plant varieties and harvesting methods. Dwarf varieties of fruit trees, for example, are now planted in large numbers because of the relative ease of harvesting.

Figure 7. Average annual sorghum yield per acre by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Figure 8. Average annual sorghum production by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.



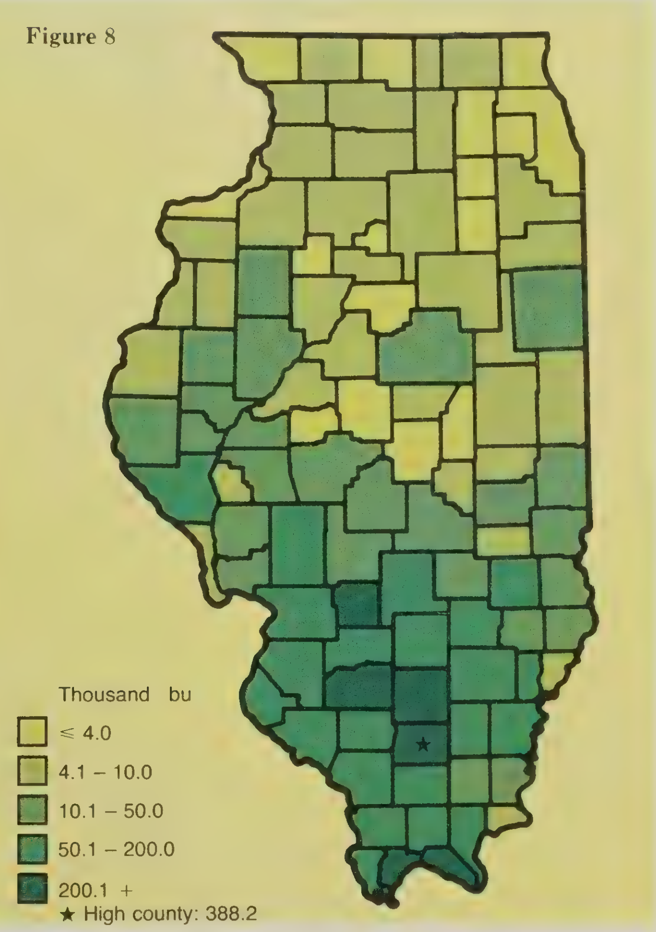


Table 5. Harvested acreage of vegetables, sunflowers, and melons, 1982.

	Number of farms	Acres	Leading producer (county)
Asparagus	52	3,259	*
Bean, dry edible	95	5,260	Iroquois
Bean, green lima	30	2,536	McLean
Bean, snap	219	4,206	*
Beet	52	69	Lake
Broccoli	64	107	Kane
Cabbage, head	129	1,458	*
Cantaloupe	161	874	Kankakee
Carrot	22	12	*
Cauliflower	59	126	*
Collard	18	217	*
Cucumber	162	517	Union
Eggplant	56	120	Kankakee
Honeydew melon	6	23	*
Lettuce and romaine	15	126	*
Mustard green	33	349	Kankakee
Onion, dry	55	306	Cook
Okra	21	16	Monroe
Parsley	9	49	Lake
Pea, green	355	13,890	Lee
Pepper, hot	42	88	*
Pepper, sweet	213	680	Union
Popcorn	312	23,723	Saline
Potato, Irish	206	2,293	Monroe
Potato, sweet	7	10	*
Pumpkin	267	5,320	Tazewell
Radish	9	149	*
Spinach	17	360	Monroe
Squash	164	484	Cook
Sunflower	59	2,244	Cass
Sweet corn	950	41,319	De Kalb
Tomato	378	1,982	Mercer
Turnip	40	162	Kankakee
Turnip green	30	423	Cook
Watermelon	113	925	Mason

* Data not available.

Source: U.S. Department of Commerce 1984

Table 6. Fruit and nut acreage, 1982.

	Number of farms	Acres
Apples	902	9,197
Apricots	81	20
Cherries	174	85
Grapes	206	226
Nectarines	48	40
Peaches	483	3,441
Pears	175	100
Persimmons	10	3
Plums and prunes	148	110
Pecans	24	23

Source: U.S. Department of Commerce 1984

Table 7. Berries harvested for sale, 1982.

	Number of farms	Number of acres	Quantity (pounds)
Blackberries	32	25	36,320
Blueberries, tame	19	119	357,625
Raspberries	65	83	140,595
Strawberries	332	858	3,079,967

Source: U.S. Department of Commerce 1984

Apples and peaches are the only orchard crops grown on more than 1,000 acres in Illinois (Table 6). Marketing factors have virtually eliminated once popular varieties such as the Winesap and Stayman, and 85 percent of the Illinois apple crop is now accounted for by Delicious, Golden Delicious, and Jonathan. Apple production in general, however, has declined in Illinois, primarily because of harvest costs (Fig. 9). Because Illinois peaches are occasionally injured by freezing temperatures, year-to-year yields vary enormously (Fig. 9). The leading apple- and peach-producing counties are shown in Figures 10 and 11. Two of the 102 Illinois counties, Union and Jackson, accounted for over 26 percent of the apple harvest and nearly 47 percent of the peach crop in 1982.

Figure 9

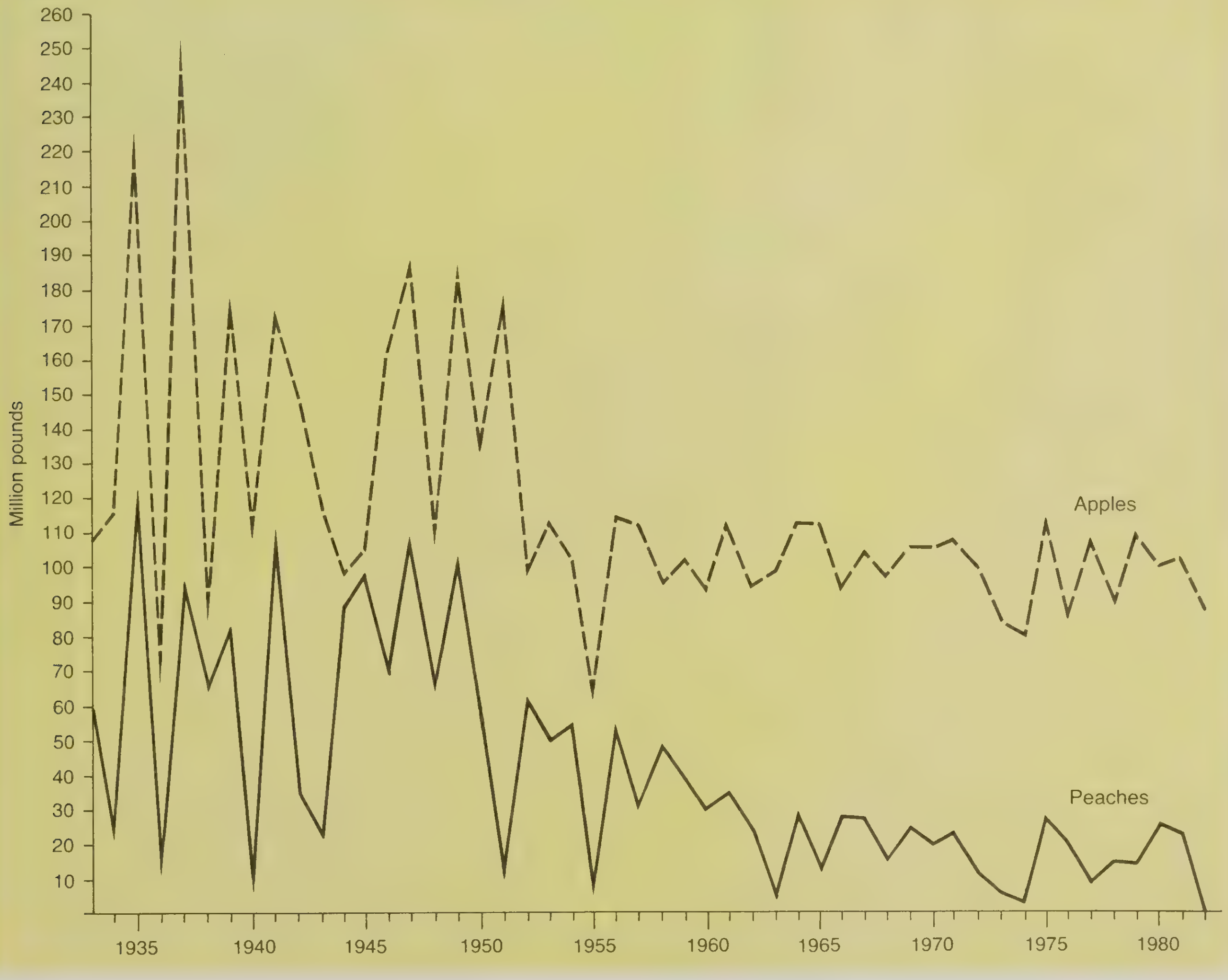


Figure 9. Annual production of apples and peaches in Illinois, 1933-1982 (million pounds). Source: U.S. Department of Commerce 1984.

Figure 10. Leading apple-producing counties, 1982. Source: U.S. Department of Commerce 1984.

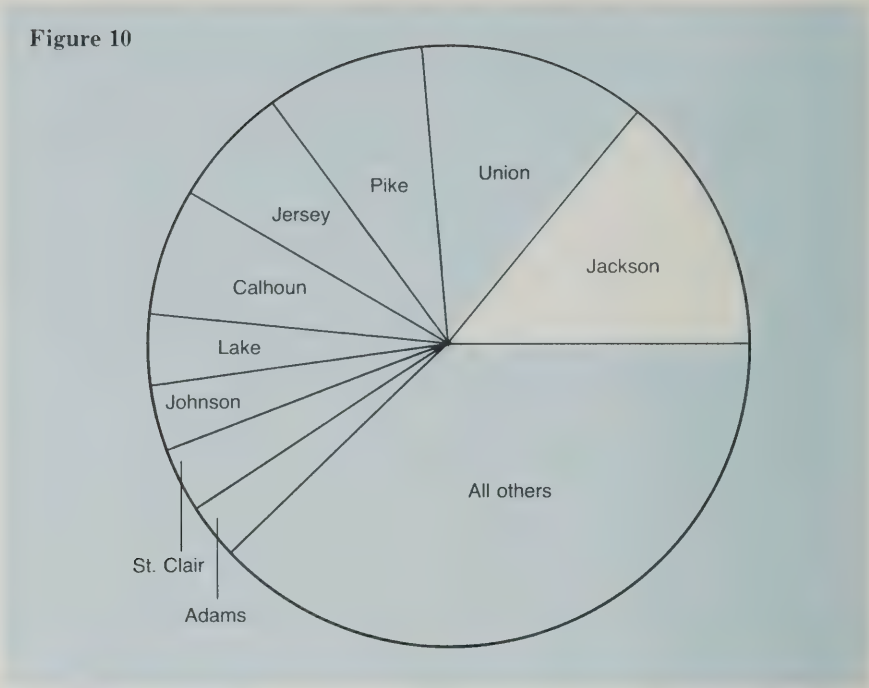
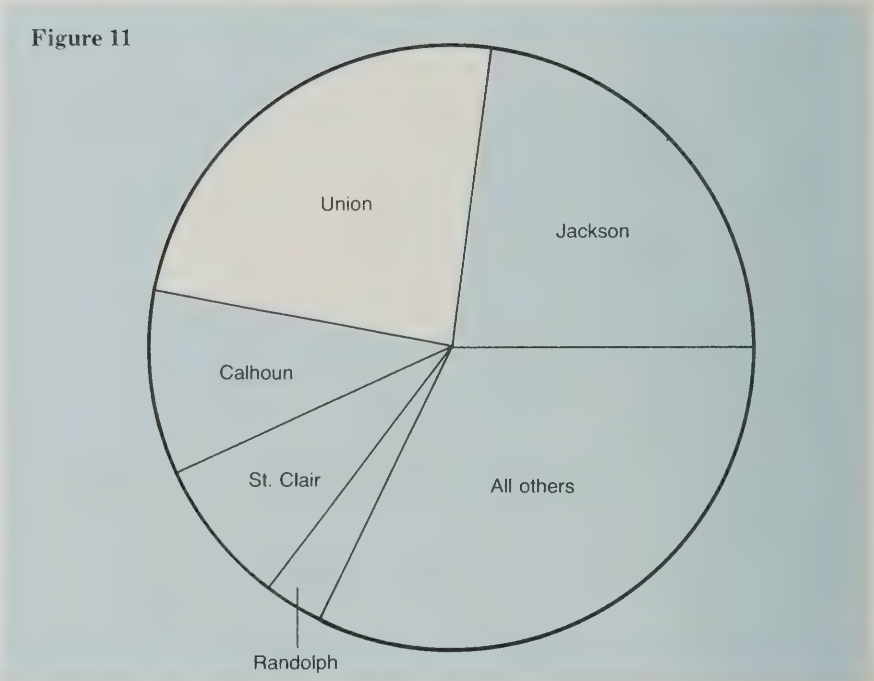


Figure 11. Leading peach-producing counties, 1982. Source: U.S. Department of Commerce 1984.



Income from all fruits and nuts grown in Illinois in 1982 was $10.4 million; berries contributed $1.4 million to that total (U.S. Department of Commerce 1984). Although more than 2,000 Illinois farms shared in that fruit and nut income, total acreages were often small–only 20 acres, for example, were given to Illinois apricot production and 23 to pecans (Table 6).

Sweet corn, green peas, and popcorn accounted for over two-thirds of the vegetable acreage in Illinois in 1982 (Table 5). Only asparagus, dry edible beans, snap beans, green peas, popcorn, pumpkins, and sweet corn were grown on 3,000 or more acres. The ten leading vegetable- and melon-producing counties are shown in Figure 12. In 1982, Illinois income from vegetable production was approximately $60 million (U.S. Department of Commerce 1984). *88, 102, 137, 138, 310, 330, 377, 389, 410*

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Figure 12

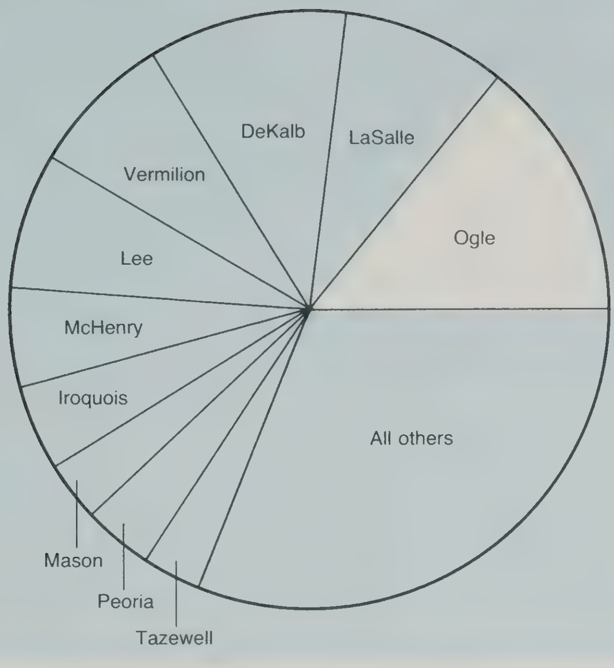


Figure 12. Leading vegetable- and melon-producing counties, 1982. Source: U.S. Department of Commerce 1984.

Livestock

Illinois ranks eighth among the states in livestock and livestock products marketed (Illinois Department of Agriculture 1984). In 1982, nearly a third of the market value of Illinois agricultural products came from the sale of livestock and poultry and their products. Although cattle and swine account for the greater market share, profits from dairying, poultry and eggs, and sheep were important to a number of specialty farmers. *197*

Beef Cattle

Beef cattle do not convert feed to food for human consumption as efficiently as poultry, swine, or dairy cattle. Beef cattle, however, have the ability to utilize roughage (high fiber, low-energy feeds), whereas swine and poultry require more concentrated, high-energy feeds (grain). In addition, cattle are adapted to semiarid grazing land and flourish without daily attention. Because suitable land for grazing has decreased, western cattle are now often grown in confinement or sold as feeder calves or stocker cattle. In the Corn Belt, however, some grazing land remains and will in all likelihood continue to be available. Farmers in this area, therefore, purchase calves or maintain cow-calf herds to utilize surplus roughage and feed grain grown on their farms.

The number of cattle in the United States varies from year to year, depending on grain costs as well as supply and demand, and Illinois beef cattle production reflects this variability (Table 1). Although beef cattle are raised throughout the State, they tend to be concentrated in the western counties (Fig. 1).

Beef cattle are found on more farms in Illinois than are swine but are less often considered the primary farm enterprise. Approximately 39,000 Illinois farms sold cattle in 1982, but only about a third (10,900) listed beef production as the primary enterprise (U.S. Department of Commerce 1984). On 4,200 of these beef farms, cattle were kept primarily in feedlots; on

Table 1. Average annual inventory of beef cattle (× 1,000), 1951–1982.

Crop-reporting districts	1951–1954	1955–1958	1959–1962	1963–1966	1967–1970	1971–1974	1975–1978	1979–1982
Northwest	80.0	86.1	79.6	93.7	108.5	135.3	136.4	129.2
Northeast	33.4	36.2	38.8	40.2	36.7	38.5	32.0	26.5
West	86.0	101.2	113.5	133.0	142.6	152.2	154.4	150.5
Central	58.9	88.6	86.1	91.5	82.9	81.9	70.8	61.3
East	70.7	63.6	58.8	60.5	43.0	40.6	35.5	31.1
West Southwest	78.1	97.1	111.1	135.7	137.3	134.9	140.0	127.0
East Southeast	52.6	65.7	77.1	90.0	86.9	82.7	88.9	82.6
Southwest	28.7	38.6	48.0	62.7	63.0	78.4	76.2	63.6
Southeast	36.1	47.6	57.5	70.2	74.8	80.5	80.3	68.8
Illinois	524.5	624.7	670.5	777.5	775.7	825.0	814.5	740.6

Source: Illinois Cooperative Crop Reporting Service

6,700 of them, cattle were grazed. Sales of feedlot cattle, however, were six times the sales of grazed cattle. Finally, farms on which the primary enterprise was beef production accounted for 63 percent of all cattle sales in 1982. The total income that year from the sale of cattle and calves in Illinois was approximately $750 million; however, $50 million of that total was derived from the sale of the calves of dairy cows.

Beef is one of America's most nutritious and favorite foods; however, per capita consumption has been down since 1976 and consumers are insisting on more lean meat and less fat. In addition, poultry prices have been highly competitive. As a result, greater efficiency in cattle operations is needed, and current research focuses on the physiology of reproduction, on genetics (cross-breeding), on animal nutrition (more efficient rations and feed additions), and on the use of feedlots, including the pollution effects of feedlots, as opposed to grazing (Lasley 1981). *263, 291, 387, 410*

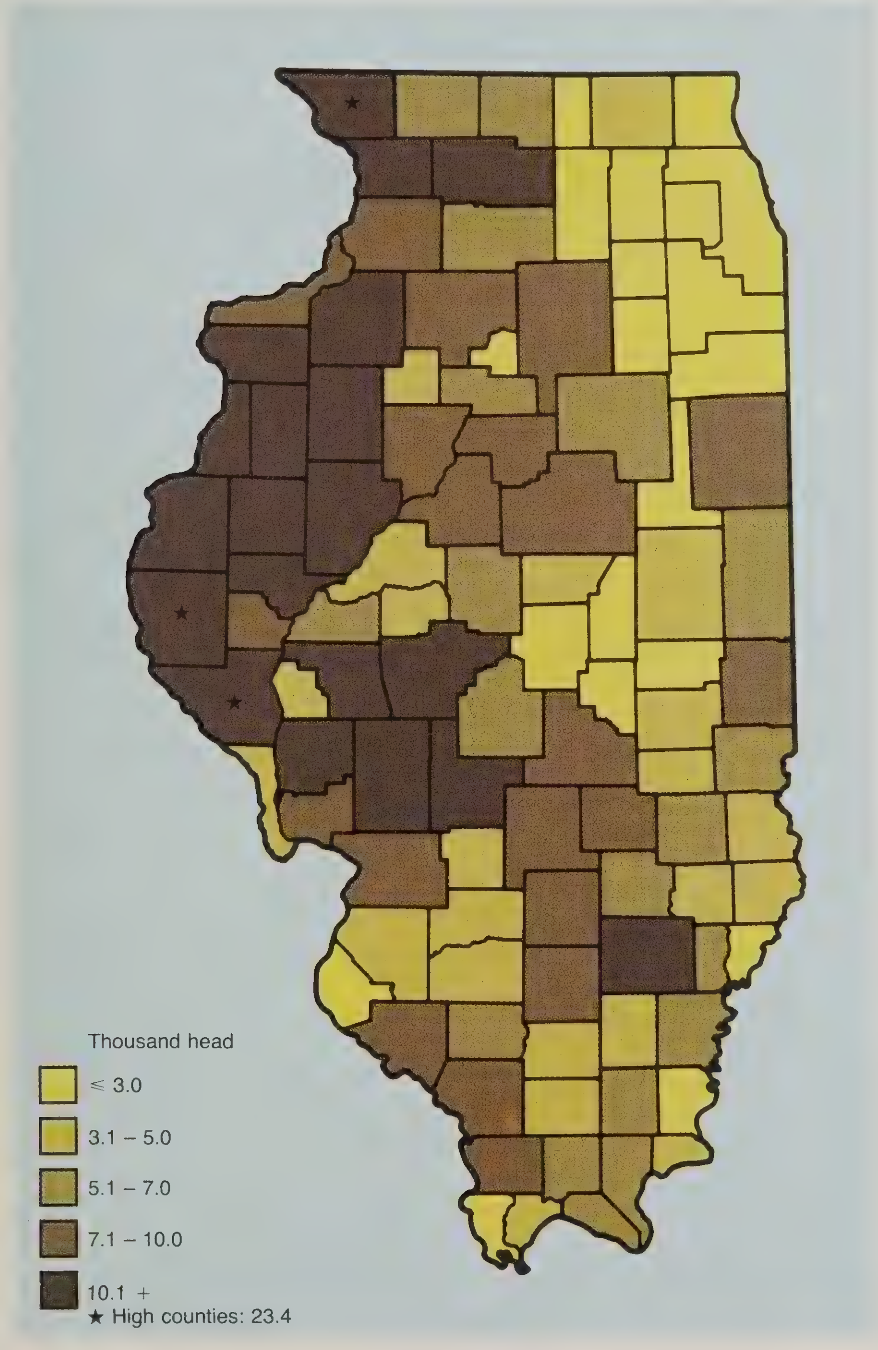


Figure 1. Average annual beef cattle inventory by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Dairy Cattle

Although mechanization has decreased the number of farm workers, dairying remains labor intensive. As a result, dairy farming has tended to remain a family business. Because individual milk producers can do little to change the selling price of milk, they can increase their profit only by lowering production costs. Most dairy farms, therefore, have cropland for the production of roughage, and many also have tillable land for producing grain. In recent years, pasturing has become rare and the use of green chop and silage or haylage (high-moisture hay) in dairy rations has increased. The reasons are primarily economic. Forage yield per acre for pasture is low, and trampage reduces it even further. In addition, the nutrient qualities of pasture are optimal for only a limited time.

The number of dairy cows on Illinois farms has been steadily decreasing over the past thirty years, with a dramatic drop in the 1960s (Table 2). Since 1948, however, milk production per cow has doubled. Over half of the milk in Illinois is produced in the northern counties (Fig. 2).

Dairying has become a specialized kind of farming in Illinois. By 1982, only 1 percent of the farmers kept the traditional one or two cows for milk consumption on the farm, and only 5 percent sold dairy products. In fact, 65 percent of the milk cows in the State were in herds of 50 or more animals, and on only 3,000 farms (6 percent of the 53,000 farms with livestock) was dairying considered the primary enterprise (U.S. Department of Commerce 1984). These 3,000 farms, however, accounted for 95 percent of the State's total income ($288 million) from dairying. *125, 410*

Swine

The Corn Belt is the center of swine production in the United States. The number of animals marketed nationally has gradually increased over the past fifty years, a marked change from the 1930s, when the number of marketed animals dropped sharply as the result of a drought-produced grain shortage. The number of hogs inventoried on Illinois farms has increased by 45 percent since 1933 (Table 3), with the western counties showing the largest numbers (Fig. 3). The modest decline in the Illinois inventory evident since 1967 reflects changes in the American diet and a decrease in the per capita consumption of pork.

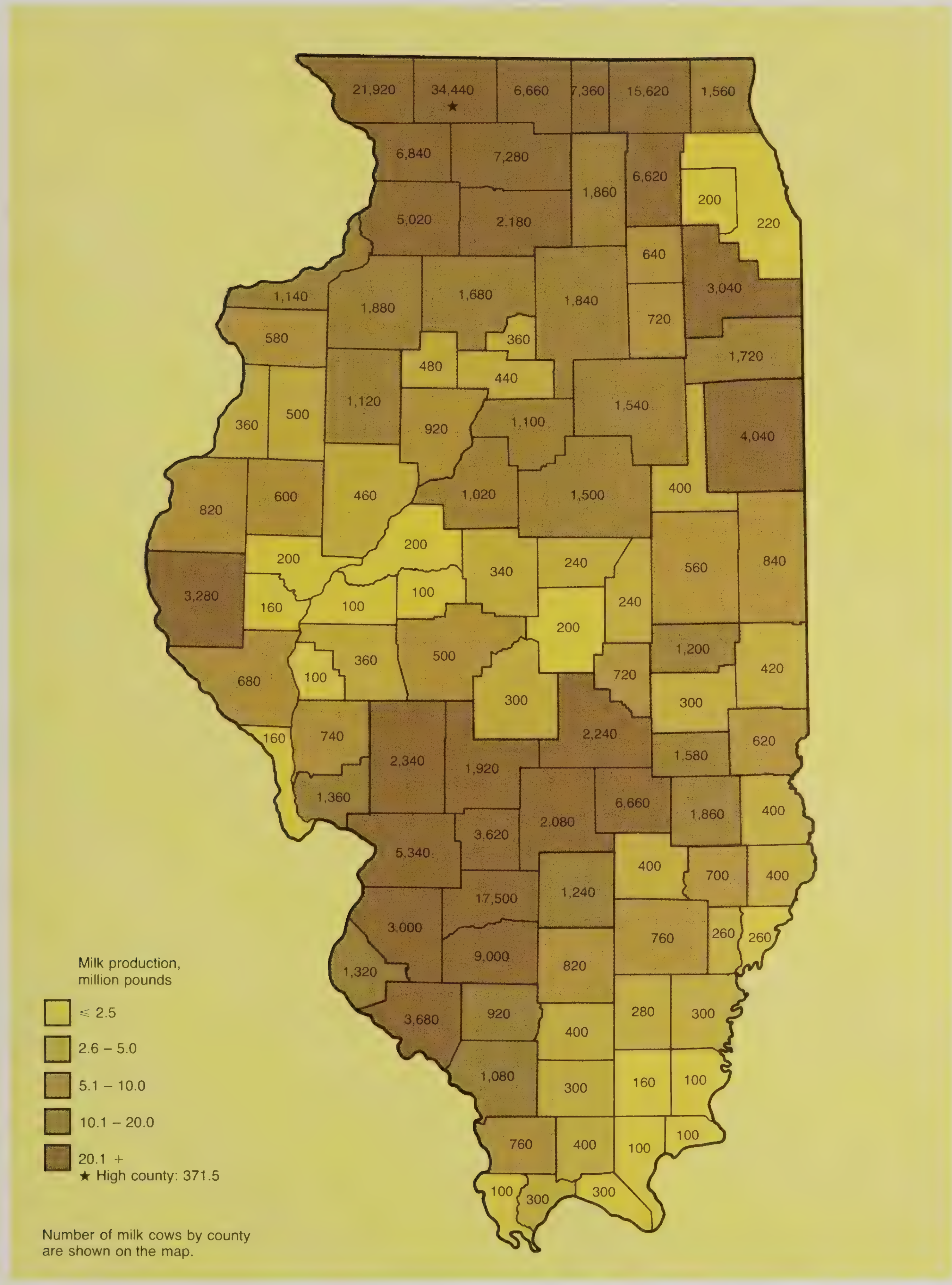
Swine production was the principal enterprise for 9,900 of the 92,000 Illinois farms in 1982 (U.S. Department of Commerce 1984). Another 12,900

▶ **Figure 2.** Average annual inventory of milk cows and milk production by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Table 2. Average annual inventory of milk cows and average annual milk production, 1948–1982.

	1948–1954		1955–1961		1962–1968		1969–1975		1976–1982	
Crop-reporting districts	Thousand head	Million pounds	Thousand head	Million pounds	Thousand head	Million pounds	Thousand head	Million pounds	Thousand head	Million pounds
Northwest	213.3	1231	207.0	1362	165.2	1314	102.2	1013	78.7	954
Northeast	191.0	1135	160.3	1193	108.9	906	59.4	575	37.1	422
West	77.1	348	54.4	282	25.0	153	110.0	89	9.0	78
Central	83.7	403	57.3	327	27.7	198	11.9	104	6.8	72
East	74.4	356	49.8	303	25.9	196	13.3	123	12.5	106
West Southwest	104.5	497	68.5	374	39.8	275	22.1	196	14.9	192
East Southeast	105.0	431	69.9	357	39.2	263	24.6	217	16.4	224
Southwest	83.0	405	67.0	383	49.6	370	39.7	382	33.0	425
Southeast	44.1	141	26.7	96	11.7	60	6.5	49	3.7	42
Illinois	976.2	5147	760.9	4675	492.9	3736	290.6	2750	212.0	2515

Source: Illinois Cooperative Crop Reporting Service


21,920
34,440 ★
6,660
7,360
15,620
1,560
6,840
7,280
1,860
6,620
200
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5,020
2,180
640
3,040
1,140
1,880
1,680
1,840
720
580
360
480
440
1,720
1,120
1,540
360
500
920
1,100
4,040
820
600
460
1,020
1,500
400
200
200
240
560
840
3,280
160
100
100
340
240
200
360
500
1,200
420
680
100
300
720
300
2,240
160
740
2,340
1,920
1,580
620
1,360
6,660
1,860
400
5,340
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400
700
400
17,500
1,240
3,000
760
260
260
9,000
820
1,320
3,680
920
280
300
400
1,080
300
160
100
760
400
100
100
100
300
300
Milk production, million pounds
≤ 2.5
2.6 – 5.0
5.1 – 10.0
10.1 – 20.0
20.1 +
★ High county: 371.5
Number of milk cows by county are shown on the map.

Table 3. Average annual inventory of hogs (× 1,000), 1933–1982.

Crop-reporting districts	1933–1937	1938–1942	1943–1947	1948–1952	1953–1957	1958–1962	1963–1967	1968–1972	1973–1977	1978–1982
Northwest	986.6	1141.0	1465.2	1485.2	1595.7	1911.5	1826.3	1730.1	1543.8	1586.6
Northeast	334.9	433.1	605.6	557.4	561.3	630.4	550.5	421.7	361.0	395.8
West	783.3	874.5	1113.3	1105.2	1022.0	1225.6	1267.6	1263.0	1091.1	1078.4
Central	528.9	594.7	784.3	712.2	658.7	774.3	685.7	582.3	556.2	573.0
East	323.2	359.4	452.7	369.6	308.9	362.3	319.2	278.5	279.0	292.4
West Southwest	641.2	720.4	949.8	922.6	834.5	1117.4	1236.1	1313.8	1185.6	1175.6
East Southeast	436.6	471.5	567.9	491.5	388.3	530.6	632.0	679.7	644.0	705.4
Southwest	213.4	231.9	292.0	259.4	228.5	307.9	319.6	373.1	385.6	359.6
Southeast	195.9	210.7	250.9	242.4	211.6	302.2	338.0	385.2	343.7	263.2
Illinois	4444.0	5037.2	6481.7	6145.5	5809.5	7162.2	7175.0	7027.4	6390.0	6430.0

Source: Illinois Cooperative Crop Reporting Service

farms raised swine as a secondary enterprise. Of the $2.2 billion income from livestock on Illinois farms in 1982, hogs accounted for 48 percent ($1.06 billion).

In 1982, 9.5 million hogs were sold from 22,900 Illinois farms; year-end inventories for these farms were about 6 million head (U.S. Department of Commerce 1984). Farms with inventories of less than 100 head accounted for 45 percent of the farms, but only about 6 percent of the animals; farms with inventories of 500 to 2,000 head accounted for only 15 percent of the farms but about 49 percent of the animals.

The majority (78 percent) of Illinois pork producers had sow and litter programs in 1982; 22 percent fattened only feeder pigs (U.S. Department of Commerce 1984). Half of the producers with sow and litter programs maintained fewer than 25 breeding pigs each and farrowed only 12 percent of the pigs; 13 percent of the producers with sow and litter programs, however, maintained over 100 breeding pigs each and farrowed 49 percent of the pigs.

In 1982, Illinois pork producers with sow and litter programs farrowed a total of 1.1 million litters. Eighty percent of these producers, however, farrowed fewer than 100 litters each and produced 35 percent of the total number of litters. Only 1 percent of these producers farrowed 500 or more litters, but these producers accounted for 14 percent of the total number of litters. Illinois swine production, obviously, has become a highly specialized undertaking. *250, 321, 410*

Sheep

Improvements in the efficiency of sheep and wool production in the United States have not kept pace with those in other livestock industries. Following World War II, productivity of lamb and wool per animal scarcely changed; diseases and parasites caused staggering losses, and the number of sheep plummeted to the lowest level since 1867, when census records began. Consequently, the United States now imports a substantial portion of its lamb and most of its wool (Ensminger 1970). More sheep are currently raised in the southern than in the northern hemisphere, with Australia and New Zealand having ten times more sheep than people.

America's first woolen mill was built in 1662 in Watertown, Massachusetts. By 1840 there were 19 million domestic sheep in New England and New York, but none in the West. By 1850, sheep were being raised in the Ohio Valley and the Great Lakes region, but as land values in these areas rose, sheep raising moved to the range states. Sheep numbers peaked in this country in 1884 (Ensminger 1970).

The vast majority of sheep in the United States are found in the western range, where they graze on arid or semiarid pastures and waste fields. In many states, sheep are grown in farm flocks for wool, and the lambs are sold directly for slaughter. On a few farms, sheep production has become a major enterprise, and economics have dictated new practices. As early weaning has proved practical, confinement as opposed to grazing has become more general. The use of hormones to increase the number of multiple births has also proved profitable.

Over the past fifty years, sheep inventories in Illinois have decreased by 80 percent (Table 4). Sheep are widely distributed throughout the State, however, (Fig. 4) and the 1982 Census of Agriculture (U.S. Department of Commerce 1984) revealed that sheep and lambs were found on more Illinois farms than were dairy cows and calves (4,500 farms versus 4,400).

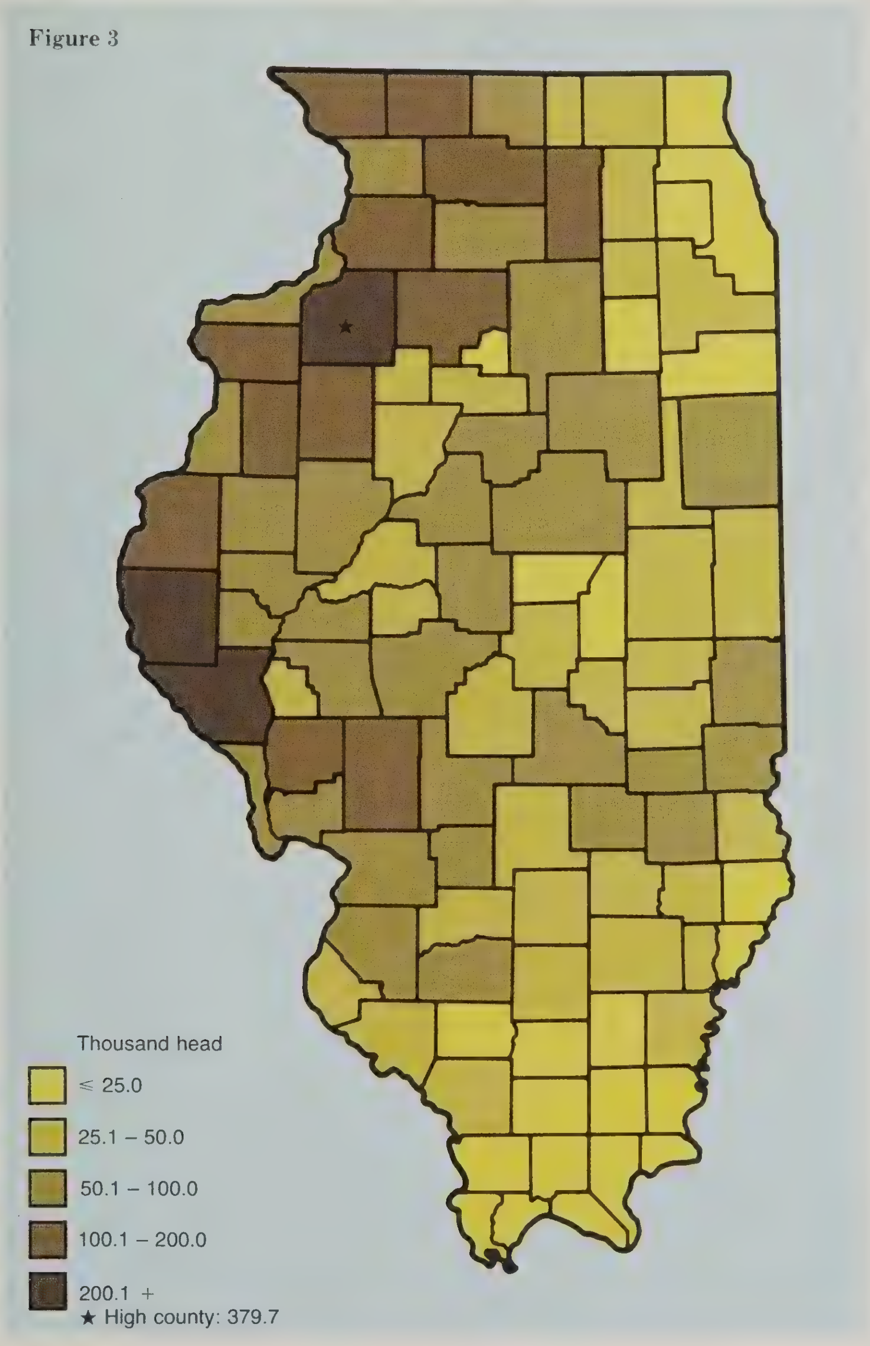

Figure 3. Average annual hog inventory by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Table 4. Average annual inventory of sheep (× 1,000), 1933–1982.

Crop-reporting districts	1933–1937	1938–1942	1943–1947	1948–1952	1953–1957	1958–1962	1963–1967	1968–1972	1973–1977	1978–1982
Northwest	207.6	173.7	83.3	73.4	93.5	98.1	71.5	57.5	42.7	37.1
Northeast	108.5	95.5	52.4	50.2	64.0	65.0	46.7	32.3	22.4	18.6
West	103.0	99.5	68.6	50.5	70.9	76.7	57.5	38.9	27.9	25.6
Central	92.3	92.0	68.1	57.4	76.7	76.3	53.1	34.7	23.7	22.5
East	57.7	59.3	47.4	42.4	54.2	62.4	43.5	28.1	18.8	15.0
West Southwest	123.8	126.1	82.2	56.5	60.7	62.2	45.8	34.1	23.8	22.8
East Southeast	123.9	119.0	83.2	56.0	67.2	72.2	50.4	35.2	20.2	14.1
Southwest	20.6	21.1	17.6	16.2	19.1	19.0	11.9	9.5	6.6	5.7
Southeast	48.2	48.4	38.4	28.5	34.1	27.6	14.2	9.4	7.3	4.7
Illinois	886.0	835.0	541.0	431.0	540.0	560.0	395.0	280.0	193.0	166.0

Source: Illinois Cooperative Crop Reporting Service

Presently, sheep production constitutes the primary enterprise on only 13 percent of the farms with sheep, but these farms account for 52 percent of the total income from the sale of sheep, lambs, and wool ($7.8 million). Net sales by sheep producers, however, amount to less than one-half of 1 percent of the total income in Illinois from livestock.

Most flocks in Illinois are very small. Three-fifths of them (2,900) have fewer than 25 sheep. Only 260 flocks have 100 or more sheep, but these flocks account for 47 percent of the total income from sheep. In 1982, 1.1 million pounds of wool were shorn from Illinois sheep; 150,000 head of sheep were sold in that year. *111, 410*

Poultry

The poultry industry has experienced a technological revolution. Dramatic changes have occurred in both scale and level of mechanization with rapid shifts in geographical distribution and marketing patterns. Before 1930, most poultry were raised in small flocks as a sideline farm enterprise which provided extra money for the household. Fresh broilers or fryers were available only during the late spring or summer. Since 1930, the poultry industry has become the most efficient meat producer in the world: from chick to broiler in 8 weeks, using less than 3 pounds of feed per pound of meat. Most broilers are grown in confinement and in large flocks, and one person using automated machinery can care for 40,000 to 50,000 birds (North 1978).

Poultry consumption in the United States has doubled since 1950, but egg consumption has steadily declined. The egg, traditionally a breakfast dish, has many competitors, and the use of egg substitutes has risen following the cholesterol controversy. Even so, automation, disease control, and improved nutrition and breeding have increased egg production per hen to over 200 eggs per year. As a result of photoperiod control and the elimination of broodiness and winter pause, egg production is now nearly uniform throughout the year.

In the past twenty-five years, egg production in Illinois has decreased by 55 percent and become concentrated in the northeastern, eastern, and southwestern counties (Fig. 5 and Table 5). The 1982 Census of Agriculture (U.S. Department of Commerce 1984) determined that 7,100 of the 92,000 farms in Illinois had an inventory of poultry, but only 44 percent of these farms sold poultry or poultry products. The sale of chicken eggs accounted for 86 percent of the total income in Illinois from poultry enterprises.

Even fewer farmers raised turkeys: 580 maintained an inventory, but only 126 reported sales from turkeys or turkey eggs. Three Illinois producers, each with flocks of over 60,000 turkeys, accounted for 65 percent of the gross income from turkey production.

Only 456 Illinois farms listed poultry as their primary enterprise in 1982. Of these, 7 specialized in the production of broiler chickens, 375 in the production of chicken eggs, and 13 in the production of turkeys; 4 were classified as hatcheries and 57 were listed as poultry combinations. These primary-enterprise farms grossed $70 million of the total $75 million in cash sales from poultry production in 1982. *298, 305, 309, 378, 410*

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Figure 4

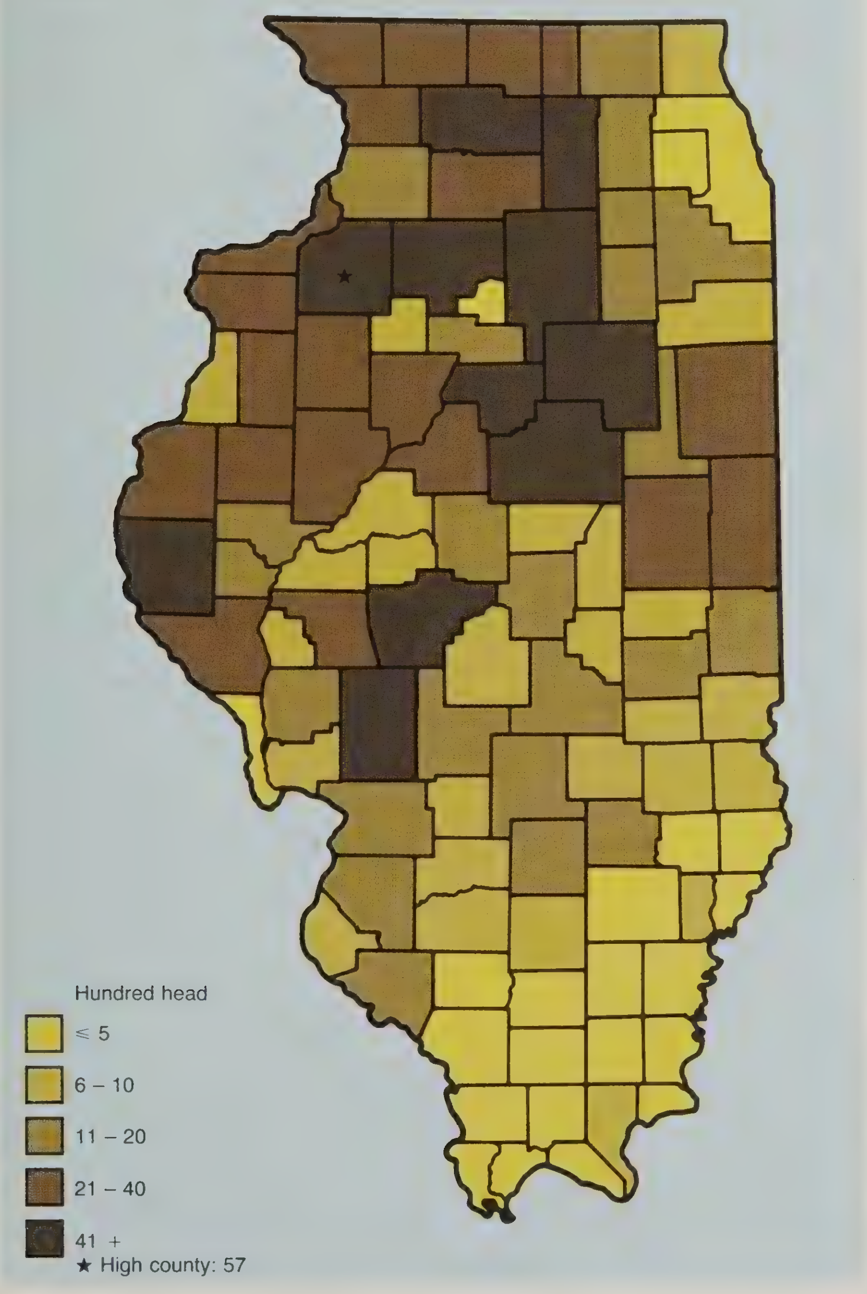
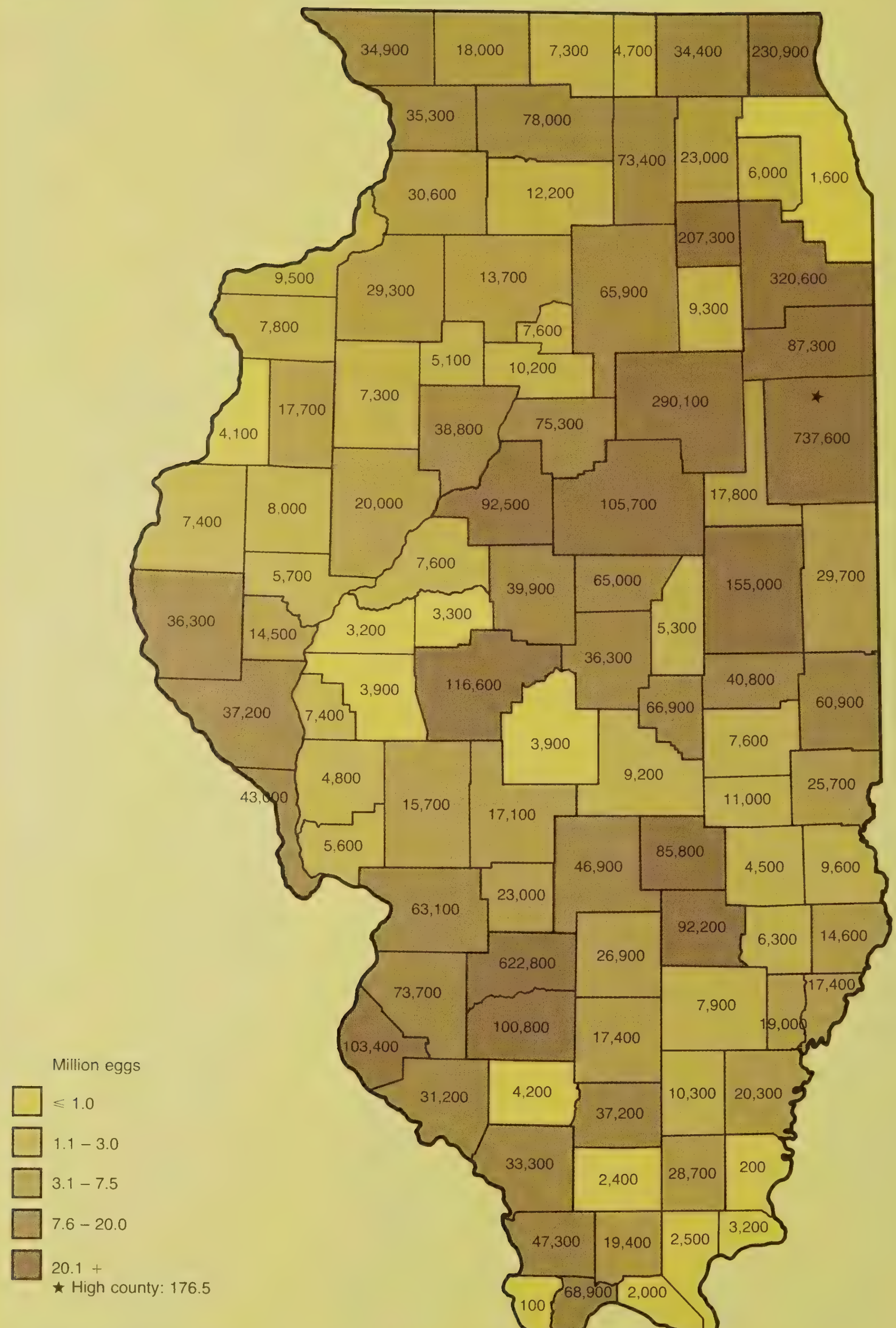


Figure 4. Average annual sheep inventory by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Figure 5



Number of layers by county are shown on the map.

Table 5. Average annual inventory of layers and average annual production, 1953–1982.

Crop-reporting districts	1953–1958		1959–1964		1965–1970		1971–1976		1977–1982	
	Thousand layers	Million eggs	Thousand layers	Million eggs	Thousand layers	Million eggs	Thousand layers	Million eggs	Thousand layers	Million eggs
Northwest	2156	429	1518	337	967	214	511	116	291	69
Northeast	1728	344	1235	267	1636	369	1567	352	1018	242
West	994	187	643	133	408	88	265	59	129	31
Central	1381	272	865	185	631	141	680	158	501	122
East	1742	364	1381	309	1170	266	1475	335	1347	320
West Southwest	1871	346	1344	274	793	171	494	111	348	84
East Southeast	2282	424	1541	313	898	192	619	146	510	128
Southwest	1632	309	1387	287	1338	291	1142	266	1084	262
Southeast	1189	213	726	137	424	88	291	66	176	42
Illinois	14975	2889	10642	2243	8265	1820	7044	1610	5404	1300

Source: Illinois Cooperative Crop Reporting Service

◀

Figure 5. Average annual inventory of layers and egg production by county, 1978-1982. Source: Illinois Cooperative Crop Reporting Service.

Fish and Wildlife

Illinois is host to hundreds of fish and wildlife species. Recent inventories indicate that 200 species of nesting birds and from 20 to 30 species of waterfowl are present on a permanent or transient basis. Almost 200 fish species are found in Illinois waters; 98 reptile and amphibian species and 57 species of mammals complete the tally (Sheviak and Thom 1981; Stephen P. Havera, personal communication). Economically and aesthetically, these species are an important natural resource of the State. Each year, over 400,000 hunters spend nearly $150 million and more than 8 million days afield in Illinois in pursuit of game. Approximately 1.5 million anglers fish about 42 million days in Illinois, spending nearly $550 million annually on their sport (Illinois Department of Conservation 1983a). Illinois remains one of the top ten freshwater fish-producing states in the nation. Commercial fish harvests exceed 5 million pounds each year, and the annual retail value of Illinois fish products varies from $2.5 to $3 million (Fritz 1984a). In addition, large numbers of Illinoisans spend recreational time observing and studying the wildlife of the State in city parks, forests, nature preserves, and wildlife refuges.

In the nearly two centuries since Illinois was settled, fish and wildlife habitats have been dramatically altered and reduced. In the 1820s, 40 percent of the State was forested, with the remainder mostly tallgrass prairie. Today, less than 10 percent of the forest and 1 percent of the prairie remain. Once Illinois had over 9 million acres of wetlands, but less than 500,000 acres of this vital wildlife habitat remain (Illinois Wildlife Habitat Commission 1985). The advent of row cropping has reduced hay acreage and livestock pasture, forms of "substitute prairie" that support much of the wildlife of Illinois. Urbanization has further reduced fish and wildlife habitats, and toxic chemicals released into the environment have jeopardized normal energy and nutrient cycles. As competition for food and other habitat components increases, the displacement of some species and the demise of others inevitably result.

To ensure an abundant and renewable wildlife resource, the Illinois Department of Conservation (IDOC) and the Department of Energy and Natural Resources (DENR) monitor and manage the fish and wildlife populations of the State. The Division of Fisheries and the Division of Wildlife Resources (IDOC) manage fish and wildlife populations for outdoor recreational purposes; the Division of Natural Heritage (IDOC) initiates programs for endangered and other nongame species of fish and wildlife; and the Illinois Natural History Survey (DENR) studies the animal and plant life of the State, including the life histories of organisms and the biological processes of ecological systems. Most of the information generated by these agencies is free to the public upon request. Their addresses are given in Appendix B. *15, 130, 131, 145, 172, 201, 203, 219, 227, 272, 303, 360, 400, 409*

Robert A. Heister, Illinois Natural History Survey


Photograph: Larry Kanfer

Commercial Fishing

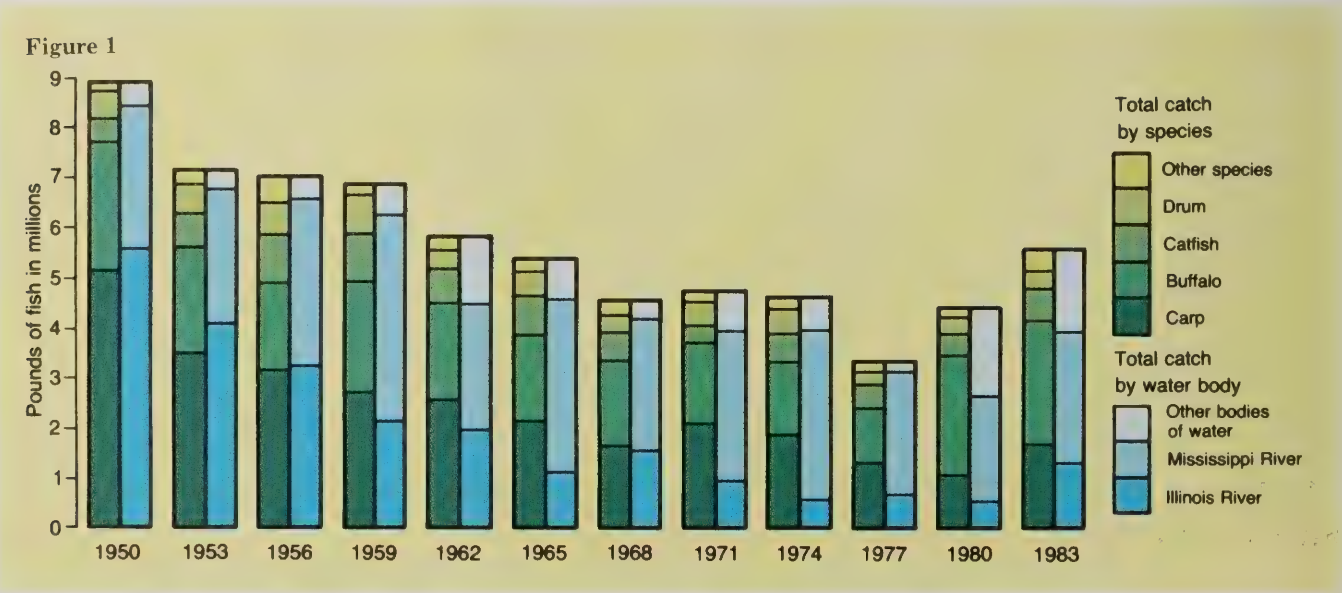
The historical development of commercial fishing in Illinois, as well as the current composition of its harvest, is best understood when the information is reported from two perspectives–Illinois waters *excluding* Lake Michigan and Illinois waters *of* Lake Michigan. That division is maintained in the discussion that follows.

Illinois Waters excluding Lake Michigan

Commercial fishing has long been an important industry in Illinois. From 1905 to 1915, more freshwater fish were harvested from Illinois waters than from any other area in the nation, with the exception of the Columbia River Basin. In 1908, commercial fishermen took nearly 25 million pounds of fish valued at more than a million dollars from the Illinois River alone. However, by 1913–only five years later–the catch had dropped to 11.5 million pounds valued at a half-million dollars. By 1931 the commercial harvest on the Illinois River was only 6.8 million pounds.

The draining of bottomland lakes and sloughs and the dumping of industrial and domestic wastes into rivers contributed to the decline of commercial fishing throughout the State. Additional degradation of rivers and streams occurred as row-crop farming intensified during the 1940s, and a further decline of fishery habitat resulted. Waterway basins began to fill with silt as soil erosion increased, and water quality deteriorated even further with the widespread use of deadly or flesh-contaminating pesticides and herbicides. The commercial harvest continued to decrease through the 1960s and 1970s, and in 1984 commercial fishermen took only 5.7 million pounds of fish from Illinois lakes and rivers. In spite of these detrimental changes, Illinois remains one of the top ten freshwater fish-producing states. Commercial fishermen continue to harvest such food fishes as carp, buffalo, drum, and catfish, which generally comprise 80 to 90 percent of the total catch (Fig. 1). Other species taken commercially include bullheads, paddlefish, sturgeon, suckers, gar, bowfin, and eel.

Figure 1. Estimated annual commercial catch by dominant species and water body (excluding Lake Michigan) for every third year, 1950-1983. Source: Illinois Department of Conservation, Illinois Commercial Catch Report Exclusive of Lake Michigan.



The general decline in the commercial harvest since 1950 shown in Figure 1 has been most dramatic for the Illinois River. The Illinois accounted for nearly two-thirds of the annual catch in 1950; since 1971, however, it has never accounted for more than about a fourth. The overall increase shown for the early 1980s is the result of opening Carlyle and Rend lakes to commercial fishing rather than improved water quality or increased fish reproduction. Although the commercial fish harvest has diminished, its value has increased. At the retail level, Illinois fish products are currently worth between 2.5 and 3 million dollars a year.

Hundreds of tons of marketable mussel shells are also taken from Illinois rivers each year (Table 1). The Japanese cultured pearl industry represents a major market for these shells, and the total wholesale value paid for all shells from all Illinois rivers in 1983 was approximately $476,000. How long the rivers of the State can sustain an annual harvest of a thousand tons has been questioned by biologists, and regulatory legislation has been proposed.

Table 1. Tons of mussel shells harvested by river and year, 1965–1984.

Year	Mississippi River	Wabash River	Illinois River	Rock River	Total
1965	181.0	191.0	1,159.0	0.0	2,259.0
1966	1,244.6	1,194.6	1,118.4	0.0	3,557.6
1967	74.3	317.2	388.5	0.0	780.0
1968	—*	—*	93.0	0.0	93.0
1969	272.8	32.7	331.7	55.7	692.9
1970	—*	50.8	358.9	0.0	409.7
1971	—*	12.0	0.0	0.0	12.0
1972	175.0	31.3	0.0	0.0	206.3
1973	0.0	0.0	0.0	0.0	0.0
1974	213.8	0.0	80.0	0.0	293.8
1975	149.8	0.0	220.0	0.0	369.8
1976	471.5	35.0	80.2	0.0	586.7
1977	585.0	59.0	288.0	0.0	932.0
1978	698.2	40.0	110.1	0.0	848.3
1979	770.2	37.0	12.4	0.0	819.6
1980	849.5	28.4	83.6	0.0	961.5
1981	1,166.7	19.4	132.8	0.0	1,319.0
1982	341.8	16.0	240.7	0.0	598.5
1983	801.5	28.5	333.2	0.0	1,163.2
1984	604.6	0.0	662.7	0.0	1,267.3

*Data not available.

Source: Fritz 1984b

The inland Illinois commercial fishery provides a substantial annual supply of quality food fishes, a major foreign export, and a source of income to several hundred Illinoisans. These fish and mussel resources also serve as a reliable barometer of the quality of our stewardship over the past 80 years. The waters of Illinois are capable of providing more benefits than are currently realized, however, and it behooves state agencies and citizens alike to ensure that these resources are managed wisely not only for our immediate benefit but for the quality of life for generations that follow. *18, 71, 131, 132, 144, 201, 290, 314, 331, 380*

Arnold W. Fritz, Division of Fisheries, Illinois Department of Conservation

Illinois Waters of Lake Michigan

In area and in volume, Lake Michigan is the sixth largest lake in the world. Its commercial fishing is controlled by four states–Michigan, Wisconsin, Illinois, and Indiana–and those jurisdictional boundaries are shown in Figure 2. Approximately a million acres (about 7 percent of the lake) comprise the Illinois waters.

Preceding the arrival of white settlers, several indigenous tribes of Indians occupied the shores of southern Lake Michigan. During this period, the unspoiled waters of the lake and its tributaries were host to large numbers of native fishes. Whitefish, lake trout, and lake herring were the most abundant original species, although burbot, yellow perch, lake sturgeon, and suckers were also present. Although the Indians fished primarily for sustenance rather than for trade, they used spears, dip nets, weirs, and traps.

Just as the water had attracted the Indians, so it drew explorers and traders, and the settlement of the Illinois area bordering Lake Michigan was well under way by the early 1800s. Aside from supplying human needs for water, lakes and streams provided natural highways for transporting people and goods, and their control had important economic and colonial implications. In this regard, a number of early explorers dispatched by the French government sought both a northwest passage to the Orient and a connection between the Great Lakes-St. Lawrence River system and the Mississippi River system. The existence of such a connection was made known to the explorers by the Indians, and the importance of this connection soon led to settlement and military fortification at the mouth of the Chicago River.

Protection from hostile tribes, treaties with friendlier ones, and the promises of new lands rich in natural resources attracted more and more immigrants from the East, who brought with them their European taste for fish and created the market for a commercial fishing industry.

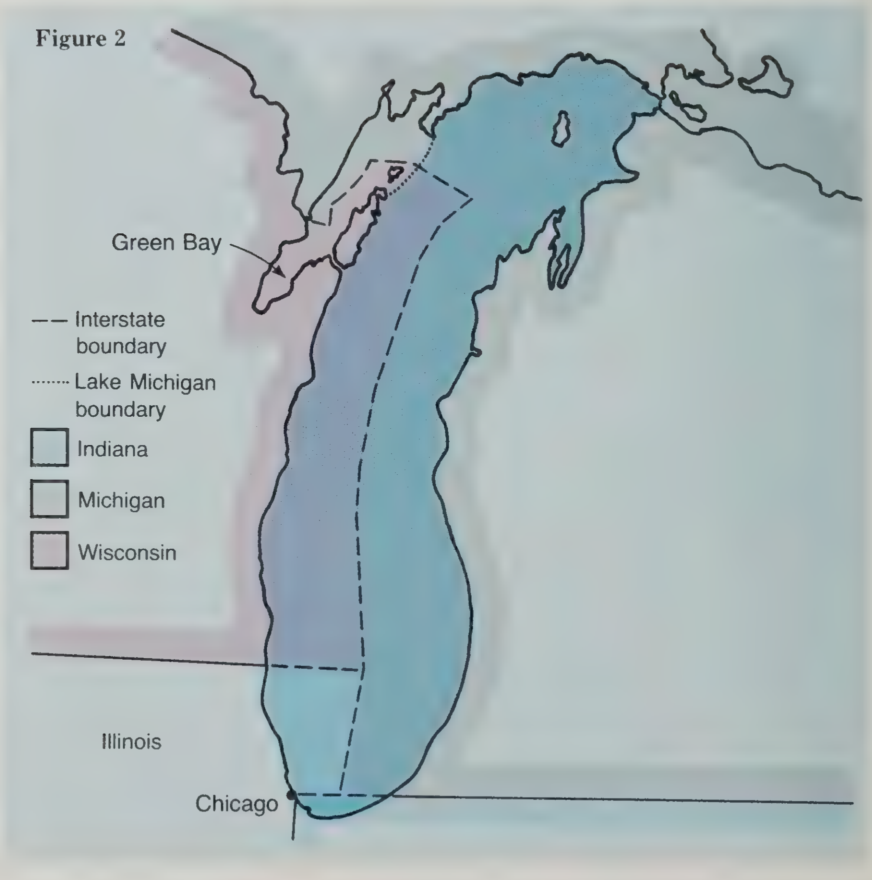


Figure 2. Jurisdictional divisions of Lake Michigan. Source: Baldwin et al. 1979.

The early commercial fishery in Illinois took place in shallow bays and tributaries and along the shoreline, and in many ways it must have resembled the fishery of the tribes. Seins, spears, dip nets, and hook and line were used to take whitefish, suckers, yellow perch, lake herring, and lake sturgeon from nearshore waters. Many of the fishes taken near shore also spawned in these shallow areas and in the tributaries, and their populations were soon affected.

Some streams were already becoming polluted with domestic and industrial wastes (particularly from sawmills), making them unfit for species intolerant of such changes in water quality. The clearing of forests bordering streams intensified erosion and increased turbidity and sedimentation, which prevented some species from utilizing upstream spawning grounds. In addition to these environmental problems, the increased demand for fish for rapidly growing markets soon generated even greater efforts on the part of increasing numbers of commercial fishermen.

By the mid-1800s, commercial fishermen had begun to exploit deeper waters from sailing vessels. The move to deeper waters was partly in response to the declining number of fish in shallow waters, but it was also made possible by the development of the gill net. This net, which continues to be used today, was designed to be fished on or near the lake bottom. The thin threads used in its construction were not easily seen by fish, which swam into and became entangled in the net. Steam-powered vessels, which greatly increased the fishing range, soon followed as did the steam-powered gill-net lifter, which allowed fishermen to haul in many more nets in a single day than they had previously been able to do.

These new capabilities were exercised without regulation, and by the turn of the century their effects had begun to take a heavy toll. By 1900 the lake sturgeon had all but disappeared from an annual catch of about 1 million pounds of whitefish, lake trout, lake herring, chubs, and yellow perch. Although the legislature had passed the first fish conservation law in 1872, which included a limit on the size of nets, legislators had enacted no harvest regulations. A fish commission was established by the Governor several years later (1879), but its initial activities were confined to the rearing and distribution of fish and to rescuing those stranded in the backwaters by returning them to the stream. During this period no species of fish was protected from commercial sale.

In 1913, the Governor combined the separate game and fish commissions into a single Game and Fish Commission, which was replaced by the Division of Game and Fish in 1917 and placed in the Department of Agriculture. Under this department, the present-day game species of fish were removed from the commercial list and a hook-and-line license was required for taking them. The Department of Conservation, as we know it today, was created in 1925 and given responsibility for conserving the fisheries of the State.

Although records are scarce prior to the 1930s, the commercial catch for the Illinois waters of Lake Michigan has been recorded consistently since 1933 (Fig. 3). During the 1930s, the catch, which averaged about 1.3 million pounds annually, was made up primarily of chubs, perch, lake trout, and lake herring (Baldwin et al. 1979). Lake whitefish had virtually disappeared from the catch, and the lake sturgeon had been given protected status in 1929.

By this time, three exotic species had established themselves in Lake Michigan and were destined to affect the fishery in different ways: the sea lamprey and the alewife, which had entered the upper Great Lakes via the Welland Canal, and the smelt, which had originated from a planting in Crystal Lake, Michigan, in 1912.

Initially, the parasitic sea lamprey attacked lake trout, but it soon began to prey on whitefish, suckers, yellow perch, and carp. An escalated harvest of lake trout from the Illinois waters of Lake Michigan during

Figure 3

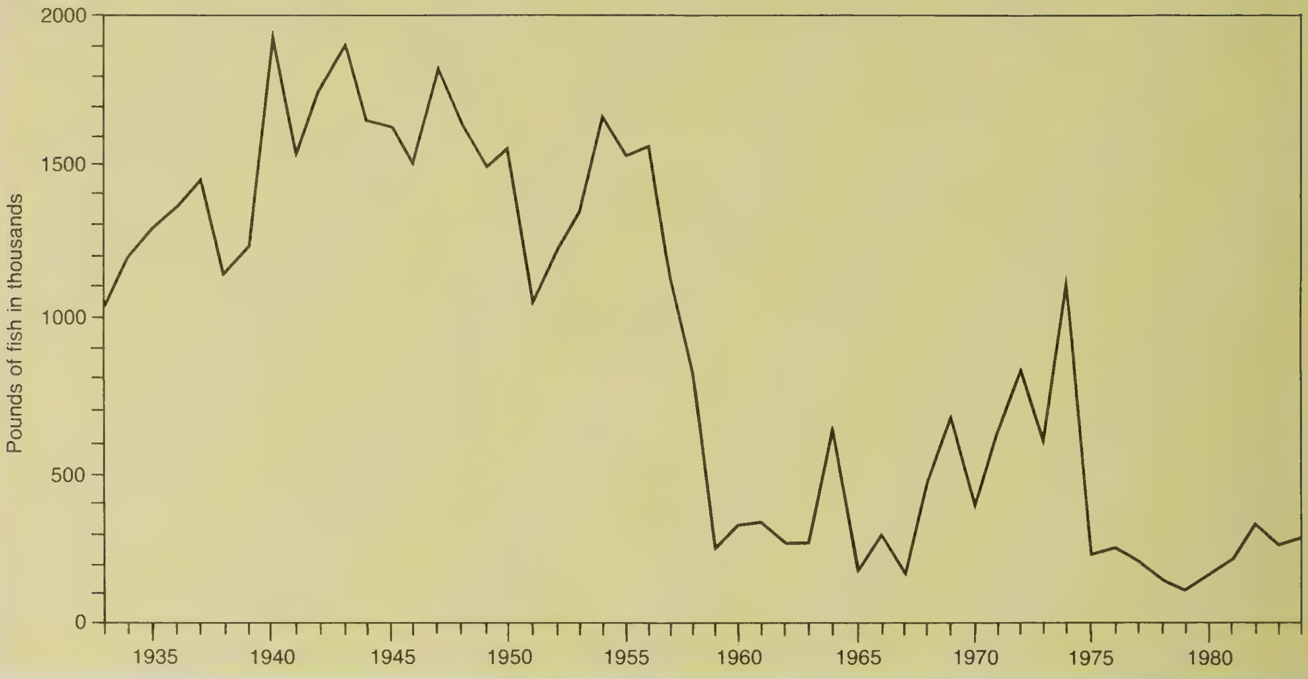


Figure 3. Estimated annual commercial catch from Illinois waters of Lake Michigan, 1933-1984. Source: Baldwin et al. 1979; updated data from Richard J. Hess, Illinois Department of Conservation.

World War II placed additional stress on this already threatened species. Technological developments during this period also led to the introduction of the diesel-powered gill net tug, and more efficient nylon twine replaced the traditional cotton meshes in gill nets. Within decades after the war, lake trout had become extinct, and herring, primarily because of heavy exploitation and competition from smelt and alewife, disappeared from the lake soon after. The multispecies commercial fishery on the Illinois waters of Lake Michigan had ceased to exist, and chubs and yellow perch became the mainstays of the fishery during the 1950s and 1960s.

In the absence of their major predators, alewife and smelt increased in numbers and competed with chubs and perch for food and space. Declines in the populations of chubs and perch resulted, and increased efforts by commercial fishermen inevitably led to more stringent regulations. The use of large-mesh gill nets and the taking of lake trout (which were reintroduced to Illinois waters in 1967 after effective chemical control of the sea lamprey had been achieved) were prohibited in 1974. In the following year, a limited-entry commercial fishery was established, reducing the number of Lake Michigan commercial license holders in Illinois from 44 to 3.

Today the commercial fishery on the Illinois waters of Lake Michigan continues to be one of limited entry with strict quotas of chubs and yellow perch. The gill net is permitted, but with restricted mesh sizes, and species other than chubs, yellow perch, alewife, and smelt must be returned to the water. Biologists monitor the commercial fishery through monthly catch reports, examinations of commercial landings, and on-board observations. Annual surveys assess the condition and supply of chubs and yellow perch and are used to determine harvest quotas. In the interests of public health and environmental quality, contaminant levels in all of these species are evaluated. Finally, the reintroduction of lake trout has continued with an aggressive stocking program in an effort to restore naturally reproducing populations of trout capable of once again creating a commercially harvestable surplus. *17, 18, 144, 177, 179, 180, 201, 359, 364, 372, 384, 420, 439, 446*

Richard J. Hess, Illinois Department of Conservation

Sport Fishing

Sport fishing continues to be an important Illinois resource, both economically and recreationally. Each year approximately 1.5 million anglers fish over 40 million days on the more than 1.5 million acres of Illinois surface waters. They contribute to the economy of the State by spending over a half billion dollars annually on their sport. This expenditure of time and money yields a yearly catch of over 100 million fish.

The Illinois sport fishing resource, however, is much more than the number and type of fish anglers pull from the water in a given year. As with other resources, sport fishing is subject to demands and stresses that threaten its stability and limit its capacity for renewal. Pollution and other forms of degradation severely restrict the extent of quality fishing waters. Declining fish habitats, in turn, limit the numbers and types of fish that occupy Illinois waters. The sport fishing resource, therefore, encompasses an entire network of management efforts that focus on the renewal of fish habitats, the hatching and stocking of fish, and the eradication of undesirable species. These efforts are directed at four categories of surface water: Lake Michigan, reservoirs, impoundments, and streams.

Illinois has jurisdiction over 7 percent (976,640 acres) of Lake Michigan and over 4 percent (63 miles) of its shoreline. In 1983, fishermen spent more than 3.5 million fishing days on these waters. Approximately 40 percent of these days were devoted to salmon fishing; about 25 percent were given over to trout and another 25 percent to yellow perch (Table 1). Excellent sport fishing exists in the Illinois waters of Lake Michigan for yellow perch, smelt, coho and chinook salmon, and for three species of trout, but the collapse of many fish populations has occurred over the last 50 years and such native species as lake sturgeon, whitefish, and lake herring are now rare. Five of the original seven species of chubs (an important component of the commercial catch) are considered extinct, and only the bloater chub remains abundant. The much desired lake trout were ravaged by the sea lamprey in the early 1950s; however, extensive management efforts by the Illinois Department of Conservation, Division of Fisheries, in cooperation with the Great Lakes Fisheries Commission, have succeeded in reintroducing the lake trout. Lampricide applications and barrier dams help to control the sea lamprey population, and annual plantings of young lake trout into the Illinois waters (about 200,000 each year) have produced fish of spawning size. Other management efforts include monitoring the sport catch, analyzing fish samples for contaminants, and the stocking of approximately 1 million fish each year, including lake, rainbow, and brown trout, chinook and coho salmon, and smallmouth bass.

Three Army Corps of Engineers reservoirs with a total surface area of 55,000 acres are important sites for sport fishing: Lake Shelbyville, Carlyle Lake, and Rend Lake. Anglers make about 3 million fishing trips to these lakes each year, spending well over a third of their time fishing crappie (Table 1), which comprised about 62 percent of the catch from these three reservoirs in 1983. Management by the Division of Fisheries at these sites includes fish population assessments, walleye egg collection for hatchery needs, habitat improvement, and supplemental stockings from hatchery production and nursery ponds adjacent to the reservoirs. Recent stockings have included muskie fingerlings, walleye fry, and threadfin shad at Lake Shelbyville; walleye fry, largemouth bass fingerlings, threadfin shad, and fingernail clams (for additional forage) at Carlyle Lake; and striped bass fingerlings, hybrid striped bass fry, largemouth bass fingerlings, and threadfin shad at Rend Lake.

Impoundments in Illinois number more than 84,000 (excluding the three reservoirs cited above) and account for about a quarter million acres of fishing waters. Most of these lakes and ponds are man-made and therefore require intensive management to produce good fishing for the anglers who spend about 23 million fishing days on these waters each year. Over 80 percent of these fishing days were given over to black bass, sunfish, crappie, and catfish in 1983 (Table 1). About 45 percent of the catch was made up of sunfish; crappie represented an additional 25 percent. Data collected on fish populations, habitats, and angler use help to develop and update a variety of management plans, including vegetation control at 60 lakes, fish population control at 90 lakes, and the stocking of fish at more than 300 lakes each year.

Illinois has over 13,200 miles of streams that total more than 256,500 acres. Presently, about a third of those stream miles have been ditched or otherwise altered, and many of these waterways provide poor fishing because of pollution from silt, sewage, and toxic substances. To counter this loss, the Illinois Department of Conservation annually conducts more than 200 investigations, including annual fish population and contaminant studies, on approximately 1,100 miles of streams. Anglers annually spend more than 10 million fishing days on Illinois streams and rivers. Fishing for catfish occupied about 39 percent of those days in 1983, but a variety of other species were also pursued by Illinois stream fishermen that year (Table 1). Taken together, catfish, crappie, sunfish, and bullheads made up over 70 percent of their catch.

With the dedication in 1983 of the Sand Ridge Hatchery in Mason County, the final phase of the renovation and construction of the Illinois Fish Hatchery System was completed. This hatchery, along with the renovated Little Grassy Hatchery in Williamson County, began production in 1982-1983. More than 37.9 million fish of 21 species were stocked in Illinois waters in 1985. Of these, the new Hatchery System provided 32.2 million, including largemouth bass, bluegill, redear, channel catfish, walleye, coho salmon, and rainbow and brown trout. An additional 5.7 million fish were

Table 1. Percent of number of days fished for each species by water type, 1983.

Species	Lake Michigan	Reservoirs	Impoundments	Streams
Trout	24.5		1.2	0.4
Salmon	40.6			
Smelt	8.8			
Northern pike, muskie		0.7	3.1	3.5
Walleye, sauger	0.1	6.2	2.4	7.9
Yellow perch	25.3	0.2	1.0	0.7
Black bass	trace	20.7	37.0	13.7
White, yellow, striped, and hybrid bass		12.9	4.3	5.6
Catfish		11.2	13.7	39.2
Bullhead		0.9	3.4	7.0
Sunfish	trace	6.3	17.0	5.8
Crappie	0.1	38.3	14.8	9.0
Carp	0.2	1.1	1.0	5.3
Other fish species, frogs, and turtles	0.4	1.5	1.1	1.9
Number of days fished	3,569,242	2,905,635	23,222,410	10,395,718

Source: Baur and Rogers 1985

obtained from the U.S. Fish and Wildlife Service, from other states or agencies, and from commercial sources. Species from these sources included chinook salmon, lake trout, striped bass and striped bass hybrids, walleye, and muskie. *19, 71, 72, 127, 128, 201, 226, 235, 262, 290, 304, 370, 446*

Source: Baur and Rogers 1985; updated data from Richard Baur, Division of Fisheries, Illinois Department of Conservation

Nongame Fishes

Illinois is bordered by large rivers and by Lake Michigan and has many interior streams as well as glacial lakes in the northeast and cypress-tupelo swamps in the extreme south. These aquatic habitats support a diverse fish population. One hundred eighty-six species are considered native to Illinois; another 13 species have been introduced, either deliberately or accidentally, and are believed to be reproducing in Illinois waters.

Although most Illinois fishes are too small for human consumption or for commercial or sport fishing, they often exist in large populations and exert dominating effects on the aquatic environments in which they live. The most diverse groups are the minnows (58 species), darters (27 species), suckers (19 species), and catfishes (14 species).

Most minnows (Family Cyprinidae) are small silvery fishes that swim in midwater, often in schools, and feed on aquatic insects. Stonerollers are common, fairly large minnows that graze on algae. The southern redbelly dace is a bright red and yellow occupant of springs and small headwater streams. The fathead minnow is a native species propagated as fishing bait. Carp, goldfish, and grass carp are large minnows introduced from Europe and Asia.

Darters (Family Percidae) are small bottom-living fishes that have evolved from relatives of the walleye and yellow perch. Because of their secretive nature, they are seldom noticed, but many are brightly colored and have interesting behavior patterns. Darters feed mainly on small crustaceans and aquatic insects.

Suckers (Family Castostomidae) vary in size and are named for their large thick lips, which are adapted for extracting aquatic insects, crustaceans, and mollusks from stream and lake bottoms. Suckers are seldom caught on hook and line, but large species such as buffalos and carpsuckers are netted and sold commercially. Small species such as chubsuckers and spotted suckers provide forage for larger fishes.

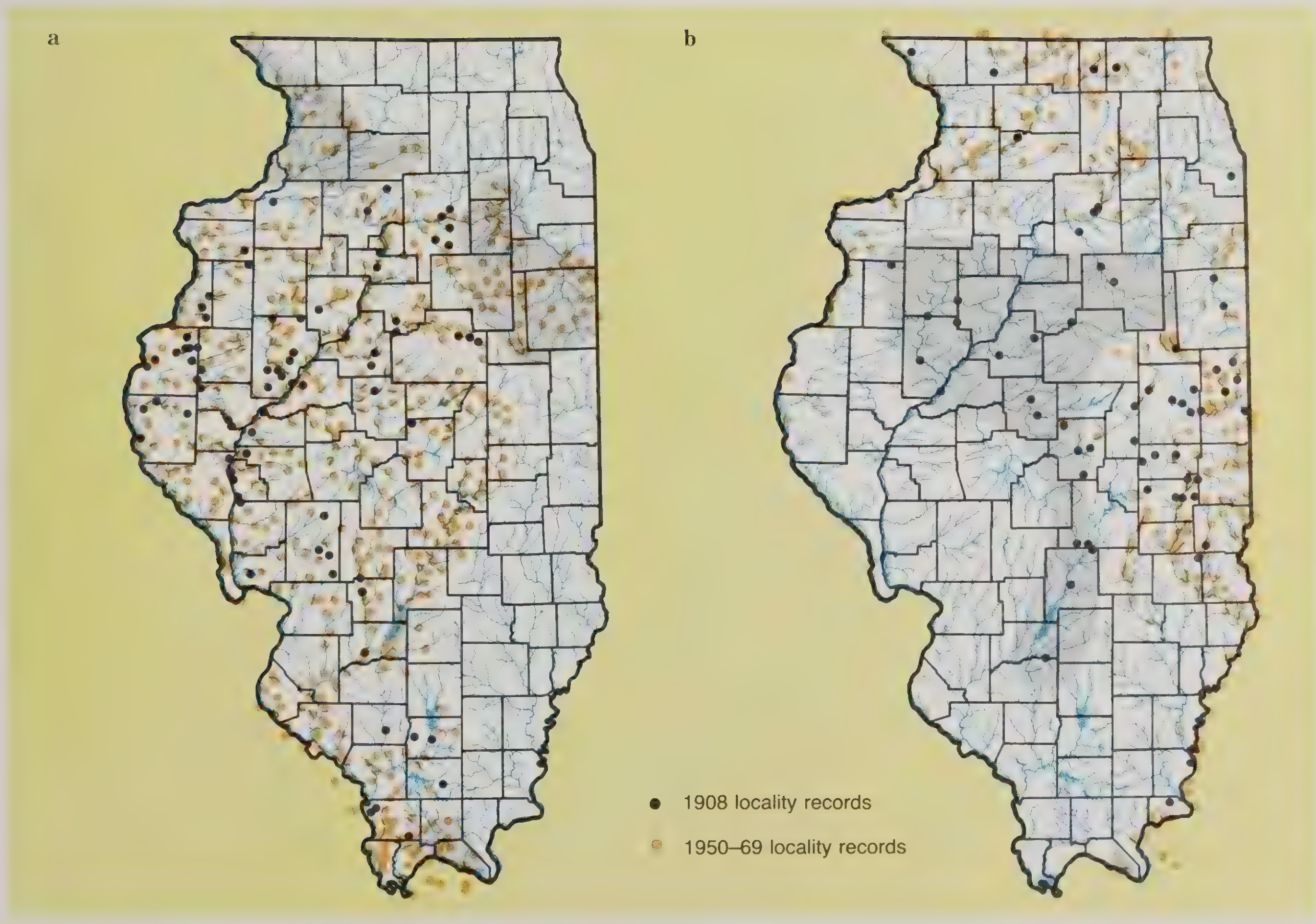
Large catfishes (Family Ictaluridae) such as the channel, blue, and flathead catfishes and the yellow, brown, and black bullheads are well known to fishermen. The majority of the catfishes in Illinois, however, are small species known as madtoms. They seldom reach a length of more than 4 inches and have poison glands associated with spines in the dorsal and pectoral fins. These spines and toxins discourage predators and can inflict a painful wound in humans.

The waters of Illinois have changed dramatically in the past 150 years, and so have their fish populations. Several species have been extirpated, including the Ohio lamprey, blackfin cisco, muskellunge, rosefin shiner, greater redhorse, and the gilt, stargazing, and crystal darters. Another 21 species are in such serious decline that they too will disappear unless their habitats are protected. Factors contributing to the extirpation of native fishes or reductions in their populations include the increased turbidity and sedimentation associated with intensive agriculture, the drainage of bottomland lakes and sloughs, pollution, the construction of dams and impoundments, increased water temperatures due to the loss of riparian vegetation, and desiccation during droughts because of the loss of moisture-holding vegetation. In some cases, one species invades the range of another and causes its displacement (Fig. 1). The red shiner (*Notropis lutrensis*) and the spotfin shiner (*N. spilopterus*) are related but apparently cannot coexist in the same streams. Although most species are becoming less numerous in Illinois, the red shiner is tolerant of increased turbidity and is therefore expanding its range as agriculture becomes more extensive.

A number of excellent catalogs describe the fishes of Illinois. The earliest of these was compiled by E. W. Nelson (1876) and the most recent by P. W. Smith (1979). Such volumes contain a wealth of information, including keys for the identification of Illinois fishes, distribution maps, and ecological explanations for changes in distribution. *51, 53, 90, 127, 128, 235, 262, 279, 304, 311, 312, 368, 369, 370, 371*

Lawrence M. Page, Illinois Natural History Survey

Figure 1. a. Distribution of red shiner. Shaded areas indicate major expansions in range from 1908 to 1969. b. Distribution of spotfin shiner. The shaded area indicates the reduction in range from 1908 to 1969. Source: L. M. Page and R. L. Smith, 1970. Recent range adjustments and hybridization of *Notropis lutrensis* and *Notropis spilopterus* in Illinois. *Transactions of the Illinois State Academy of Science* 63(3): 264-272. Reprinted by permission of the Illinois State Academy of Science. See also P.W. Smith 1979.



Game Birds

In 1982, 47,200 waterfowl hunters bagged 393,200 ducks in Illinois; 21,500 goose hunters shot 30,837 geese. Managing this migratory waterfowl resource is the responsibility of the Waterfowl Program of the Illinois Department of Conservation. Among its activities are the banding of waterfowl (6,790 were banded during 1983), the monitoring of lead shot ingestion by waterfowl, aerial counts of waterfowl along the Mississippi and Illinois rivers, and assessments of hunter effort and success.

Management of pheasant, quail, woodcock, dove, and Hungarian partridge populations falls under the direction of the Upland Wildlife Program. During 1983, 15,107 acres were enrolled in "Acres for Wildlife," a Department of Conservation program that encourages landowners to protect existing wildlife habitat. "Roadsides for Wildlife" was responsible for planting 536 acres of rural roadsides with nest cover of smooth brome and alfalfa. Forty-four sites on public land also benefited from upland game management in 1983, including tree and shrub plantings, herbaceous seedings, and the establishment of sunflower fields and food patches for doves, quail, and other seed-eating birds. Seventy-one sportsmen's organizations in 48 counties received 58,400 day-old quail and 20,250 day-old pheasant chicks from the State's game farms. Taken together, these management programs help to ensure that waterfowl and game birds will remain an Illinois resource for years to come. *46, 109, 151, 170, 201, 274, 285, 332, 343, 365, 454*

Ducks

Illinois is located along the Mississippi Flyway about midway between the breeding and wintering grounds of many species of waterfowl. As a result, major migrations are observed during the spring and fall. The primary breeding grounds for the majority of the duck species that pass through Illinois are the pothole region of the Dakotas, the prairies of Canada, and the parkland region north of the Canadian prairies. Illinois is also crossed by several migration corridors leading to such diverse wintering grounds as Chesapeake Bay, coastal South Carolina, Florida, Mobile Bay, Arkansas, Louisiana, and Texas. Illinois is indeed the crossroads for waterfowl migrating through the Midwest.

Approximately 20 species of ducks pass through Illinois. The blue-winged teal (*Anas discors*) is the first species to migrate in fall, with major numbers appearing during late July and in August and September. The pintail (*Anas acuta*) appears in greatest numbers in late October and early November, and the migration of the mallard (*Anas platyrhynchos*) peaks about mid-November. Average weekly sightings of these ducks during the fall migration are shown in Figure 1.

Mallards belong to the group known as dabbling ducks, those ducks that tip up to feed in shallow water. The mallard is the most abundant duck in Illinois as well as the species most actively pursued by hunters. Of all waterfowl using the Illinois River in the fall, approximately 86 percent are mallards. Mallards also account for about 47 percent of the waterfowl use of the Mississippi from Rock Island to Alton. In turn, mallards make up about 50 percent of the Illinois duck harvest. The numbers of mallards that appear each fall are related to the numbers that appear each spring on the northern breeding grounds and the degree of their nesting success. How

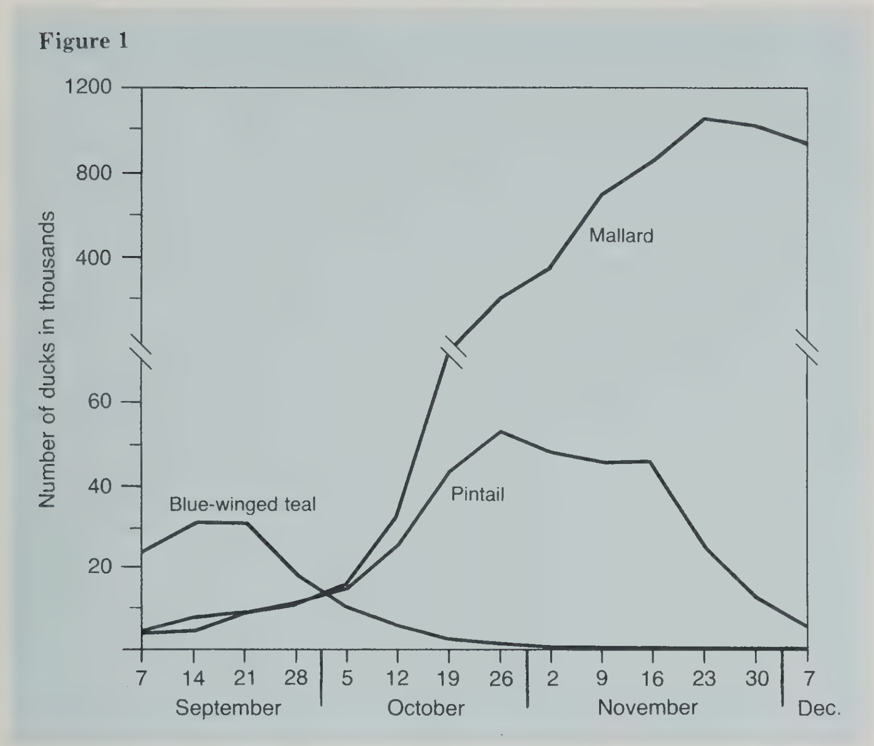


Figure 1. Average number of ducks counted each week along the Illinois River and the Mississippi River from Rock Island to Alton, September 1 through December 7, 1948-1980. Source: Illinois Natural History Survey River Research Laboratory, Havana, Illinois.

long mallards stay in Illinois depends upon weather conditions along the Flyway, the availability of food, and the presence of refuges on migration areas.

The peak population count of mallards in Illinois usually accounts for at least 40 percent of the mallards counted in the entire Mississippi Flyway during the annual winter inventory in January. In recent years, however, the number of mallards using the wetlands of the Illinois River Valley and the Mississippi River Valley from Rock Island to Alton has reached a record low (Fig. 2). The Illinois has always accommodated more mallards than this portion of the Mississippi, but the difference is decreasing. The reduced numbers in Illinois since 1980 can be attributed to the low level of the mallard breeding population and to poor habitat and weather conditions on

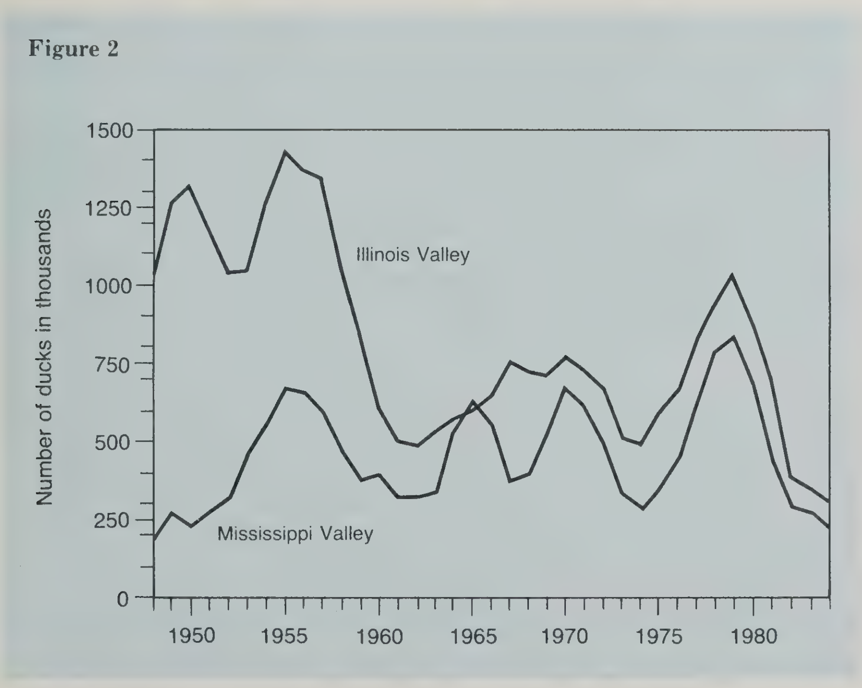


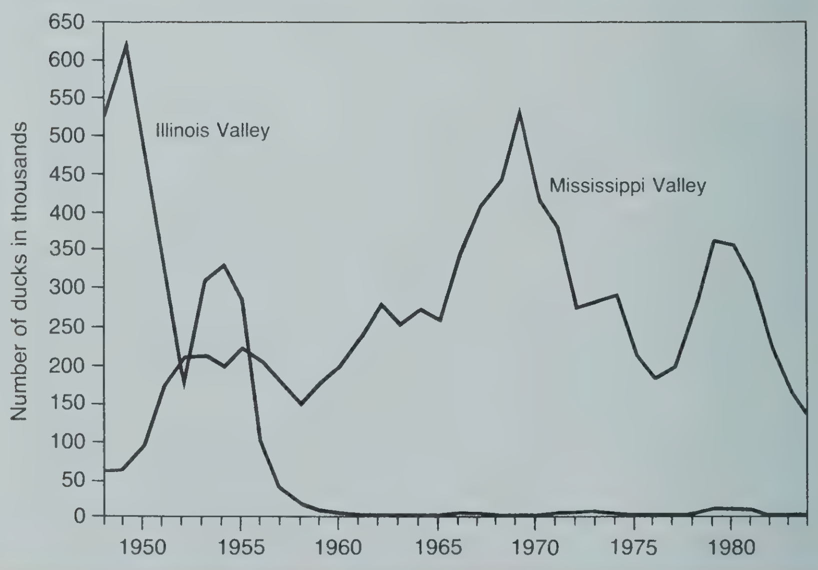
Figure 2. Three-year moving average of peak populations of mallards using the Illinois River Valley and the Mississippi River Valley from Rock Island to Alton, 1948-1984. (Three-year moving averages are determined by averaging the peak population for a given year with the peak populations of the two previous years.) Source: Illinois Natural History Survey River Research Laboratory, Havana, Illinois.

the breeding grounds. However, the significant decline in mallard numbers in the Illinois Valley since the 1950s, in spite of the relatively stable number of mallards inventoried on the Mississippi between Rock Island and Alton, is explained by the waterfowl habitat associated with each river. The wetlands of the Illinois River Valley have been degraded by sedimentation, which has greatly reduced the variety and abundance of aquatic plants and other natural foods available to mallards. In addition, the popularity of fall plowing of harvested corn fields in central Illinois has sharply decreased the amount of waste grain available to mallards. By contrast, the aquatic plant life of the Mississippi River Valley has been less affected by sedimentation. Moreover, public refuges established during recent years in key locations along the Mississippi are attracting waterfowl.

Diving ducks, the second major group of ducks, feed by diving under the water to reach submerged vegetation and the invertebrate organisms that live in the river bottom (benthos). The upper Illinois River (principally Peoria Lake) formerly attracted thousands of diving ducks each fall. Then in the mid-1950s such divers as the lesser scaup (*Aythya affinis*) and the canvasback (*Aythya valisineria*) suddenly disappeared from these waters. The food base of fingernail clams and other benthos that Peoria Lake had provided diving ducks also disappeared about 1955. The reason is unknown, but an increase in the concentration of ammonia in the river system is suspected. In addition, the aquatic vegetation required as food by some species of divers also declined sharply during the 1950s and 1960s as a result of sedimentation. Instead of Peoria Lake on the Illinois River, diving ducks now use Pool 19 (Keokuk Pool) of the Mississippi River as their major migration area. The abrupt disappearance of the lesser scaup from the upper Illinois Valley is shown in Figure 3 in contrast to its increased presence in the Mississipppi River Valley from Rock Island to Hamilton.

Figure 3. Three-year moving average of peak populations of lesser scaups using the Illinois River Valley from Spring Valley to Pekin and the Mississippi River Valley from Rock Island to Hamilton, 1948-1984. (Three-year moving averages are determined by averaging the peak population for a given year with the peak populations of the two previous years.) Source: Illinois Natural History Survey River Research Laboratory, Havana, Illinois.

Figure 3



The major nesting species of waterfowl in Illinois is the wood duck (*Aix sponsa*). Nearly extinct as a result of overharvesting in the early 1900s, the wood duck has recovered dramatically in Illinois and throughout the eastern United States because of protection and management. Wood ducks are cavity nesters and readily take to artificial nest boxes placed in suitable wetlands.

An index to the current nesting species of waterfowl in Illinois can be found in the data from a 1982 survey conducted by the Illinois Natural History Survey. Seventy-three areas that contained waterfowl habitat and were owned or controlled by the Illinois Department of Conservation were investigated. Nesting waterfowl were found in 97 percent of the areas. Individual species were represented on the 73 sites as follows: wood ducks on 93 percent of the sites, mallards on 48 percent, blue-winged teal on 26 percent, giant Canada geese on 14 percent, hooded mergansers on 5.5 percent, and black duck and coot on 1.5 percent of the sites.

Each year the duck harvest in Illinois is estimated by the U.S. Fish and Wildlife Service. Since 1962, the statewide harvest of ducks has generally increased (Fig. 4). Since 1975, between 300,000 and 460,000 ducks have been killed annually in Illinois. Mallards account for about 50 percent of the total kill, wood ducks for about 15 percent, green-winged teal for about 7 percent, and wigeon and lesser scaup for about 5 percent each. The percentage of the total harvest made up by a given species during the hunting season reflects the chronology of fall migration. Wood ducks, green-winged teal, and wigeon are most abundant early in the hunting season, and their representation in the harvest decreases after the first few weeks of the season. Mallard numbers, however, peak later in the hunting season during November and their percentage of the total duck harvest increases throughout the season. Illinois typically ranks about fifth among the fourteen states of the Mississippi Flyway in the annual flyway kill of 4.5 to 6.5 million ducks. *11, 21, 22, 23, 24, 25, 26, 27, 290, 345*

Figure 4

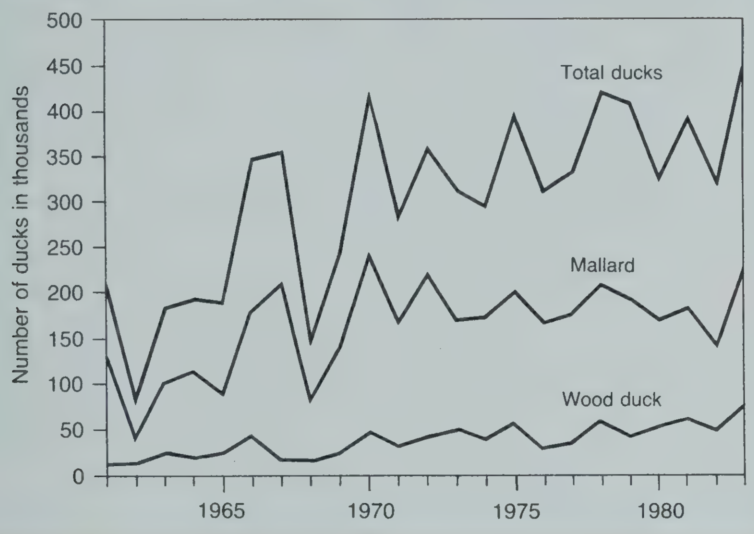


Figure 4. Estimated annual harvest of ducks in Illinois, 1961-1983. Source: U.S. Fish and Wildlife Service.

Stephen P. Havera, Illinois Natural History Survey

Geese

Two species of geese frequent Illinois in numbers: the lesser snow goose and the Canada goose. Occasionally, small flocks of migrating white-fronted geese drift in from the West. Races of the Canada goose vary from the diminutive Richardson's (*Branta canadensis hutchinsii*) to the giant form (*Branta c. maxima*); on the basis of abundance, however, the interior race (*Branta c. interior*) far exceeds all others.

Lesser snow geese migrate through Illinois during fall and spring on their way between breeding grounds in the high Arctic and wintering grounds on the coastal marshes of Louisiana. Of the 300,000 to 400,000 that pass across Illinois in the fall, an average of 35,000 stage (stop) for a month or more at 37 sites scattered over the State: 5 in the northeast, 15 in the Illinois River Valley, 9 in the Mississippi Valley, and 8 in southern Illinois. "Core flocks" appear to return each fall to the same location. During the past 15 years (1970-1984), the number of lesser snow geese staging has ranged from 15,000 to 75,000, a variability that reflects breeding success and the availability of food. Depending upon the weather and the food supply, from a few hundred to a few thousand remain in Illinois through the winter, principally in the southern third of the State. On their northward flight from Louisiana in March, only a small fraction of the lesser snow geese pass through Illinois; most flocks head for the Missouri River near the borders of Missouri and Iowa. From a few hundred to a few thousand, however, do appear in spring in a reversal of their fall flight.

Because of their wariness and erratic activities and the large size of their flocks, relatively small numbers of lesser snow geese are bagged by Illinois hunters. The kill over the last 10 years has averaged 3,050, with yearly variations from 380 to 5,900.

Canada geese migrating into Illinois belong to the Mississippi Valley population. These geese originate from breeding grounds in a vast muskeg west of James Bay and winter largely at a complex of refuges in the southern part of the State. Next to the Atlantic Coast population, this is the largest population unit in the country.

The tremendous numbers of Canada geese now present in Illinois began to develop in 1927 with the establishment of the Horseshoe Lake Refuge in Alexander County by the Illinois Department of Conservation. During its first few years, this refuge held 1,000 to 2,000 geese, increasing to 30,000 by 1933. As numbers increased and local kills became excessive, the concentration of geese at Horseshoe Lake was dispersed by establishing new refuges, including Crab Orchard National Wildlife Refuge in Williamson County in 1947 by the U.S. Fish and Wildlife Service and the Union County Wildlife Area in 1950 by the Illinois Department of Conservation. By 1957 more than 200,000 Canada geese were found in the so-called southern Illinois quota zone. Except for a brief upward spurt to more than 400,000 geese in 1977-1978, the number of geese in the southern zone has been fairly constant, at about 200,000 (Fig. 5).

About 58,000 geese have been bagged annually in Illinois over the last decade (Fig. 6); about 95 percent of these are Canada geese and about 60 percent of the Canadas are generally taken in the southern quota zone (Williamson, Jackson, Union, and Alexander counties), where state and federal refuges are located. A season limit is placed on the kill in the quota zone; when it is reached, the season is closed by emergency order. This system makes for an efficient control of the harvest in keeping with the size of the goose population.

Figure 5. Peak populations of Canada geese in southern Illinois (including Union County Wildlife Area, Horseshoe Lake Refuge, Crab Orchard National Wildlife Refuge, and Rend Lake), 1960-1984. Source: Dennis D. Thornburg, Illinois Department of Conservation.

Figure 5

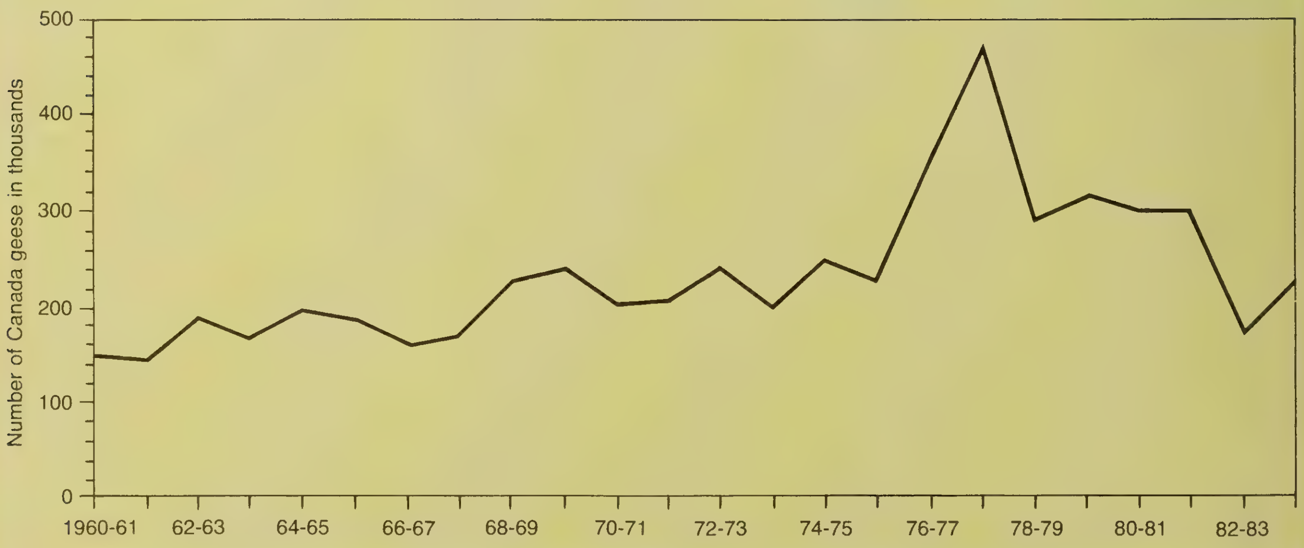


Figure 6

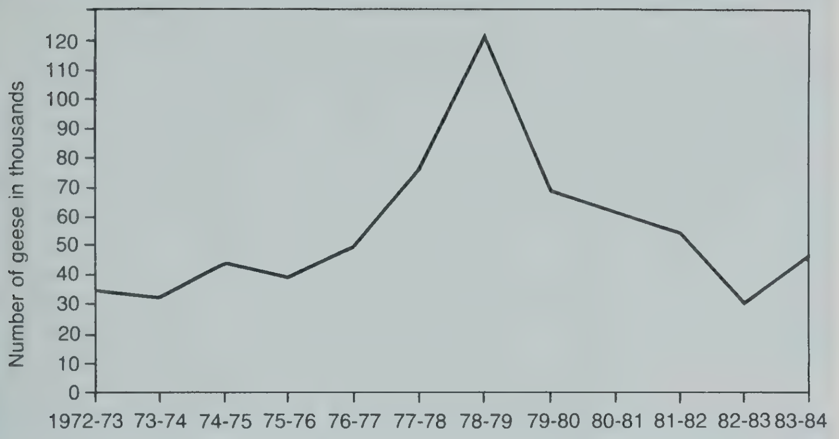


Figure 6. Estimated annual harvest of geese, 1972-1984. Source: U.S. Fish and Wildlife Service, Annual Administrative Reports, Waterfowl Harvest and Hunter Activity in the United States.

Migrating Canada geese begin to appear in southern Illinois late in September, and the censuses usually show a steady increase in numbers through late December. When mild weather and an available food supply occur in southern Wisconsin, however, large numbers may remain there until late December or even early January. Figure 7 illustrates how the migration chronology may differ from year to year. In 1983-1984, for example, the southern migration was essentially completed by mid-January; in 1984-1985, however, the December peak did not occur and the southward migration continued well into February.

Early in February, a few hardy pioneers start moving northward from their winter grounds in southern Illinois. By late March, most Canada geese have moved up to staging areas farther north. One of the most important is in the Illinois Valley near Hennepin, where concentrations of 25,000 to 65,000 frequently occur in the spring.

Figure 7

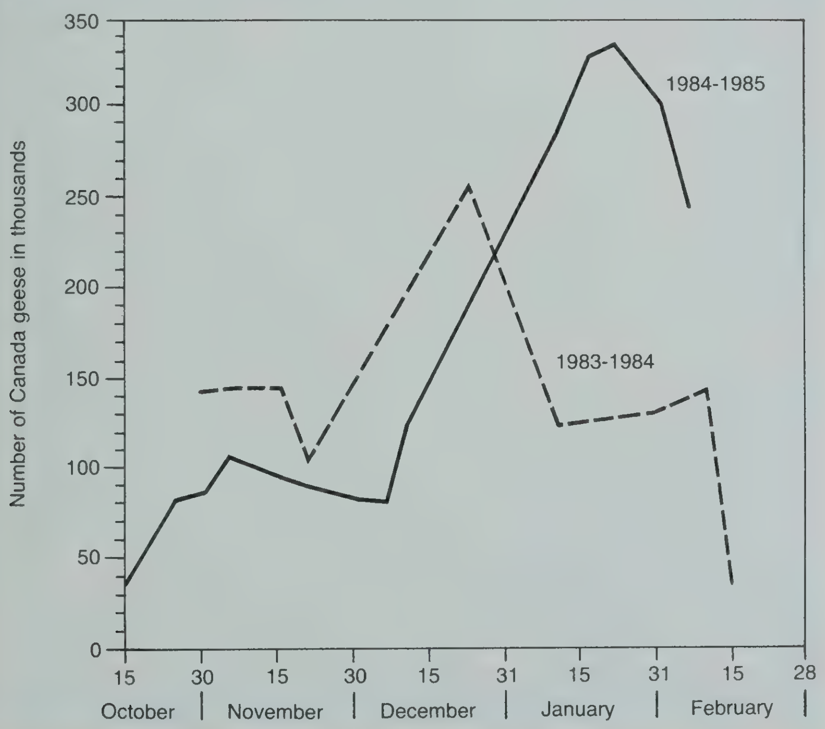


Figure 7. Chronology of Canada goose migration in southern Illinois, 1983-1984 and 1984-1985. Source: Dennis D. Thornburg, Illinois Department of Conservation.

In addition to hosting migrating Canada geese from James Bay, Illinois produces a sizable number of giant Canada geese in an area of strip-mine lakes in Fulton and Peoria counties. Started in 1967 with birds obtained from game breeders by George Arthur of the Department of Conservation, this population now numbers about 8,000 birds. These geese are semi-migratory. Some winter in Fulton and Peoria counties, but others migrate to southern Illinois, Kentucky, and Tennessee. *23, 26, 165, 238, 390, 391, 413*

Frank C. Bellrose, Illinois Natural History Survey, and
Dennis D. Thornburg, Illinois Department of Conservation

Pheasants

The ring-necked pheasant (*Phasianus colchicus*) has been associated closely with agricultural practices in Illinois. For nearly a century, pheasant populations have reflected changes in land use, from the time of small patchwork farms that provided a variety of cover to intensively cropped present-day farms that leave few nesting areas for pheasants. Rural residents can recall their first sightings of pheasants and remember the years of booming populations; more recently they report only a rare glimpse of a fleeting ringneck.

In the early part of the century, a relatively favorable environment for establishing pheasant populations existed in the State. Interspecific competition had relaxed as the numbers of prairie-chickens declined, and patterns of farming and weather were favorable. The Illinois Game Commission had begun distribution of Chinese pheasants for release as early as 1906; and by the 1920s the recently formed Department of Conservation had developed a game-farm system that made available large numbers of eggs and chicks to farmers and sportsmen (Robertson 1958). The combined

Figure 8. Pheasant distribution, rural mail carriers' census, April 1963. Source: Preno and Labisky 1971.

Figure 9. Pheasant distribution, rural mail carriers' census, April 1983. Source: Warner and Etter 1986.

Figure 8

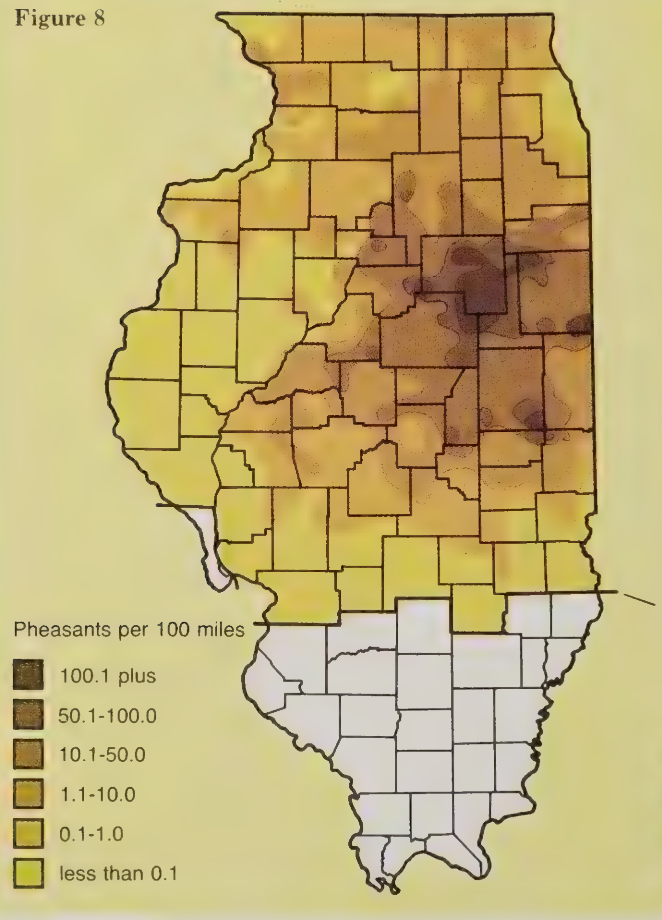
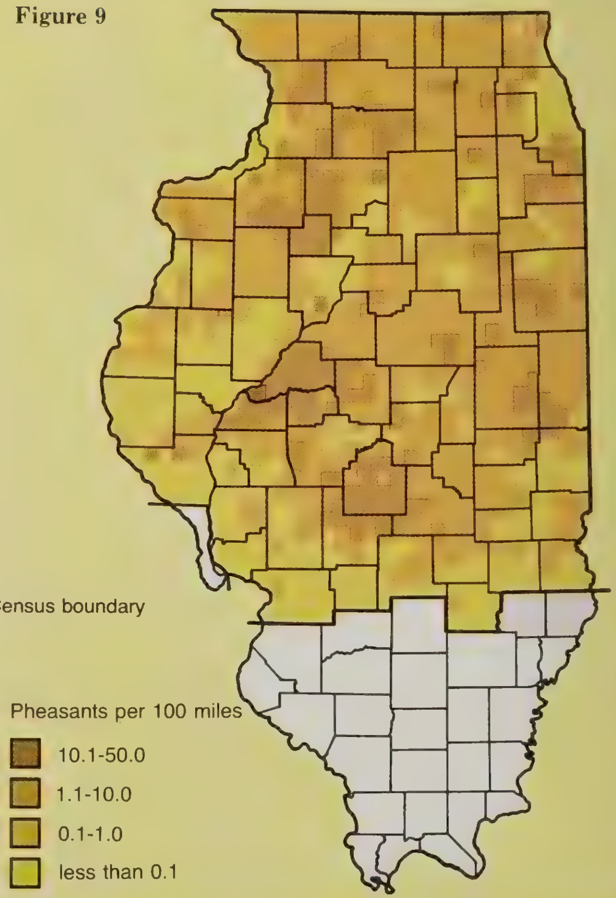


Figure 9



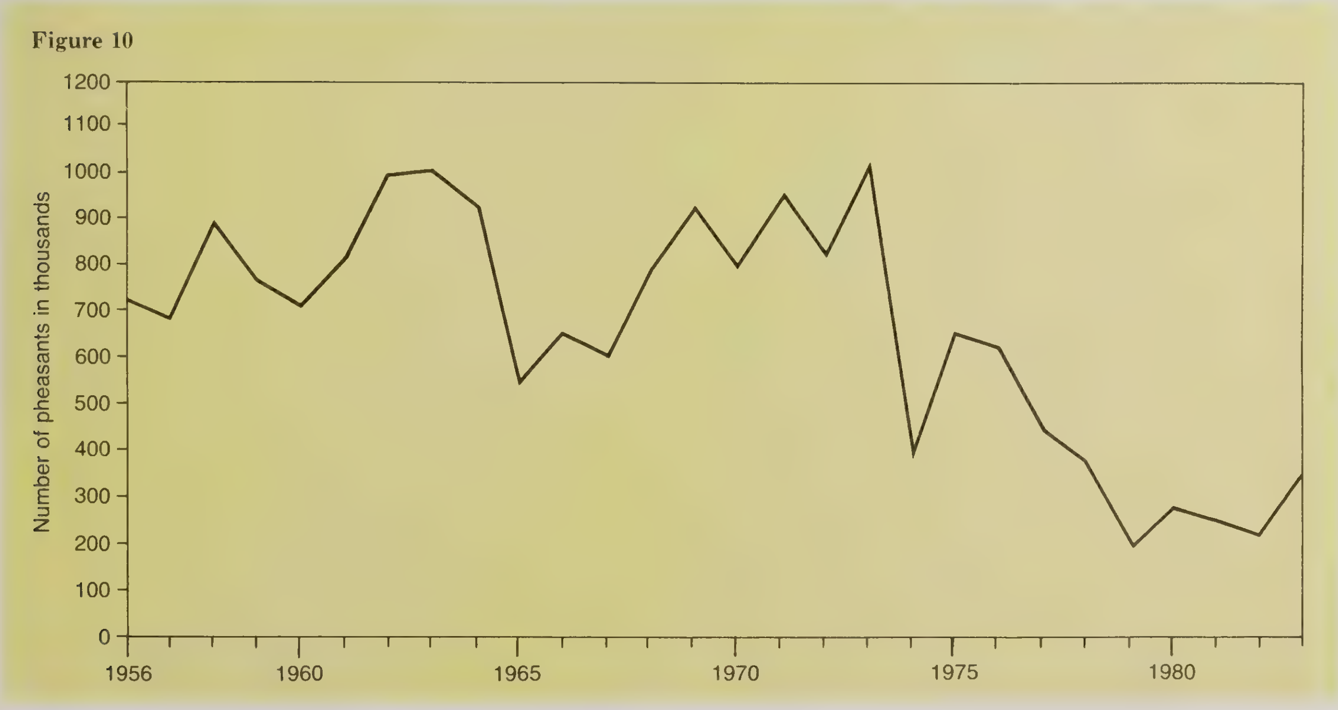
efforts of state and privately fostered propagations were widespread, and releases of pheasants occurred in every county.

Self-maintaining populations of pheasants became well established first in northeastern Illinois, but by the mid-1920s scattered populations were found east of the Illinois River and down to the central counties, especially along tributaries and other bottomland (Leopold 1931; Robertson 1958). Pheasants eventually became distributed over the northern two-thirds of Illinois, primarily in intensively cultivated counties with less than 10 percent of the land area in woodland (Labisky et al. 1964). The window of opportunity for establishing or enhancing wild populations by releasing game-farm stock was rapidly closing, however, and in the relatively harsh environment associated with modern agricultural practices, released pheasants typically survived only days or weeks. Since the 1940s, the ebb and flow of pheasant distribution and abundance in Illinois have therefore been closely linked with the reproduction and survival of wild birds.

Important trends in the distribution and abundance of pheasants are evident in the range maps for 1963 and 1983 (Figs. 8 and 9). First, the center of abundance formerly associated with the flat prairie soils has disappeared. Second, by earlier standards, the pheasant is no longer truly abundant anywhere in Illinois, and no areas with sightings of 50 to 100 or more pheasants per 100 miles exist on the 1983 map. Finally, changes in the range occupied by pheasants have occurred. A modest increase in the range can be seen in counties along the west and southwest peripheries; however, the 1983 census also suggests that the initial phase of a breakup in the contiguous pheasant range–particularly in north-central Illinois–has begun.

Legal hunting of cock pheasants, initiated in 1915, had expanded from a few days to 20 days by the mid-1950s. The current season runs for 50 to 60 days. In spite of longer hunting seasons, fewer cocks are now shot, and a smaller percentage of the population is harvested by hunters. Hunting is in part self-regulated because fewer birds attract fewer hunters. From the 1950s through the early 1970s, the estimated annual harvest of cocks typically ranged from 700,000 to 900,000 (Fig. 10). Since then, however, the bag has plummeted to about 250,000 cocks per year (Ellis 1984). Through the 1960s, pheasant hunters in Illinois typically numbered about 250,000, but in recent years this number has diminished to about 100,000 (Ellis 1984).

Figure 10. Estimated annual harvest of pheasants, 1956-1983. Source: Preno and Labisky 1971; Warner 1981; Ellis 1984.



The success of many life-sustaining activities by pheasants is highly subject to the nature and timing of farm operations. The timing of hay mowing, for example, is important because nesting pheasants are attracted to fields of forage legumes and grasses. Thus many nests and incubating hens have been destroyed by the cutter bar (Robertson 1958; Warner and Etter 1985). On the other hand, pheasants flourish where such fields are left undisturbed, often as a part of government programs to limit the production of cash grains. The survival of pheasant chicks has declined (Warner et al. 1984; Warner 1984) along with the disappearance of oats-hay fields and the initiation of clean farming methods that limit the availability of insect foods and small seeds. Mortality is also common during autumn when the onset of cold weather, the crop harvest, and field tilling produce a rapidly changing and highly disturbed landscape that is conducive to dislocation and stress among pheasants. Since 1950, progressively less crop stubble has been left untilled over winter, and only sparse protective cover can be found in the remaining stubble (Warner and Etter 1985).

Even in intensively farmed regions, however, practices can be adopted that will ensure the future of pheasant populations and hunting in Illinois. Efforts by the Department of Conservation to develop rural road rights-of-way as nest habitat (David and Warner 1981) have demonstrated that pheasants respond to critical habitat components that occupy only a small portion of the landscape (Warner, personal observation). Soil and water conservation practices also offer potential for establishing pheasant habitat (Warner and Etter 1985). In regions where several conservation practices are applied in concert–for example, the elimination of fall tilling, the introduction of terracing, and the development of nest cover on roadsides–pheasants may benefit substantially. The need for a more stable and diverse farm economy along with enhanced soil and water conservation are critical issues for agricultural producers in Illinois, and the future of the pheasant will depend largely upon how these issues are resolved. *6, 95, 103, 109, 159, 254, 255, 256, 274, 325, 338, 434, 435, 436, 437, 438*

Richard E. Warner, Illinois Natural History Survey

Bobwhite Quail

The bobwhite quail (*Colinus virginianus*) is often referred to as the prince of North American game birds. Speed and strength of wing are among its characteristics, but its explosive takeoff and ability to get beyond gun-range through the thickest tangle of brush leave even an expert wingshot breathless. Perhaps no other game bird generates so close an association between hunter and bird dog. When danger threatens, birds in a covey flatten out and conceal themselves in whatever cover they happen to be using. Their coloration blends closely with the terrain, and not even the sharpest eyes can readily spot a frozen covey on the ground. One of the greatest pleasures of quail hunting occurs when the dogs are on point and the hunter walks toward them in measured steps. The covey explodes; although the hunter knew it would, he is never quite prepared. A covey rises in no fixed pattern, and each is different from the last. Some members of the exploding covey may fly directly at the hunter, and most members are out of sight in seconds.

The bobwhite quail is primarily a bird of the southeastern United States. Its primary range is confined within the area that extends westward from southern New Jersey to southeastern Nebraska and then southward through eastern Kansas, Oklahoma, and Texas to the Gulf of Mexico. Bobwhites occur statewide in Illinois, with the highest population densities south of Interstate 70 and west of U.S. Route 67.

The vegetative cover used by bobwhites varies from cultivated fields to mature timber stands. The intervening successional stages of annual grasses, forbs, and perennial herbaceous plants play a vital role in quail ecology, and these successional stages are the key to quality quail habitat.

Throughout the year, quail prefer areas where about half the ground is exposed and the other half has an upright growth of herbaceous and woody plants. The best quality quail habitat in Illinois consists of a mix of woodland, cropland, idle land, and pasture.

Quail eat a variety of seeds and insects. In Illinois, insects, spiders, and slugs are readily consumed when they are available. With the advent of cold weather, quail shift to seeds of agricultural crops including corn, soybeans, wheat, and milo. In addition, wild foods such as common ragweed, lespedeza, crabgrass, foxtail, trailing wild bean, and beggarweeds are found in the crops of bobwhites. Seeds from mast-producing trees such as ash, oaks, and sassafras are also eaten.

Bobwhites in Illinois, especially populations in the extreme northern part of the State, are adversely affected by sub-zero temperatures and by snow when it covers their food supplies for prolonged periods. Under these conditions, coveys utilize cover, usually Japanese honeysuckle and patches of brambles, that offers protection from the wind. Fortunately, these weather conditions do not normally occur in southern Illinois.

Quails are extremely gregarious, but coveys break up into breeding pairs in late March and April. The peak of egg-laying extends from mid-May until mid-June, and in some years, broods are hatched well into September. As broods mature, they group together in coveys of 12 to 15 birds, although a covey may contain 20 or more birds. A covey may range over an area from a few acres to 40 or more acres, depending on the adequacy of the area.

Bobwhites have long been a popular game species with Illinois hunters. The earliest recorded season was in 1900, when legal hunting extended from November 1 until December 20 with no daily or possession limits. In 1913, a daily bag limit of 12 quail was established. Since that time, the season has been extended and the bag limit reduced.

Each year from 1956 to 1981, an average of 146,000 quail hunters spent 795,000 days in the field and harvested 1,176,000 quail. The annual bobwhite harvest has ranged from a high of 2,800,000 in 1958 to a low of 393,000 in 1979 (Fig. 11). The low harvest figure in 1979 was the result of three successive severe winters (1976-1978) throughout Illinois that drastically reduced quail populations.

Figure 11

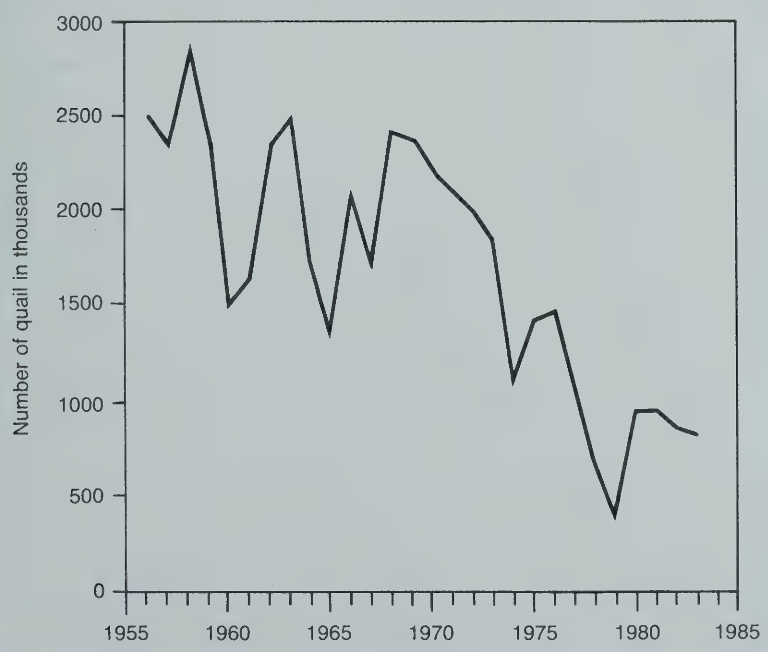


Figure 11. Estimated annual harvest of bobwhite quail, 1956-1983. Source: Jack A. Ellis, Illinois Department of Conservation.

The current quail population in Illinois is low compared to populations twenty or thirty years ago. The future does not seem bright for this popular game bird because its habitat is being destroyed much faster than it is being replaced. Although the Illinois Department of Conservation annually produces 80,000 quail at its facility in Mt. Vernon for distribution as day-old chicks to cooperating sportsmen's clubs, support is needed for agricultural programs that will sustain and enhance quail habitat. *109, 110, 231, 253, 325, 339, 353*

Jack A. Ellis, Illinois Department of Conservation

Woodcock

Although well-distributed locally as a breeding bird where favorable habitat remains and at times quite abundant during migration, the American woodcock (*Scolopax minor*) is perhaps the least-known game bird in Illinois. It breeds throughout the mixed mesophytic and northern hardwoods forest regions, particularly the latter, primarily east of the Mississippi River, and winters mostly in moist bottomland forests along the south Atlantic and Gulf coasts.

Woodcock coloration is a mottled mixture of predominantly rich browns with black splotches. The most interesting physical attributes of woodcock are their very large eyes perched high on their heads and their long flexible bills used to probe for and capture earthworms in moist soil.

The migratory arrivals of woodcock in late winter may be likened to a series of waves coinciding with arrivals of major warm air masses from the south. The local breeders are the first to reach the nesting grounds. They arrive with a rush that coincides with the first really warm weather of late winter or early spring. Later migrants nest farther north, and their migrations are timed to the later arrival of spring at higher latitudes. Woodcock are present in Illinois in varying numbers from late February or early March after the ground is thawed until the ground freezes in November or early December and earthworms, their principal food, are no longer available. Fall migration is largely a reversal of spring migration except that woodcock now take advantage of cold fronts, flying south riding polar air masses moving down out of Canada.

Woodcock have well defined habitat preferences and their nocturnal habitats are quite different from their diurnal ones. Woodcock typically fly from their diurnal to their nocturnal ranges, although they may walk when the two habitats are in close proximity.

During the day woodcock are invariably found in dense, moist woodlands, usually in draws in north-facing slopes, often near springs and seepages, or on river-bottom flood plains and moist terrace soils. Diurnal coverts are characterized by thick stands of young trees growing on moist fertile soils that are high in organic matter and relatively bare of leaves and herbaceous vegetation; they also contain an abundance of earthworms in the upper one to three inches of soil. Such habitat also provides protection from natural predators during the day.

Woodcock tend to spend their nights in cover characteristic of disturbed areas undergoing secondary succession to woodland. Such areas contain a mix of herbaceous plants (grasses and weedy forbs), clumps of brush and young trees, and patches of level bare ground. At mid-latitudes, woodcock seek out lightly grazed, unimproved, infertile, old pastures and abandoned farmland showing spots of erosion and clumps of briars, brush, and young trees. In the northern hardwoods region, woodcock are often found in old forest openings created by logging, fires, and abandoned farmland. Such disturbed nocturnal habitats are used as peenting grounds in the spring.

The peenting ground is typically a small open amphitheater 5 to 50 feet in diameter and quite bare of vegetation. Its soil is usually poor, often with bare subsoil exposed by erosion. Peenting grounds are generally spaced about 200 yards apart and tend to be used year after year. Peenting, which begins when the migrants arrive and ends abruptly in June, occurs shortly after sunset. Since peenting is largely controlled by the amount of light, it commences later in the evening and goes on longer under clear than under cloudy skies; it also begins later in May, as the days get longer, than it did in April. The male starts with a series of throaty peents or buzzing sounds spaced about 10 seconds apart. Then the peenting ceases, and the bird flies upward in a series of wide spirals as he emits a musical twitter. The spirals get steeper and smaller as the bird ascends, and the twitter gets louder and louder. Suddenly the bird drops to the peenting ground and begins the performance again. This display is clearly a mechanism by which the male calls the attention of other woodcock, males or females, to his presence and territory.

Woodcocks usually position their nests on the ground less than 100 yards from the peenting grounds, near the edges of small thickets, and relatively close to their feeding areas. The nests are poorly constructed and camouflaged primarily by the color pattern of the hen and the eggs, which are a light cinnamon color with numerous dark brown spots. The eggs are large, about 15 grams, and thus the normal clutch of four eggs weighs almost a third of the weight of the hen. Large egg size, however, results in comparatively large, active (precocial) chicks that grow rapidly and fly strongly at an early age. The rapid physical maturity of the chicks allows the woodcock to move relatively long distances seeking food in the summer when earthworms begin to become inaccessible as upland forest soils dry out.

The woodcock is hunted in Illinois but not nearly so extensively as bobwhites and pheasants, and hunters may be deterred by the unpredictable times of arrival and locations of the woodcock during their migratory flights. The estimated annual kill has not exceeded 41,000 in the past decade and has shown a decline in recent years (Fig. 12). Because of the significance

Figure 12

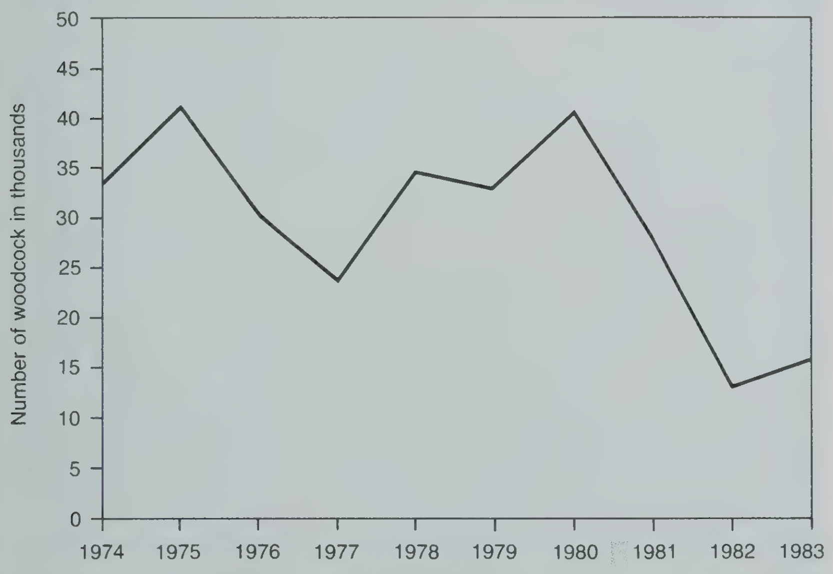


Figure 12. Estimated annual harvest of woodcock, 1974-1983. Source: Ellis 1984.

of moist woodlands to local and migrant woodcock, as much as possible should be done to save the limited woodlands that remain in Illinois and to develop additional ones wherever possible. For woodcock, however, woodlands should not be managed as large stands of even age. For many wildlife species, including woodcock, forests are best managed as a matrix of numerous relatively small and interspersed patches of different ages separated by small, well-placed forest openings, which is not to imply that mature woodlands should be cut to provide forest openings. Watersheds above and around natural springs and seepage areas should also be protected so that feeding coverts with moist soils are not lost. *109, 357*

William R. Edwards and Richard J. Siemers,
Illinois Natural History Survey

Mourning Dove

Mourning doves (*Zenaida macroura*) are a versatile, adaptable species that breeds throughout the contiguous 48 states. One of the foremost game birds in the United States, they have sustained annual harvests of tens of millions for many years. Doves nest in every county of Illinois, and flocks winter in many parts of the State. Most mourning doves, however, winter in the southern tier of states, in Mexico, in Central America, or in the West Indies.

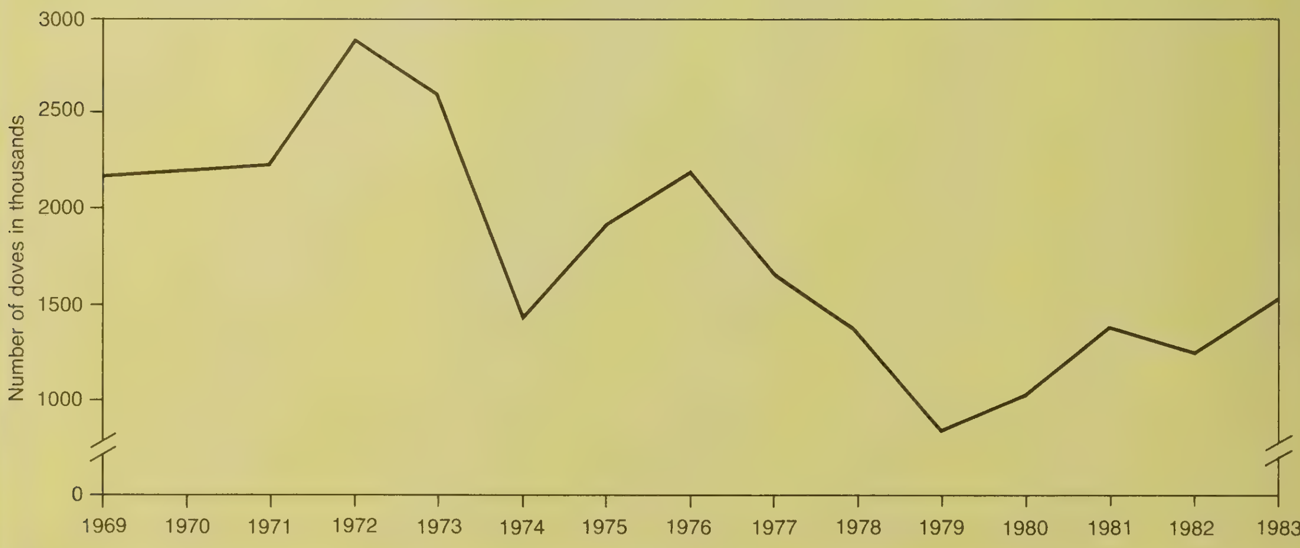
The pattern of distribution of doves in Illinois is determined by the quality and quantity of habitat and by weather conditions during the breeding season. During the relatively long nesting season, as many as six broods may be fledged by a single set of parents. During fall migration, flocks of doves can be encountered almost anywhere in Illinois. By mid-September, however, a majority of the doves have migrated from the northern third of the State.

As early as 1900 the dove was listed as a game species in Illinois, with no bag limit during the September through November hunting season. The first state bag limit of 15 was established in 1915. The Migratory Bird Treaty Act of 1918 placed the dove and all other migratory species under the management of the Federal Biological Survey, now the U.S. Fish and Wildlife Service. Since then, harvest regulations have been established by the Illinois Department of Conservation based on guidelines provided by the U.S. Fish and Wildlife Service.

Illinois has monitored the harvest of doves since 1956. Since 1969, annual harvests have ranged from a high of 2,879,000 in 1972 to a low of 822,000 in 1979 (Fig. 13). During this period, dove hunters averaged a kill of 16 doves per season. Dove populations in Illinois have demonstrated a modest long-term downward trend (less than 1 percent annually) as determined by roadside surveys (counts of doves seen and heard along randomly selected routes). Because of the dove's general abundance throughout the State, little management attention has been granted it. In recent years,

Figure 13. Estimated annual harvest of mourning dove, 1969-1983. Source: Jack A. Ellis, Illinois Department of Conservation.

Figure 13



the planting of sunflowers on selected areas of the State has successfully attracted doves during the hunting season. In 1982, for example, 177 fields in 66 state-owned areas were planted to sunflowers. These fields, in turn, provided Illinois sportsmen with a harvest of nearly 50,000 doves. *4, 109, 166, 203, 325, 343*

Division of Wildlife Resources,
Illinois Department of Conservation

Hungarian Partridge

The Hungarian partridge (*Perdix perdix*), commonly known as the gray partridge, is a native to Europe and Asia. Although introductions were made in the United States as early as 1790, most introductions were made in the late 1800s and early 1900s. From 1906 through 1927, over 12,000 gray partridges were released by the State of Illinois. The existing populations in Illinois originated from these releases or from releases made in neighboring Wisconsin.

The present range of the gray partridge is characterized by intensive agricultural land use. The partridge occupies the northern fourth of Illinois, with the highest populations occurring in the north-central counties of La Salle, Lee, Ogle, DeKalb, Winnebago, Boone, and McHenry. Gray partridges have probably reached the limit of their range extension in Illinois, particularly since they require relatively cool, dry weather during the hatching season (Farris 1970). Partridge populations in Illinois are unlikely to increase under current levels of management.

Illinois initiated a hunting season on gray partridges in 1961 and has monitored the annual harvest since that time. The kill has fluctuated dramatically, with the highest harvest, 16,100, in 1966 and the lowest harvest, 976, in 1982 (Fig. 14). Sportsmen usually take partridges incidentally while hunting more abundant upland species, particularly cottontails and pheasants. During the twenty-year period from 1961 to 1981, an average of 6,220 hunters bagged about one partridge per hunter per season. In 1984, however, approximately 2,500 hunters took only 1,200 birds. *5, 44, 103, 119, 120, 203, 231, 401, 457*

Division of Wildlife Resources,
Illinois Department of Conservation

Figure 14. Estimated annual harvest of Hungarian partridge, 1961-1984. Source: Jack A. Ellis, Illinois Department of Conservation.

Figure 14

Coot, Snipe, and Rails

Among the less familiar Illinois game birds are the common snipe and members of the rail family. Of the eight rail species in Illinois, only the American coot and the sora and Virginia rail are legally hunted at the present time. Although the snipe and rail species are classified as webless migratory game birds, the coot is considered a waterfowl for purposes of wildlife management because of its close association with ducks during migration and on wintering grounds. All of these species are protected under the Migratory Bird Treaty Act of 1918, and the hunting of them is regulated by the U.S. Fish and Wildlife Service.

Intensive land use in Illinois has greatly altered the habitats of these species and influenced their populations. Coot and rail were common breeding birds around the turn of the century, but the snipe's breeding population had already dwindled by 1907 (Woodruff 1907; Ridgway 1889). Presently, only the sora rail maintains a relatively substantial breeding population in Illinois. The coot and Virginia rail may breed locally when suitable habitat is available, but these species along with the sora are currently observed most often during migration (Table 1).

The breeding and foraging activities of the coot, snipe, and rail occur in wetland habitats. Though their microhabitats may differ, in Illinois these species breed primarily in freshwater marshy areas. Suitable cover appears to be essential for nesting to occur and is usually provided by such marsh vegetation as cattails, bulrushes, and sedges. Water conditions and vegetative structure, however, and not plant species composition seem to be the important factors in habitat choice (Rundle and Fredrickson 1981). Coot and rail nests are constructed in emergent marsh vegetation and invariably

Table 1. Migration period and migrant status for coot, snipe, and rails in Illinois.

Species	Migration period	Migrant status
American coot	Early March to mid-May Mid-September to mid-November	Abundant migrant
Common snipe	Late March to early May Late August to late September	Common migrant
Virginia rail	Early April to mid-May Late August to late September	Fairly common migrant
Sora rail	Early April to late October	Fairly common summer resident in northern Illinois

Source: Bohlen 1978

Table 2. Breeding habits of coot, snipe, and rails.

Species	Average clutch size	Incubation	Nest
American coot	8–12	23–24 days, male and female	Typically floating in 1–4 feet of water, firmly attached to surrounding vegetation.
Common snipe	4	18–20 days, female only	Concealed in grasses in or at the edge of wetlands.
Virginia rail	8–10	19 days, male and female	Suspended over water or over drier area of wetland.
Sora rail	10–12	16–19 days, male and female	Suspended approximately 6 inches above water, supported by marsh vegetation.

Source: Harrison 1975

Table 3. Foraging modes and food habits of coot, snipe, and rails.

Species	Foraging mode	Food habits
American coot	Dabbler and grazer	Largely (90 percent) herbivorous except during breeding season; commonly eats naiads, pondweeds, sedges, algae, and grasses.
Common snipe	Probes substrate	Predominantly animal matter, especially insects and their larvae, earthworms, and small crustaceans.
Virginia rail	Probes substrate	Predominantly animal matter, especially beetles and dipterans and their larvae, true bugs, and snails; also eats seeds of marsh plants.
Sora rail	Picks from surface	Primarily beetles, insects, snails, and spiders except in fall when seeds of *Polygonum* and sedges, for example, are important.

Source: Martin et al. 1961

placed near or suspended over shallow water. The snipe, however, nests on the ground, typically in a dry area, even if the surrounding area is saturated. Table 2 summarizes the breeding habits of these birds. All of them forage in marshy habitats but occasionally feed in upland fields, especially during migration. They are omnivores, eating both animal and plant matter, although the proportions may differ, especially on a seasonal basis. Particular food habits and foraging modes are listed in Table 3.

Snipe, coot, and Virginia and sora rails have been considered legal game since the turn of the century and have experienced varying degrees of hunting pressure. Snipe and the Virginia and sora rails, perhaps because of their secretive habits and low rates of encounter, are seldom hunted in Illinois except in localized areas. Currently, less than 1 percent of Illinois hunters pursue them (Ellis 1984). Coots have long been viewed negatively by hunters, who generally consider them unsporting and unpalatable (Sanderson 1977). Nevertheless, large numbers are shot each year because of their close association with duck populations. Commonly they have been used as practice targets and never retrieved. In recent years as waterfowl availability declined, coots have attracted increased fire.

The extensive and intensive drainage that has characterized land use in Illinois has markedly reduced the breeding and foraging habitats of waterfowl. For snipe and rails the most important aspect of wildlife management is the maintenance and creation of wetlands. *46, 109, 170, 234, 285, 332, 341, 343, 454*

Patti L. Malmborg, Illinois Natural History Survey

Nongame Birds

The ability of birds to fly and their remarkable diversity have fascinated people since ancient times. Birds were sought after for food and for plumage and were often kept as pets. More recently, however, human manipulations of the environment have contributed to sharp declines in many bird species. Sportsmen were aware of diminished numbers of game birds well before the turn of the century; only recently has the general public recognized the aesthetic, scientific, and recreational losses that accompany reduced numbers of nongame birds. Although these birds are not hunted, they have enormous economic value. They eat massive numbers of insects, prey on rats and mice, and transport seeds from one area to another. Approximately 90 percent of the 383 bird species in Illinois are nongame species. These birds are often categorized according to their residency within the State–summer or winter resident, permanent resident, or migrant.

Two common summer residents in Illinois are the purple martin and the red-eyed vireo; both winter in South America. The purple martin resides in Illinois from late March through the middle of September, occupying open, grassy areas near water or living in towns, where it has adapted to martin houses. It feeds on insects that it usually catches while in flight, although it also feeds on the ground. The red-eyed vireo arrives in late April and spends its summer in woodlands and in towns where there are large shade trees. It feeds on tree insects, berries, and fruits. Red-eyed vireos usually leave Illinois to migrate south in early October.

The dark-eyed junco and the rough-legged hawk inhabit Illinois during the winter months. The junco arrives in late September or early October from its nesting grounds in the northern United States and Canada. It resides in open woods, in brush, and in weed fields, where it can be observed in groups foraging on the ground for seeds. In March and April, it returns north. The rough-legged hawk resides in fields and marshes, usually arriving in mid-October from its nesting grounds in the arctic regions of Canada. It can often be seen perched in bare trees or on fenceposts. This hawk eats small rodents and, occasionally, insects. In April, it returns to Canada.

The northern cardinal, the blue jay, and the great horned owl are among the permanent residents of Illinois. The cardinal can be found in thickets and hedges, in forests, in swamps, on stream banks, and in towns. It is often seen foraging on the ground for insects, seeds, or wild fruits. In the winter it may frequent bird feeders, where its preferred diet is sunflower seeds. The blue jay is a woodland bird adapted to life in gardens and towns. Omniverous, it feeds on acorns, berries, and insects and may also eat small animals such as mice or frogs. In winter, jays frequent backyard feeders for suet and sunflower seeds. The great horned owl, a less common permanent Illinois resident, lives in woodlands, forests, and wooded urban areas. Chiefly nocturnal, it also hunts during the day for a variety of animals including small mammals, birds, amphibians, reptiles, fish, and insects.

Migrants neither breed nor winter in Illinois, but they do utilize Illinois habitats as feeding and resting stops during their long migrations. The lesser golden-plover is seen in Illinois in late March through mid-May on its way to breeding grounds in northern Canada. It requires the wet fields, shores, and mud flats of Illinois to complete its journey successfully and feeds on insects and small mollusks. It is also seen in late August through October as it returns to South America for the winter. Another common migrant in Illinois, the magnolia warbler, prefers low woodlands and thickets and a diet of insects and spiders. It is seen in Illinois in May enroute to the northern United States and Canada and again in late August through October as it migrates to wintering grounds in Mexico and Central America.

The diverse habits and habitats of the nongame birds of Illinois suggest the difficulty of devising management strategies. Historically, management has been directed primarily toward game species. Sportsmen insisted on renewable supplies of game birds and represented a substantial source of funds. Nongame species, on the other hand, received little attention; neither the demand nor the funds existed.

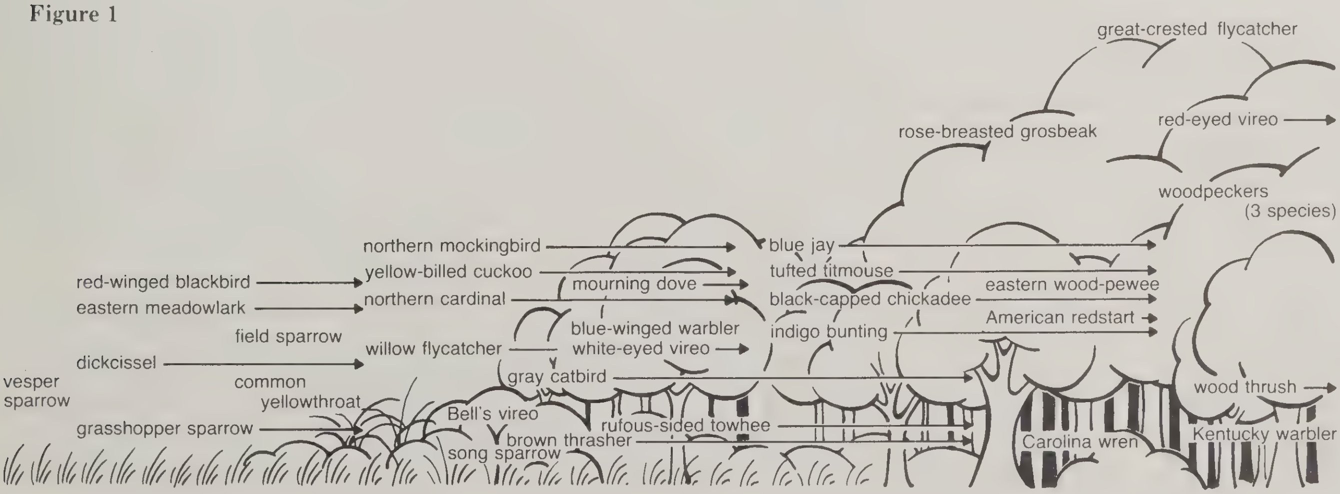
Land acquisition and maintenance initiated by game management have, of course, benefited some nongame species; on the other hand, management for target species sometimes decreases habitat diversity and eliminates niches occupied by nontarget birds. Because nongame birds occupy virtually every type of habitat and niche in Illinois, a management plan encompassing all as target species is infeasible. Figure 1 indicates the complexity of the problem. Generally, as the height of vegetation increases and its structure becomes more complex, the number of niches that may be occupied by a variety of birds increases. Hence, the number of species tends to increase along with the vertical gradient of vegetation. Forests, for example, may support species that use the high canopy, others that utilize the mid-level, and still others that require the strata at or near the ground or the area immediately adjacent to the forest. Management strategies directed toward an entire ecosystem or toward a species assemblage that utilizes a common habitat are, therefore, more likely to succeed with nongame birds than are more traditional, species-specific measures.

Most nongame species in Illinois qualify for protection under the Migratory Bird Treaty Act of 1918 and/or the Illinois Wildlife Code of 1971. The Endangered and Threatened Species Act of 1972 protects those in danger of extinction. Present programs for nongame birds include the documentation of the abundance and distribution of species, research on habitat requirements, and the continuation of the Illinois Breeding Bird Atlas. The Illinois Department of Conservation has also inventoried state-owned properties and is developing master management plans to benefit wildlife and their habitats. The Nongame Protection Act, which became effective in 1983, is designed to encourage public interest in the protection of nongame wildlife in Illinois. A voluntary designation on Illinois income tax forms allows citizens to direct all or a portion of their state tax refund to the Nongame Wildlife Conservation Fund. In 1984, taxpayers donated approximately $260,000 to this fund. *46, 90, 95, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 167, 170, 236, 285, 322, 332, 365, 385, 451, 454*

Patti L. Malmborg and Nancy E. Wiseman, Illinois Natural History Survey

Figure 1. Vegetation gradient from grasslands to forest communities along with representative bird species from east-central Illinois. The increasing vertical dimension also contributes to increased horizontal heterogeneity. Source: Adapted from M. F. Willson, 1984. *Vertebrate Natural History*. Copyright ©1984 by CBS College Publishing. By permission of CBS College Publishing.

Figure 1



Game Animals

Each year about 400,000 Illinois residents spend more than 8 million days afield in Illinois in pursuit of game animals. Their success in hunting deer, rabbits, and squirrels is reported here. Other game harvests are found in the sections on game birds and furbearers. *109, 186, 201, 274, 285*

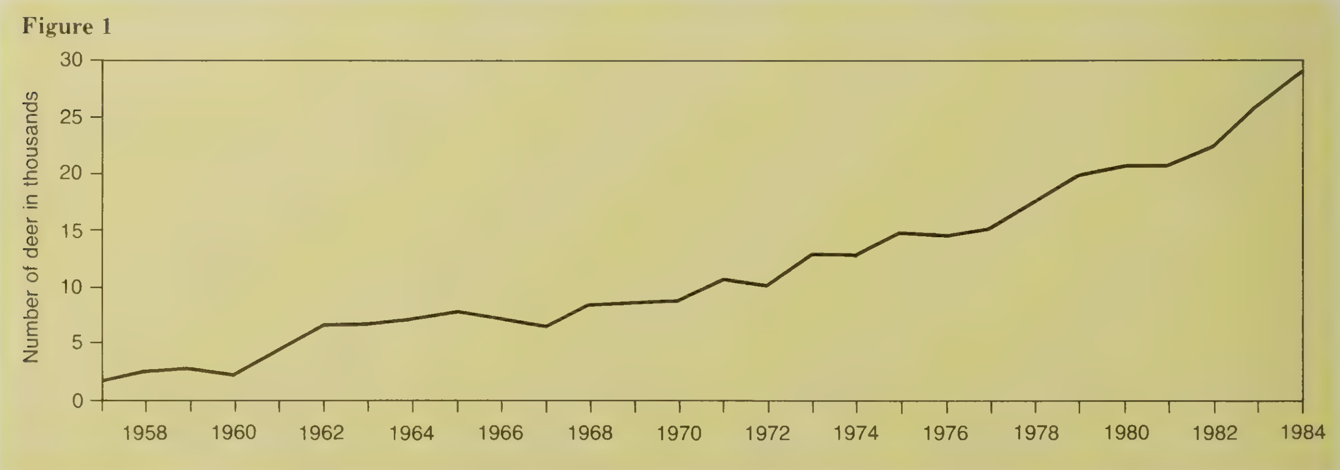
White-tailed Deer

Although Illinois is considered a prairie state, large expanses of woodland occurred in the southern, western, and northwestern parts of the State during presettlement times; less extensive woodlands existed in association with the prairies. The white-tailed deer was probably abundant in those forests, especially those associated with the prairies. Records from early settlers throughout the Midwest suggest that deer populations gradually declined east of the Mississippi River, a decline attributed to overexploitation by Indians provided with more efficient means of killing by the settlers and by the settlers themselves, who responded to their own needs and to the eastern market for skins and meat. Between 1820 and 1870 the population of Illinois increased 46-fold, and that influx of settlers may have resulted in a small increase in the number of deer because more diversified habitats were created, which generally provide deer with ideal cover and food. However, continued agricultural clearing, increased livestock grazing in the forests, and hunting of the white-tail caused a dramatic decline in deer populations during the latter half of the nineteenth century.

The killing of deer in Illinois was first regulated in 1853, when it was prohibited between January 1 and July 20 in 15 northwestern counties. The killing of deer between January 1 and August 15 was prohibited statewide in 1873. These efforts had little effect on declining deer numbers, and in 1901 the white-tailed deer was afforded statewide, year-round protection. Apparently this protection came too late; by the early part of the twentieth century, the white-tail was at or near extinction in Illinois.

Beginning in the 1930s, reintroductions of the white-tailed deer took place in various parts of Illinois through deliberate releases by the Department of Conservation and escapes from captive herds. At about this time, the livestock and dairy industries of the State declined. Pasture reverted

Figure 1. Estimated annual harvest of deer, 1957-1984. Source: Forrest C. Loomis, Illinois Department of Conservation.



to successional habitats and the understory recovered in woodlands that had been pastured; both of these changes provided better habitat for white-tails. As a result, a rapid expansion in range and numbers occurred in Illinois between 1930, when deer were found in only a few counties, and the present, when deer are common in every county of the State.

The first shotgun deer season in Illinois opened in selected counties in 1957, with 8,941 hunters taking 1,725 deer. The number of counties open to hunting and the number of hunters have increased since then as has the number of deer harvested. In 1984, 29,212 deer were taken by 81,340 shotgun hunters. All but four counties in heavily urbanized northeastern Illinois are presently open to shotgun deer hunting. In addition, 41,512 bow permits were issued in 1984, resulting in a harvest of 3,023 deer. The increase in the size of the herd is evident not only from the increased harvest (Figs. 1 and 2) but also from increased hunter success. Between 1974 and 1984, hunter success increased from 19 to 36 percent.

The future of the white-tailed deer in Illinois can be viewed with guarded optimism. Forested land continues to be lost, but the white-tail has thus far been remarkably tolerant of these losses, adapting to an agricultural-forest association and taking advantage of the food (and to some extent of the cover) provided by this association. Even if habitats are maintained, however, the herd will not be allowed to grow indefinitely. In a highly agricultural state like Illinois, conflicts arise where deer densities are high and damage to agricultural crops is excessive. Increasing white-tail densities are also associated with increased deer-vehicle accidents. The Department of Conservation monitors these factors and adjusts the deer harvest accordingly, either to stabilize the size of the herd or to allow it to increase. *70, 87, 164, 183, 184, 277, 318*

Lonnie P. Hansen and Charles M. Nixon, Illinois Natural History Survey

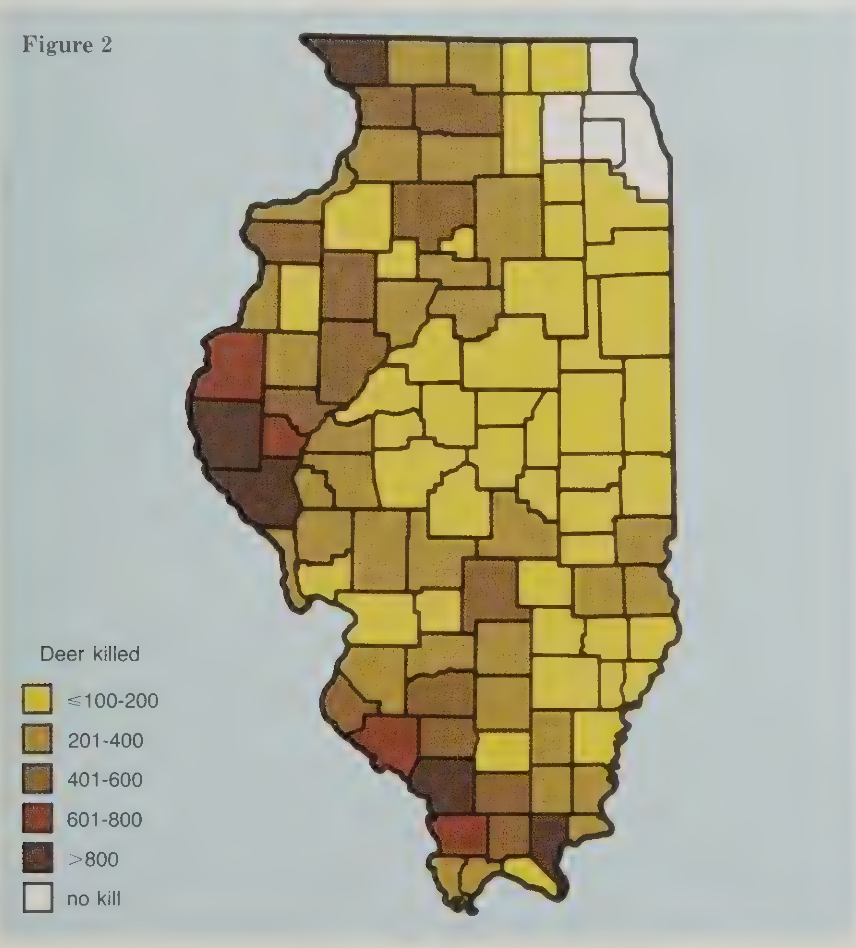


Figure 2. Deer harvest by county, 1984. Source: Forrest C. Loomis, Illinois Department of Conservation.

Cottontail Rabbits

Cottontails are widely distributed from southern Canada, through most of the United States, into Mexico, and southward into parts of Central America. They belong to the order Lagomorpha and the family Leporidae, which includes hares and rabbits. Hares are born covered with hair, eyes open, and teeth in place. Cottontails are born naked, eyes closed, and without teeth. Young cottontails develop rapidly, however, and leave the nest to forage for green weedy forbs and grasses in about 8 to 10 days. Hares are adapted to cooler, more rigorous climates although the ranges of hares and rabbits extensively overlap in parts of southern Canada, in several northern and western states, and in Mexico.

Illinois has three native leporids. The eastern cottontail (*Sylvilagus floridanus*) occurs throughout the State. The subspecies *Sylvilagus f. alacer* is found in extreme southern Illinois (south of the Shawnee Hills); another subspecies (*Sylvilagus f. mearnsii*) is found through the remainder of the State. These subspecies are similar in size and general appearance, but a slightly larger and more darkly colored leporid is the swamp rabbit (*Sylvilagus aquaticus*). Its distribution is restricted to bottomland forests, canebrakes, and thickets along the Ohio River and its tributaries in southern Illinois. The State's only hare, the white-tailed jackrabbit (*Lepus townsendi*) is found today in at most a few, scattered, low-density, remnant populations. It may, in fact, survive only on the Savanna Ordinance Depot in Jo Daviess County. The discussion that follows is limited to the cottontail, the common rabbit of Illinois, although the term "common" is not nearly so appropriate as it was only twenty years ago.

The cottontail is brown to gray-brown in color with a white underside, a conspicuous cotton-white tail, and often a small white spot in the middle of the forehead. Fully mature, they weigh about three pounds. Cottontails have earned their reputation for reproduction; however, they do not breed year-round in Illinois. Their annual reproductive cycle is controlled by hormones secreted by the endocrine system centered in the pituitary. That organ responds to changes in length of day–photoperiod. As days grow longer after the winter solstice, cottontails respond physiologically to an increased production of sex hormones and become capable of reproduction. During the first truly warm period of late February or early March, they breed. A high degree of synchrony occurs in mating, and essentially all females in local and even regional populations breed in a period of relatively few hours. The cottontail is said to be a post-partum breeder because females normally copulate only a few minutes after giving birth. Given the synchrony of the initial breeding, a 28-day gestation, and post-partum breeding, cottontails show a high degree of synchrony in their reproduction throughout the annual breeding season.

Adult females have four to six litters each breeding season, with an average litter size of about five. Thus an average female alive in March has the potential to produce 25 to 30 young in the next five to six months. In addition, much of the late summer breeding is probably by juveniles. In a single breeding season, therefore, cottontails have the potential to produce 50 or more young per adult female alive at the start of the breeding season. Species with high rates of reproduction, however, suffer high rates of mortality–and so it is with cottontails. Typically, only one of six cottontails alive in early November will survive to the next November.

The peak abundance of upland game, including cottontails, probably occurred in Illinois from 1870 to 1880. Since then, the relatively continuous trend to intensive farming has been accompanied by loss of habitat quality and quantity–and by a reduction in the statewide abundance of cottontails. Two conspicuous breaks in this trend have occurred. During the depression of the 1930s, thousands of acres went unfarmed or were withdrawn under subsidy of the U.S. Department of Agriculture and seeded to soil-conserving forage grasses and legumes. These fallow fields and seeded grasslands provided much improved wildlife habitat and cottontail numbers jumped. World War II brought strong grain markets and the fields diverted from cropping in the 1930s were again plowed; in the 1940s and early 1950s rabbit numbers once again fell. By the mid-1950s American farms were again overproducing and grain prices fell. The Soil Bank was established in 1956 in an attempt to restore agricultural markets and to conserve soil by seeding diverted acres to grasses and legumes. Once more cottontails benefited. As the Soil Bank began to be phased out in the early 1960s, cottontail numbers began a decline that has continued more or less unabated. Since about 1960 the number of cottontails has declined more than 70 percent statewide and over 90 percent in intensively farmed regions. The phasing-out of the grassland-type seedings made under federal subsidy was particularly significant. Perhaps even more important was the continuing loss of unimproved pastures that often provided an ideal combination of weeds, briars, and brush for cottontail cover. In the long run, cottontail populations clearly reflect changes in land use and habitat; however, even where habitat is relatively stable, large fluctuations in numbers from year to year are apparent on individual farms, locally, and even regionally. Cottontail numbers are also affected by adverse weather (especially subnormal temperatures accompanied by above-normal precipitation), predation, and diseases such as tularemia. Where rabbits are found in relative abundance, however, they remain a sought-after game species in Illinois (Fig. 3).

Cottontails tend to clump together on "islands" of favorable habitat. They apparently evolved the capacity to survive in a variety of woodland edge and disturbed environments that developed locally as a result of such random events as fires, floods, outbreaks of plant diseases, and grazing. These islands of cover were somewhat separated in space and temporary in time (successional) because they reflected natural types of habitat disturbance. Dispersal is critical for the perpetuation of animals like the cottontail that are dependent on successional (temporary) habitats. Although dispersing individuals typically suffer high rates of mortality, sufficient benefit accrues to those who are successful in establishing home ranges in new locations for dispersal to have survival value for the species.

Wildlife managers often refer to a "harvestable surplus" of annually produced animals that provides the basis of sport hunting. Under normal conditions, wild populations produce considerably more young than are needed to compensate for the natural mortality of purely resident individuals. This surplus is roughly equivalent to the dispersing cohort in a population. As a rough approximation, about half the annual number of young that survive to the hunting season may be taken by hunters without jeopardizing the local breeding population or the number of dispersers needed

Figure 3

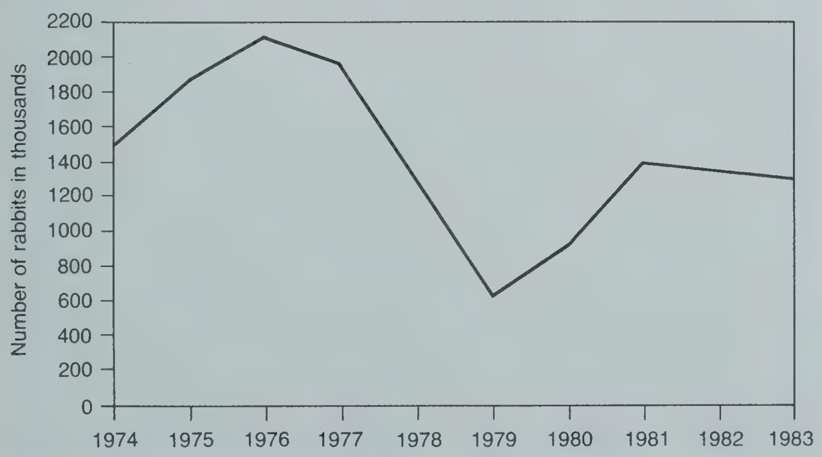


Figure 3. Estimated annual harvest of rabbits, 1974-1983. Source: Ellis 1984.

for recolonization. If we return to the idea of cottontail habitat as islands in a sea of intensive agriculture, dispersal comes into clearer focus. In effect, as agricultural land use intensifies, habitat islands become fewer, smaller, and farther apart. These islands sustain fewer resident individuals and put out fewer dispersers; these dispersers, in turn, have less chance of reaching another island. Populations on smaller islands have greater chance of becoming extirpated (going to zero), with longer average time intervals to recolonization at lower rates of recolonization. On average, the result is a combination of less habitat supporting lower densities of animals per unit of habitat. *16, 87, 107, 109, 280, 325*

William R. Edwards, Illinois Natural History Survey

Squirrels

Three species of tree squirrels are found in Illinois. The most widely distributed and the largest is the fox (*Sciurus niger*), found throughout the State (Fig. 4). The gray (*Sciurus carolinensis*), only about half the size of the fox, is most common in the forests of the southern third of the State, along the Mississippi River north to Wisconsin, and in the counties bordering the Illinois River as far north as Putnam County. Gray squirrels are scarce or absent in many counties of central and northern Illinois. The red squirrel (*Tamiasciurus hudsonicus*), the smallest squirrel in the State, is found today only along the Kankakee and Iroquois rivers in Kankakee County and in scattered locations in Iroquois, Grundy, and Will counties.

Fox squirrels prefer mature oak-hickory dominated forests free of a dense, hardwood understory and located adjacent to corn and soybean fields. They reach their greatest abundance in the thousands of farm woodlots that dot the landscape in Illinois, particularly those that have been

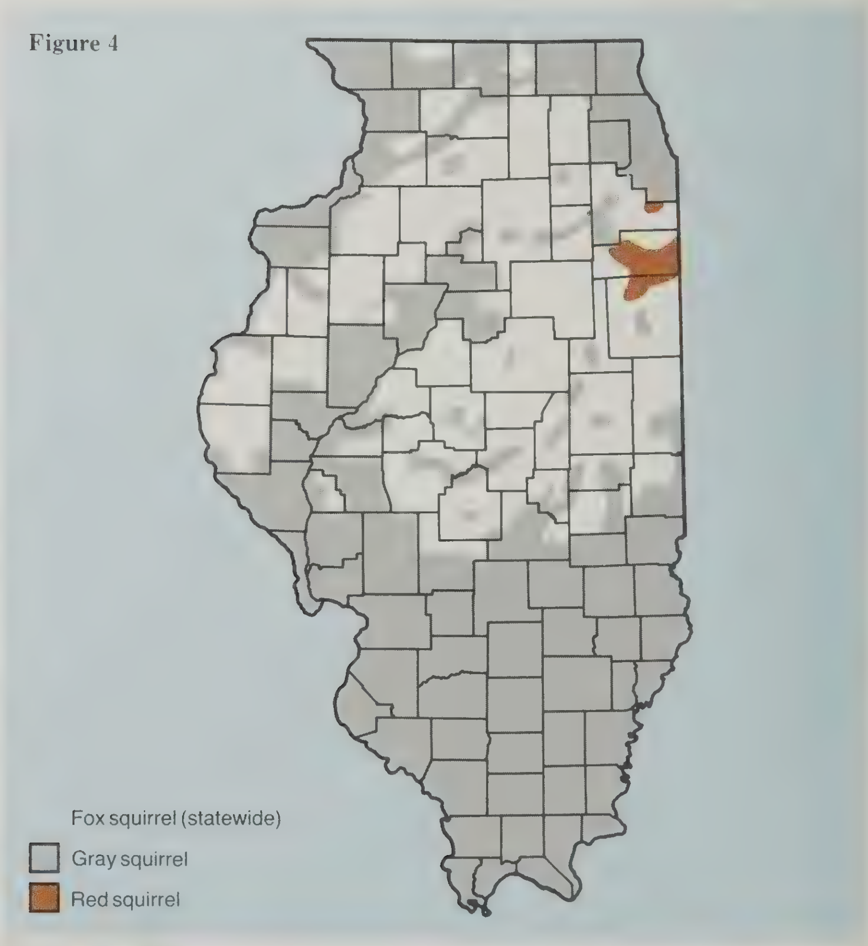


Figure 4. Distribution of fox, gray, and red squirrels. Source: Nixon et al. 1978b; Brown and Yeager 1945.

pastured enough to reduce the understory. These squirrels also inhabit nearly all other forest types in the State, from osage orange hedgerows to the flooded bottomlands of southern Illinois, even those with a low complement of oaks and hickories. In the best habitats, fox squirrels reach densities of 2 to 3 per acre in the fall. Gray squirrels prefer larger forests, and at least 20 percent of the landscape must be forested to support them. Unlike fox squirrels, these agile climbers prefer a dense understory. Where the two species coexist, grays are usually found in the ravine and bottomland forests and fox in the uplands adjacent to crop fields. Gray squirrels are also common in urban areas, reaching densities of 3 to 4 per acre where people feed them. In rural areas, grays average about 1 squirrel per acre in the fall. Red squirrels coexist with fox squirrels in Illinois at densities of 1 to 2 per acre. They have been observed in pine plantations and hardwood forests and also prefer a dense understory.

Although acorns and hickory nuts are the staple foods, all three species eat a wide variety of fruits, seeds, and nuts according to the season and supplement their diets with insects, mushrooms, plant leaves, and agricultural crops. In urban areas they raid vegetable gardens, fruit trees, and flower beds and quickly become habituated to backyard bird feeders. In general, however, squirrel populations increase or decline in response to the supply of acorns and hickory nuts each fall.

All three species prefer to nest in tree cavities, but only grays seem to require them. In one study, grays were not found in forests that did not have at least 1 to 2 tree cavities per acre suitable for nesting (an opening 3 to 4 inches in diameter and deep enough to discourage predators). While all three species construct leaf nests and use them in warm weather, only fox squirrels make extensive use of leaf nests in winter. Because they do not depend on tree cavities for shelter, fox squirrels can and do colonize younger forests than do grays and in Illinois often live in hedgerows. Red squirrels are the most adaptable of the three regarding shelter and use tree cavities, leaf nests, woodpiles, and even ground burrows.

The three species are polygamous and have 1 or 2 litters a year. The size of a litter varies from 1 to 6 offspring for fox and gray squirrels and from 2 to 8 for red squirrels. The average life expectancy for all three species is about one year. The number of litters a female has each year depends on her age and physical condition and on the food supply.

Red squirrels are protected in Illinois, but hunters have killed between 1 and 4 million gray and fox squirrels each fall since 1956 (Fig. 5). Although the harvest varies with hunter interest and squirrel abundance, the trend has been downward and reflects the reduced number of hunters, the increasing amount of forestland closed to hunting, and the decreasing number of forests throughout the State. *58, 87, 109, 282, 307, 308, 325*

Charles M. Nixon, Lonnie P. Hansen, and Bruce W. Brown,
Illinois Natural History Survey

Figure 5

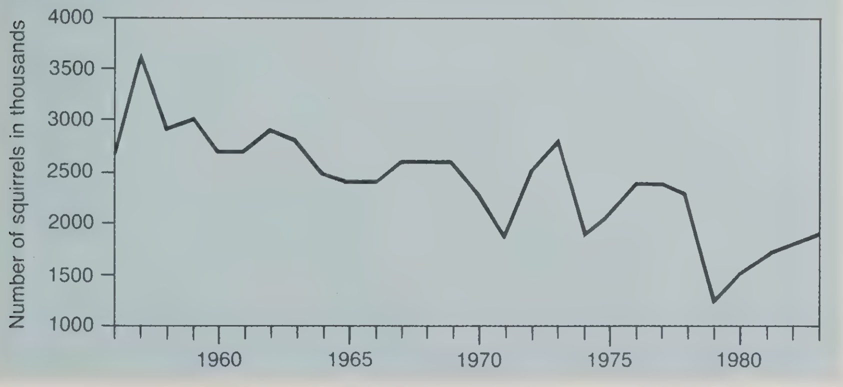


Figure 5. Estimated annual harvest of fox and gray squirrels, 1956-1983. Source: Ellis 1984.

Furbearers

Illinois is populated by a variety of furbearers. Although their value for many lies in their pelts, furbearers are significant controllers of pests as well as aesthetically important members of our natural communities. Among the most intensively sought Illinois furbearers are raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), mink (*Mustela vison*), and coyote (*Canis latrans*). These species are of considerable importance because of the large numbers taken by hunters and trappers and because of the prices their pelts bring in the fur garment industry (Table 1). Although the fur of the opossum and other long-haired species is often used to trim garments made from the furs of other animals, opossum (*Didelphis marsupialis*), beaver (*Castor canadensis*), striped skunk (*Mephitis mephitis*), and long-tailed weasel (*Mustela frenata*) are less valuable from an economic standpoint. The badger (*Taxidea taxus*), otter (*Lutra canadensis*), and bobcat (*Felis rufus*) are furbearers for which harvest is not allowed in Illinois.

Although people value the pelts of furbearers, they often label the animals themselves as pests, overlooking the numerous positive contributions that furbearers make. Rodents make up a large part of the diet of mink, red and gray fox, weasel, and coyote. Raccoons, skunks, and opossums eat a considerable number of insects and other invertebrates as well as rodents and a variety of plant matter. Furbearers sometimes kill sick, crippled, and old prey animals and help to keep the environment aesthetically pleasing by consuming carrion. Some furbearers may help to regulate over-abundant populations of prey animals, but they seldom cause major declines in populations of prey species. Dams built by beavers help to create fertile river valleys. Furbearers do make occasional raids on poultry and livestock, but the losses due to such activities are relatively small. The major problems associated with furbearers are caused by raccoons that consume sweet corn and occupy dwellings and other buildings; muskrats that drill dikes, dams, and levees in farm ponds and small lakes; and beavers that destroy expensive ornamental plantings in urban areas and flood road culverts, tile outlets, drainage ditches, and cropland. The positive activities

Table 1. Estimated statewide harvest and value of furbearers, 1983-1984.

Species	Estimated harvest	Average pelt price	Estimated total value to fur-takers
Raccoon	203,633	$ 13.55	$ 2,759,227
Muskrat	248,146	3.15	781,660
Red fox	8,719	30.90	269,417
Gray fox	4,152	27.35	113,557
Mink	16,056	15.15	243,248
Coyote	7,289	9.40	68,517
Opossum	22,289	0.85	18,946
Beaver	2,742	5.45	14,944
Skunk	137	1.55	212
Weasel	60	0.65	39
Total			$ 4,269,767

Source: Hubert 1984

of furbearers, however, and their monetary, recreational, and aesthetic values far outweigh their negative behavior.

The habitat for each species is determined by its biological requirements. For muskrat, beaver, mink, and otter, a permanent water source is an important component of the primary habitat. Each species lives along rivers, streams, ponds, and lakes. The muskrat builds its house from whatever is available–cattails, bulrushes, smartweed–or digs a den in a bank. The beaver constructs a large bulky lodge in quiet water areas or excavates a tunnel or den in a high bank. The mink makes its home in bank cavities, in hollow trees or logs, in piles of driftwood, or in muskrat burrows or houses. Occasionally, a mink may dig a burrow for itself or rear its young in a den in a farm building or hayfield a considerable distance from water, usually near an abundant food source, perhaps a high population of mice.

Weasel, raccoon, and opossum prefer wooded areas near or adjacent to water sources, but all are found in fields, towns, and villages. The weasel lives in a shallow burrow, usually the former den of a mole or ground squirrel, but may also live in rock piles, junk heaps, or even abandoned buildings. The raccoon prefers the cavity of a tree for its natal den as long as it is large enough and dry, but raccoons also live in haystacks, squirrel nests, deserted groundhog burrows, attics, chimneys, barns, and even the lodge of a muskrat. The home of the opossum is any dry, safe, shelter, including garages and basements, but it does not go into attics and chimneys as often as the raccoon. Both raccoons and opossums use dens and nests of other animals, cavities in rocks, brush piles, trash heaps, dry culverts, and hollow trees and logs.

The coyote and the red and gray fox favor wooded areas; the gray fox, in fact, readily climbs trees. The coyote and red fox seek out open and brushy country, but the gray fox prefers more heavily timbered areas and sometimes dwells in rough, rocky terrain. All three inhabit open or abandoned farmland.

Control of the annual harvest is the most important tool available for furbearer management, but the maintenance and restoration of furbearer habitats are also essential. The preservation of old, decaying trees with cavities, of wetlands, woodlands, and brushy areas, of unchannelized streams, of grasslands, and of fencerows and other strip cover is as important for furbearers as it is for other wildlife. The control of domestic animals and livestock and adequate maintenance of buildings are also important to furbearer management. Additionally, measures must be taken to prevent access by furbearers to croplands and gardens, and local conservation officials can provide advice on how to control furbearer behavior that interferes with human activities. With public concern and awareness, furbearers can thrive without unduly disturbing human interests. *1, 57, 87, 126, 185, 186, 192, 201, 296, 319, 344, 347, 348, 423, 456*

Robert A. Heister, Illinois Natural History Survey

Snakes

Snakes are reptiles that are closely related to lizards. Snakes are characterized by their elongated bodies and lack of limbs and by the lack of external ear openings and eyelids. They have poor eyesight and rely chiefly on their sense of smell for locating prey. Since snakes have no teeth adapted for chewing, they swallow their prey whole.

In the fall snakes seek a frost-free place to spend the winter. Some hibernate in groups and others hibernate individually underground, in stumps, or in crevices of rocks. Snakes in Illinois may shed their skin two to four times a year. Some snakes reproduce by laying eggs; other species give birth to live young.

The majority of snakes in Illinois are nonvenomous. The garter snake is probably the most common nonpoisonous snake and is widely distributed throughout the United States as well. Twenty to 30 inches long, it ranges in color from light brown to black, with yellow to brown stripes. It can be seen near water or wet areas, such as marshes and drainage ditches, but it is also found in brush piles, woodland thickets, and city outskirts. Its diet consists primarily of frogs, worms, and insects, and its enemies include large birds, humans, and automobiles.

Almost 50 different species or subspecies of snakes are found in the State (Smith 1953), but only the timber rattlesnake, the massasauga rattlesnake, the copperhead, and the cottonmouth (also known as the water moccasin) are poisonous. All poisonous snakes in Illinois can be distinguished from nonvenomous snakes by their vertical pupils and by the pit between the nostril and the eye on each side of the head. These pits are used by the snake to detect changes in temperature. Although the bites of these venomous snakes are serious and painful, rarely are they fatal.

The timber rattlesnake (*Crotalus horridus*) is the largest venomous snake in Illinois and grows to a length of four feet. It is yellow to dark brown with black blotches and can be found near bluffs and rocky ledges. Its distribution is shown in Figure 1a. The timber rattlesnake feeds primarily on small mammals and birds.

The massasauga rattlesnake (*Sistrurus catenatus*) inhabits marshes, sloughs, and swamps and is the most widely distributed poisonous snake in Illinois (Fig. 1b). Its color ranges from gray to brown with black blotches down the back and sides. It rarely exceeds three feet in length and feeds on rodents, small birds, and frogs.

The copperhead (*Agkistrodon contortrix*) prefers to live in rocky, wooded areas near streams, where it feeds upon small mammals, birds, frogs, and insects. It has a copper-colored head and a light brown body with dark brown blotches. Like the timber rattlesnake, it is primarily found in southern Illinois (Fig. 1c).

The cottonmouth (*Agkistrodon piscivorus*) is brown or black and may have dark crossbands on its back. This ill-tempered snake inhabits swamps or areas with slow-moving water and is found in extreme southwestern Illinois (Fig. 1d). It will feed on any available animal, including other snakes.

Several nonpoisonous species have evolved to resemble venomous snakes or have habits that cause humans and other animals to confuse them with venomous snakes. As a result, potential predators may leave these harmless species alone. The many species of water snakes that live throughout Illinois are often confused with the cottonmouth because of their association with water. Although they may bite if provoked, they are not poisonous. The milk and the fox snakes, both common Illinois snakes, vibrate their tails like a rattlesnake when encountered. The hog-nosed snake may spread its "hood" and hiss loudly when confronted. As a result, these harmless species are often needlessly killed by misinformed humans.

Snakes are beneficial to humans in several ways. At least 16 species feed on rats, mice, and other rodents. Twelve others feed on insects. In addition, water snakes eat fish that are either easy to catch or ill, leaving the desirable fish for the fishermen (Smith 1953). Other snakes eat frogs, toads, worms, and other snakes. By helping to keep populations of other animals in check, snakes play an important role in the ecological balance of Illinois. In turn, snake populations are kept in balance by such predators as hawks, owls, opposums, dogs, and rats. *56, 68, 90, 105, 247, 281, 288, 297, 313, 366, 367, 432*

Nancy E. Wiseman, Illinois Natural History Survey

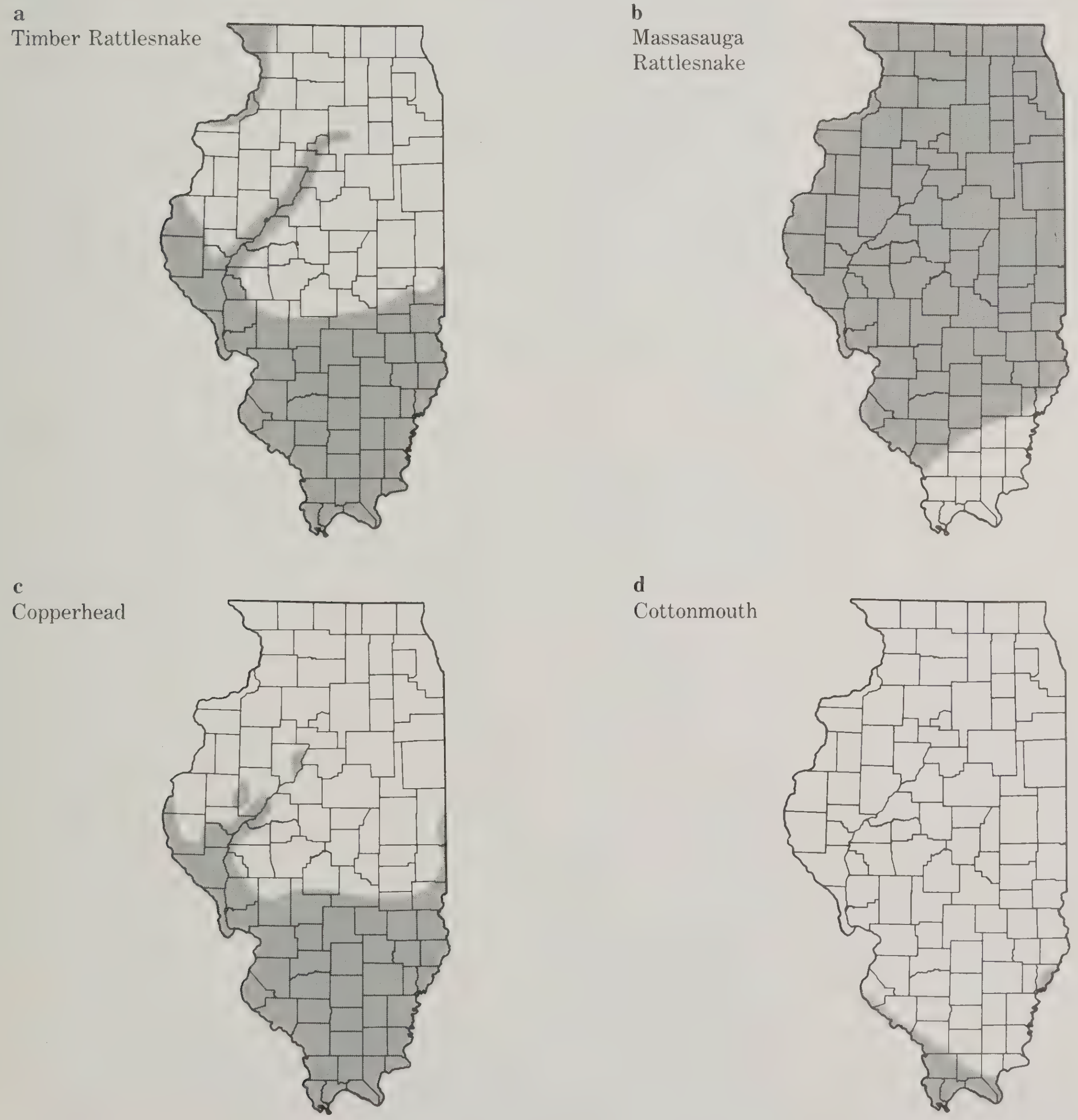


Figure 1. Distribution of poisonous snakes: a. timber rattlesnake, b. massasauga rattlesnake, c. copperhead, and d. cottonmouth. Source: P.W. Smith 1961; M. Morris, personal communication.

Endangered Species

Figure 1. Past and present distribution of the royal catchfly. Source: Sheviak and Thom 1981.

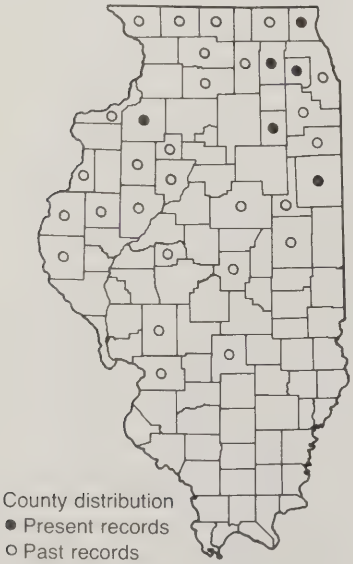


Figure 2. Past and present distribution of the prairie white fringed orchid. Source: Sheviak and Thom 1981.

Prior to the rapid and extensive agricultural, urban, and industrial development of the last two centuries, Illinois possessed approximately 36 million acres of natural habitats. Although eastern deciduous forests and tallgrass prairies dominated the State, habitats ranged from northern bogs to southern cypress swamps. This development has reduced high quality natural plant and animal communities to isolated areas totaling only about 25,200 acres.

Presently, over 3,000 plant species (of which 2,500 species are native) are found in Illinois. Nearly 200 species of nesting birds inhabit the State along with 174 fish, 98 reptile and amphibian, and 57 mammal species. The fragmentation, deterioration, and loss of natural habitats have caused the statewide extinction of many species and a threat to the survival of others, particularly species sensitive to habitat size and quality. About 2 percent of the indigenous species (approximately 50 species) have been extirpated and about 14 percent are threatened and endangered (Sheviak and Thom 1981). Habitat destruction, for example, has decimated the royal catchfly and currently only two populations remain, one on a roadside and the other on a railroad prairie (Fig. 1). Drainage has eliminated populations of prairie white fringed orchids, and even those now existing in protected sites are threatened by collectors (Fig. 2). At least 32 vertebrate species have been extirpated in Illinois. Of these, the beaver, deer, wild turkey, ruffed grouse, and muskellunge have been reintroduced or have reestablished breeding populations. The number of invertebrate species, such as insects, that have disappeared since presettlement times will never be known.

In addition to loss or deterioration of habitat, other factors threaten the existence of species. Unregulated hunting drastically reduced populations of the upland sandpiper, and illegal shootings continue to be a major cause of death for bald eagles. Environmental contaminants such as pesticides have caused reproductive failure in both bald eagles and peregrine falcons. Competition from exotic species may reduce the ability of native species to sustain viable populations, for example, the harassment of male prairie-chickens on their booming grounds by the nonnative ring-necked pheasant or the continued expansion of purple loosestrife, a plant that eventually dominates the native wetlands.

Public interest in the retention of natural communities and their constituent species grew with the passage of the Nature Preserves Act and the creation of the Nature Preserves Commission in 1963. Recognizing species as important entities, the Illinois legislature in 1972 enacted the Endangered Species Protection Act. This act gave to the Endangered Species Protection Board the responsibility for identifying species as endangered or threatened; to the Department of Conservation it gave the authority to develop a permit system for endangered animals and their products. In 1985, the act was amended to add protection for threatened animals and endangered plants and to strengthen protection for endangered animals.

A state-listed endangered species is one threatened with extinction as a breeding species in Illinois; a state-listed threatened species is one likely to become endangered within the foreseeable future. In 1978, a list of 49 endangered and 23 threatened vertebrate animals and 310 endangered and 54 threatened plant species was released.

While listing provides evidence of concern for individual species, preventing the statewide extinction of a species requires cooperation between public agencies and private individuals and groups. The combined efforts of the U.S. Fish and Wildlife Service, the Department of Conservation, the Endangered Species Protection Board, the U.S. Army Corps of Engineers, and a private citizen, for example, resulted in the construction and placement of nesting platforms for double-crested cormorants. During the past eight years, its breeding population has increased from 12 to over 100 nesting pairs. Similarly, long-term research by the Illinois Natural History Survey, in conjunction with land acquisition by The Nature Conservancy–a private conservation organization–and the Department of Conservation, helps to maintain two populations of prairie-chickens, and cooperation between the Department of Conservation and Commonwealth Edison Company provides suitable nesting habitats for the common tern.

Often public concern is shown only for plants with showy flowers or for animals that are readily visible. Less consideration may be given to such plant species as sedges and grasses and to such animal species as snakes and frogs. This differential concern, however, is based on aesthetic judgements or personal taste and may overlook other important values. Many modern medicines, for example, are derived from wild animals or plants or are synthesized chemicals that duplicate those found in animals or plants. Each species is unique and cannot be duplicated, and the loss of a species represents the loss of potential benefits that cannot be estimated. Because endangered species often inhabit unique natural habitats, they are sensitive barometers of change and can tell us much about the nature of natural communities. As we come to understand the requirements of plants and animals and their potential contributions to medicine, to agriculture, and to the viability of natural communities, their future should be more secure–and our own greatly enhanced. *9, 10, 51, 105, 114, 145, 279, 294, 329, 346, 360, 368, 369, 376, 445*

Michael Sweet, Illinois Endangered Species Protection Board;
currently Natural Heritage Program Coordinator,
Missouri Department of Conservation

Prairie-chicken

The prairie-chicken (*Tympanuchus cupido*), a buff-colored grouse with dark brown, barlike markings, is closely related to the sharp-tailed grouse and more distantly related to the quail and pheasant. Its head bears a small crest. On each side of the male's neck are orange air sacs. These are inflated during display and courtship activities and create the characteristic "booming," a sound similar to that of air being blown over the top of a bottle.

Display, a part of the courtship ritual, begins in late January or early February, but the peak booming and courtship period occurs in April. About 45 minutes before sunrise, male prairie-chickens go to the booming grounds, where each bird defends a small territory against other males. The mating dance is accompanied by continuous strutting and booming.

Prairie-chickens feed on various greens, on waste corn and soybeans, on small grains and other seeds, and on insects. They require undisturbed grassy areas for nesting and for rearing chicks. Their nests are constructed from dead grass and are built upon a layer of grassy or weedy stems. In mid-April through May, hens lay and incubate an average of 12 eggs, which may hatch in late May or early June. Incubation requires about 25 days. Pheasants sometimes lay their eggs in the nests of prairie-chickens, a practice that seriously threatens the success of prairie-chicken eggs. Often eggs, and even nesting hens, are destroyed by such predators as coyotes, raccoons, mink, skunks, dogs, and cats. Opossums, snakes, and crows also eat the eggs. If the hen is successful, she and her brood leave the nest in search of a more open area where a food source, such as insects, may be easily found. Chicks are commonly lost to predators and to farming activities, and prairie-chickens are also vulnerable to common poultry diseases and parasites. In the fall, prairie-chickens flock together for the winter. Grasslands or snow are commonly used for winter roosting cover. Grass stubble and sometimes tree buds are used for winter food.

Before Illinois was settled, about 60 percent of the State was prairie (Anderson 1970), and prairie-chickens were abundant. As forests were cleared for farmland, the prairie-chicken's range was extended and their numbers increased. Their peak population occurred around the time of the Civil War. Prairie-chickens were hunted and sent to market. The situation soon changed, and in 1887 and 1888 the hunting season on prairie-chickens was closed. This measure, however, had little effect in stemming the decline, and as agriculture became more intensive, the prairie-chicken population decreased even further. In 1912 (Fig. 3), prairie-chickens were found in 92 of the State's 102 counties but were becoming locally extinct. By 1933, no colonies existed west of the Illinois River or in east-central Illinois (Sanderson and Edwards 1966; Yeatter 1943). The prairie-chicken population in Illinois was estimated to be 25,000 birds (Lockart 1968), and the hunting season was permanently closed.

Prairie-chickens were still relatively common on farms in southeastern Illinois until after World War II. Redtop, a forage crop suited to acid soils, was the reason. During the 1930s and 1940s, southeastern Illinois produced 95 percent of the redtop seed in the United States. Prairie-chickens readily adapted to a redtop habitat because the grass is harvested in late July or early August, after the prairie-chicken young are hatched and grown. Redtop stubble, which is about 12 inches high, then provides an attractive cover for roosting and for nesting the following spring.

Low prices paid to farmers for redtop, an increase in the number of acres planted in corn and soybeans (at the expense of redtop acreage), and modern, intensive farming contributed to further declines in the prairie-chicken population. In 1956 prairie-chickens were present in 24 counties (Fig. 4). By 1962 the population was estimated at only 2,000 birds (Sanderson and Edwards 1966). By 1983 (Fig. 5), only 310 prairie-chickens were counted in three counties of southeastern Illinois (Westemeier 1985). Ninety-nine percent of this remnant population was located on or near special grassland sanctuaries established in two counties.

For many years, numerous individuals and various agencies have been working to save the remaining prairie-chickens in Illinois from extinction.

Figure 3. Prairie-chicken distribution, 1912. Source: Yeatter 1957.

Figure 4. Prairie-chicken distribution, 1956. Source: Yeatter 1957.

Figure 5. Prairie-chicken distribution, 1983. Source: R. L. Westemeier, Illinois Natural History Survey.

Figure 3

Figure 4

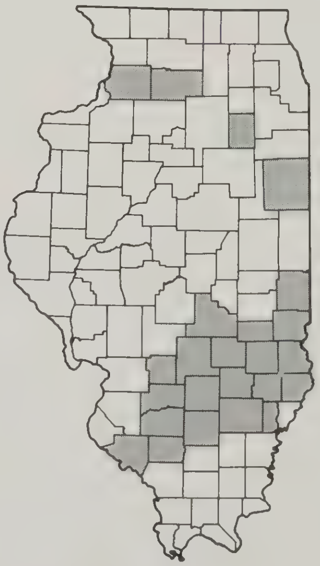


Figure 5

Between 1962 and 1983, nearly 2,000 acres in Jasper and Marion counties were acquired and developed into sanctuaries with the help of such groups as the Illinois Natural History Survey, the Illinois Department of Conservation, the Prairie Chicken Foundation of Illinois (disbanded in 1973), and The Nature Conservancy. Redtop, timothy, and brome grasses are now grown on these sanctuaries, and prairie restoration has recently been emphasized. The response of the prairie-chicken to these sanctuaries has been most encouraging, and bird and nest densities on this acreage are probably the highest of any area managed for prairie-chickens in North America. Without question, this native bird would now be gone from the State, had the sanctuaries not been established. *12, 278, 346, 349, 441, 442, 443, 444, 458, 459, 460, 461*

Nancy E. Wiseman and Ronald L. Westemeier,
Illinois Natural History Survey

Bald Eagle

Historically, the bald eagle (*Haliaeetus leucocephalus*) occurred along the major river systems of Illinois at all times of the year (Ridgway 1889) and bred throughout its range. Although the bald eagle population was decreasing by the turn of the century, many sightings and shootings were reported through the 1930s. In the 1940s, however, the nationwide decline of the bald eagle led to its federal status as an endangered species. By 1976, it had been added to the threatened or endangered species lists in all of the lower 48 states.

The adult bald eagle, the national symbol, is a large brown bird with a distinctive white head and tail. It averages 3 to 3½ feet in length and has a wingspread of 6 to 7½ feet. Its voice is harsh and gull-like. The immature bald eagle is entirely brown; the head and tail become white when the eagle reaches four or five years of age. The eagle nest is a large structure of sticks and grasses and is usually built in a tree. In the spring the female lays one to three eggs, which hatch in approximately 35 days.

About 14 percent of the bald eagles counted in the contiguous 48 states by the National Wildlife Federation winter in Illinois, primarily along the Mississippi River (Dunstan and Fawks 1981). Eagles that winter in Illinois usually appear in late September or early October and leave by mid-April to nest in northern Wisconsin, Michigan, Minnesota, and Ontario. Eagles migrate southward in the fall in search of open water, an ample food supply, protection from severe weather, and isolated areas for nighttime roosts. They prefer old trees with large branches–red oak, cottonwood, and sycamore–and tend to congregate during winter storms in an effort to survive. Typically, they leave their roosts around sunrise and fly to feeding sites several miles away. Their preferred food is fish. Locks and dams provide them with ice-free fishing, and they easily catch those fish that have been stunned or injured while passing through locks and over dams. Eagles also feed on crippled waterfowl, small mammals, and carrion.

Eagle populations declined for many years because of shooting and habitat destruction and more recently because of decreased reproduction rates caused by pesticides. Agricultural pesticides run off farmlands into streams and rivers where they are ingested by fish and become concentrated in their bodies. When eagles eat these fish, their calcium metabolism is affected and they are more likely to produce thin-shelled and infertile eggs. Because of the concern about the dwindling numbers of bald eagles, several individuals and state and federal agencies now take population counts throughout Illinois. For the past two decades, the bald eagle population has been aerially inventoried by the Illinois Natural History Survey. Areas in which counts are taken are shown in Figure 6.

Since 1972 the bald eagle population in Illinois has shown an upward trend. Generally, the Central Mississippi River Region has the largest midwinter population, with sightings occasionally exceeding 400 individuals

(Havera et al. 1984). The most populated spots along the Central Mississippi River Region include Keokuk and Burlington in Iowa, Cedar Glen Eagle Roost, Pere Marquette State Park, and the numerous locks and dams (Dunstan and Fawks 1981). In the Northeastern Illinois Region and the Illinois River Region, bald eagle wintering sites include Lake Calumet, the Des Plaines River, the Chautauqua National Wildlife Refuge, and the Pike County Conservation Area (Havera et al. 1984). Along the Northern Mississippi River Region, the Savanna Army Depot and the Oak Valley Eagle Refuge are among the common roost sites (Fawks 1984). The Oak Valley Eagle Refuge near Hampton is one of the most populous roost sites in the State, with peak concentrations exceeding 200 individuals. Along the Southern Mississippi River Region, sightings are generally lower than those observed elsewhere in Illinois, with the exception of northeastern Illinois.

Figure 7 shows the bald eagle count during the annual January inventory along the Illinois River and the portion of the Mississippi River that

Figure 6

Figure 6. Regions of the Illinois and Mississippi river floodplains and selected reservoirs and power plant cooling lakes aerially inventoried for bald eagles by the Illinois Natural History Survey. Source: Havera et al. 1984.

Figure 7

borders Illinois. These numbers probably account for 75 to 90 percent of the eagles that may actually winter there (Havera et al. 1984). Approximately 30 to 37 percent of the eagles observed recently were immature, an increase over the percentage recorded 20 years ago, which may indicate improved reproductive success (Havera et al. 1984). Because of better habitat management, more precise knowledge of the eagle's biology, the banishment of several harmful pesticides, and protective legislation, the bald eagle is making a remarkable comeback in Illinois and in the United States. *55, 104, 121, 171, 299, 300, 317, 332, 375, 376*

Nancy E. Wiseman, Illinois Natural History Survey

Figure 7. Numbers of bald eagles sighted in annual January census counts along the Illinois River and the portion of the Mississippi River that borders Illinois, 1963-1984. Source: Fawks 1984; Havera et al. 1984; updated data from Stephen P. Havera, Illinois Natural History Survey River Research Laboratory, Havana, Illinois.

Climate

Lying midway between the Continental Divide and the Atlantic Ocean, and between 500 and 800 miles north of the Gulf of Mexico, Illinois experiences a continental climate (i.e., one with cold, relatively dry winters and warm, wet summers). Annual precipitation averages about 38 inches, although the north averages about 34 inches and the south about 46 inches. Mean annual temperature also varies within the State from about 47°F in the north to about 59°F in the extreme south. During summer, southern Illinois realizes about 50 days with temperatures above 90°F; northern Illinois experiences only about 20 such days. Each winter, temperatures drop below 0°F on about 15 days in northern Illinois; southern Illinois can expect only 1 or 2 such days.

Summer temperatures in northern and southern Illinois are, in general, more similar than winter temperatures. Winters in northern Illinois are usually much colder and more severe than those experienced in the southern part of the State. These conditions result from the frequency with which three air masses dominate Illinois during the year. The coldest, driest air mass emanates from Canada and is most frequent in winter. The warmest, most humid air mass originates over the Gulf of Mexico and is most frequent in summer. The third air mass originates over the Pacific Ocean. Most of its moisture is lost to precipitation on the windward side of the Rocky Mountains, and it tends to bring mild, dry air to Illinois. Each of the three air masses can be found over Illinois during any given season, thus accounting for large day-to-day temperature and humidity variations.

The Illinois State Water Survey, a Division of the Illinois Department of Energy and Natural Resources, has been designated the Illinois Climate Center. As such, it archives records for the 5 National Weather Service (NWS) first-order stations (the airports at Chicago, Rockford, Moline, Peoria, and Springfield) and for about 110 additional NWS cooperative stations in Illinois. Daily maximum and minimum temperatures and daily precipitation records are preserved for these stations since 1901. The Water Survey also maintains 14 automatic climate-recording stations in Illinois, the Illinois Climate Network. Data are available since the early 1980s and include temperature, precipitation, solar intensity, wind direction and speed, humidity, and soil moisture and temperature at specified depths.

In 1984, the Water Survey installed a computer-based service for the acquisition and dissemination of data, the Climate Assistance Service (CLASS). Daily high and low temperatures and precipitation observations from 36 of the NWS cooperative stations in the State are transmitted to the computer at the Water Survey and may be recalled by terminal or modem for immediate viewing.

The following pages describe the major features of Illinois climate. More information can be obtained by contacting the Illinois State Water Survey (Appendix B). *15, 76, 80, 172, 219, 225, 272, 409*

Wayne M. Wendland, Illinois State Water Survey

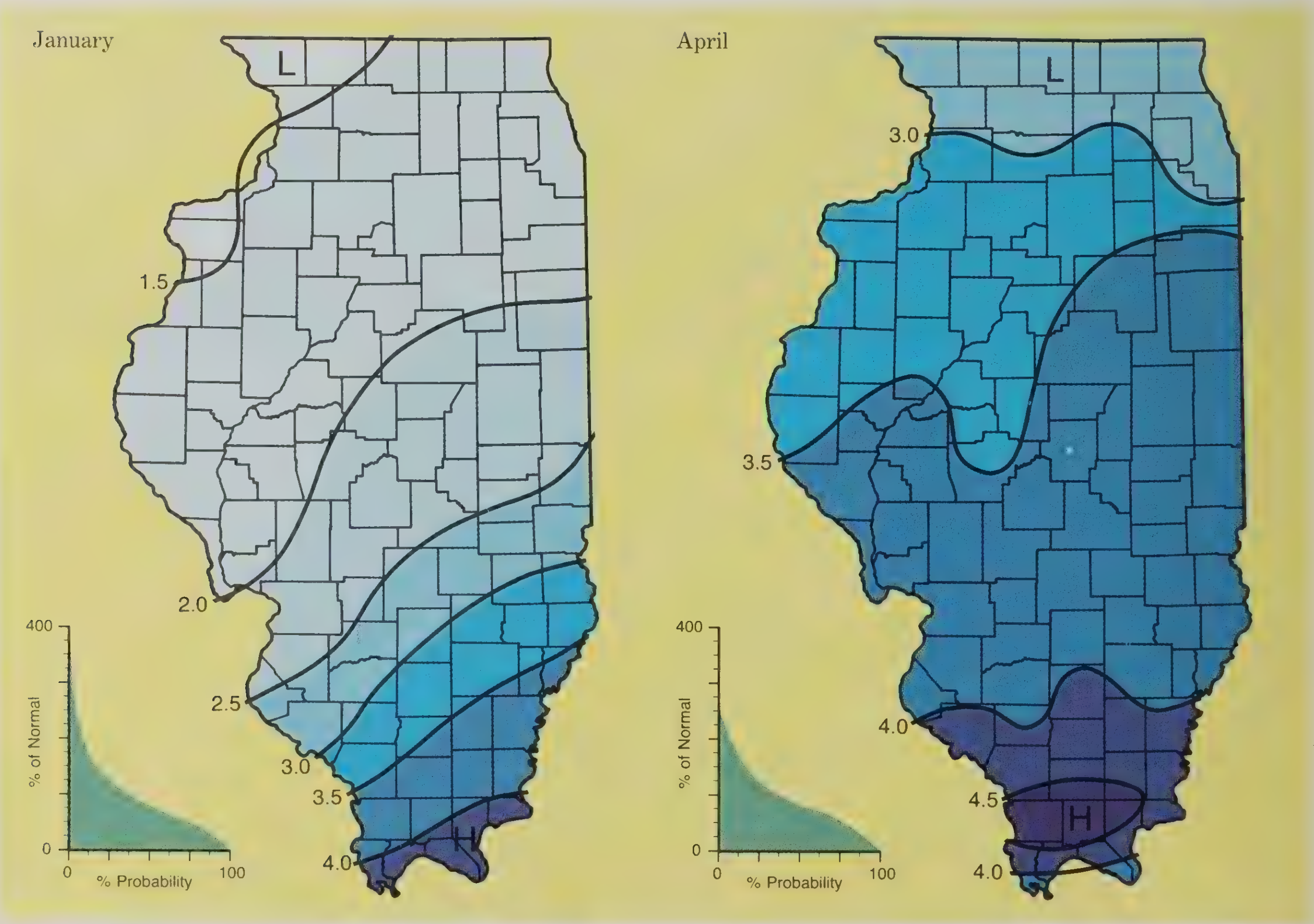
Photograph: Larry Kanfer

Precipitation

Precipitation occurs when three conditions are met: 1) the air is sufficiently moist; 2) a natural mechanism lifts the air, thus reducing its temperature; and 3) the air contains sufficient and appropriate nuclei to facilitate condensation or freezing. The first condition is most often met over or near large lakes or oceans, where water is evaporated into the air. Since energy is required for evaporation, more water is evaporated in warm areas (tropics) than in colder regions. The second condition is realized near a cyclone (a low-pressure center), in the vicinity of a front (a boundary separating air masses with different temperatures), on the upwind side of mountains, or in areas with intense surface heating. Sufficient nuclei, the third condition, are generally present for condensation or freezing. "Cloud seeding," however, is sometimes undertaken to encourage the formation of droplets or ice crystals by adding nuclei.

Studies by the Illinois State Water Survey show that precipitation is enhanced over cities with populations of a million or more. Precipitation above and immediately downwind of a city of 2 million may be increased over that of nearby rural areas by as much as 14 percent; for a city of 5 million the increase could be as much as 44 percent. Concrete, blacktop,

Figure 1. Mean precipitation (in inches) for January, April, July, and October. Source: Illinois Technical Advisory Committee on Water Resources 1967.



and brick have a higher heat capacity than do leaves, grass, and dirt, and so cities absorb more solar heat in the day than do rural areas. Cities also tend to keep this heat at night. This heat helps to provide the lifting mechanism described above as one of the necessary conditions for precipitation. Air over cities, primarily because of the by-products of industrialization, is also likely to contain more nuclei than air over the countryside, and thus a second of the necessary conditions for precipitation is met.

Most precipitation in Illinois is received during the warmer months. Summer precipitation tends to occur as showers (i.e., rainfall events short in duration at any given location but heavy in rate). Winter precipitation, on the other hand, tends to persist for hours or even one or two days at lower rates. Southern Illinois receives about 46 inches of precipitation in an average year, whereas northern Illinois receives about 34 inches. Part of this difference can be attributed to the hills of southern Illinois, which help to lift the air sufficiently to increase rainfall locally by about 10 percent.

Monthly and Annual Mean Precipitation

Climatologists determine mean monthly precipitation by summing 30 years of precipitation data for a given month and dividing the sum by 30. The result is sometimes called the normal monthly precipitation for that month. The mean precipitation for every third month of the year in Illinois is shown in Figure 1. (Frozen precipitation is melted before measurement.) Each map also includes a curve from which the probability of a deviation from the mean precipitation can be calculated. In July, for example, there is an 80 percent probability that at least 40 percent of normal precipitation will be received, a 20 percent probability that 140 percent will be received, and a 10 percent probability that 180 percent will be received.

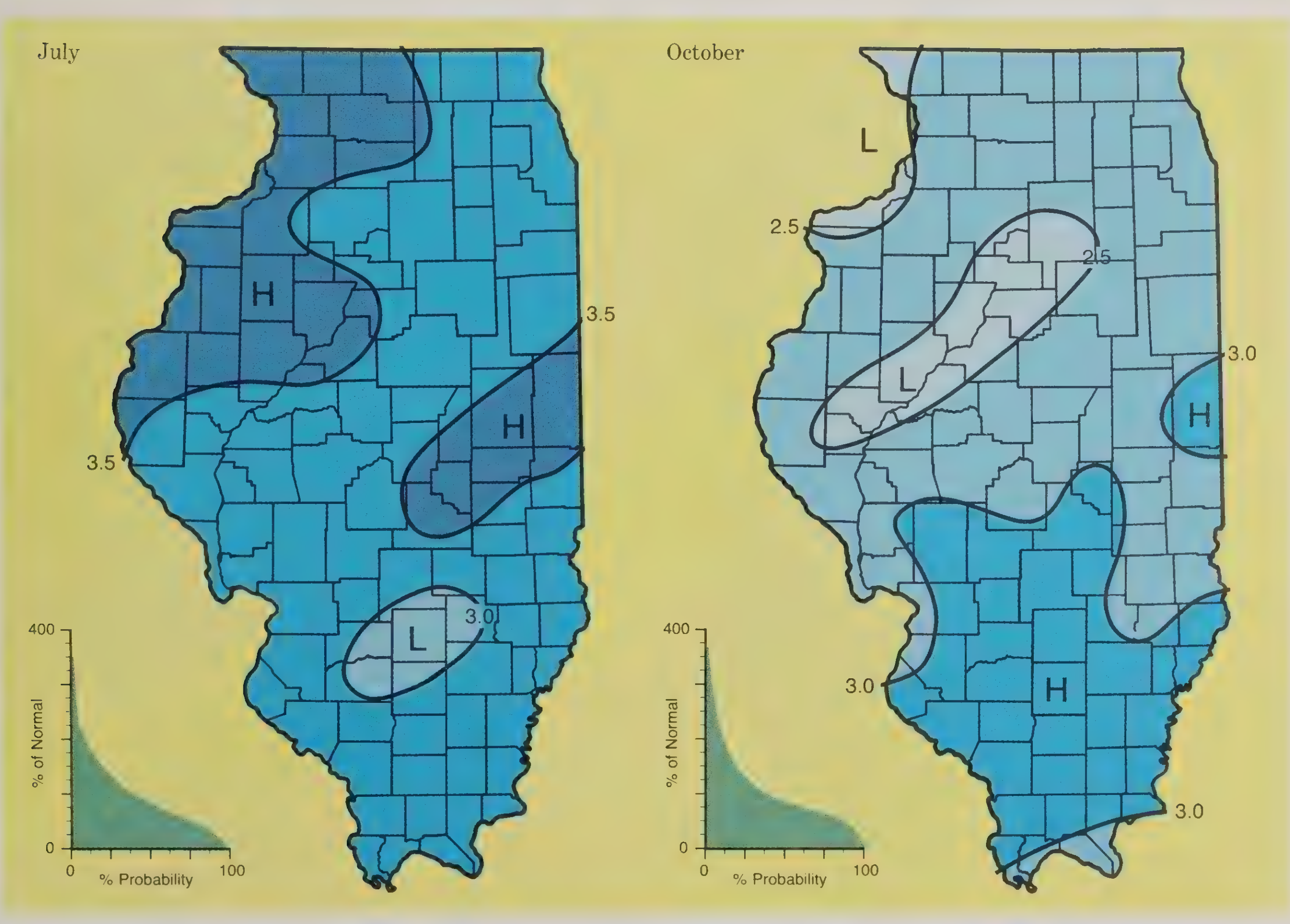
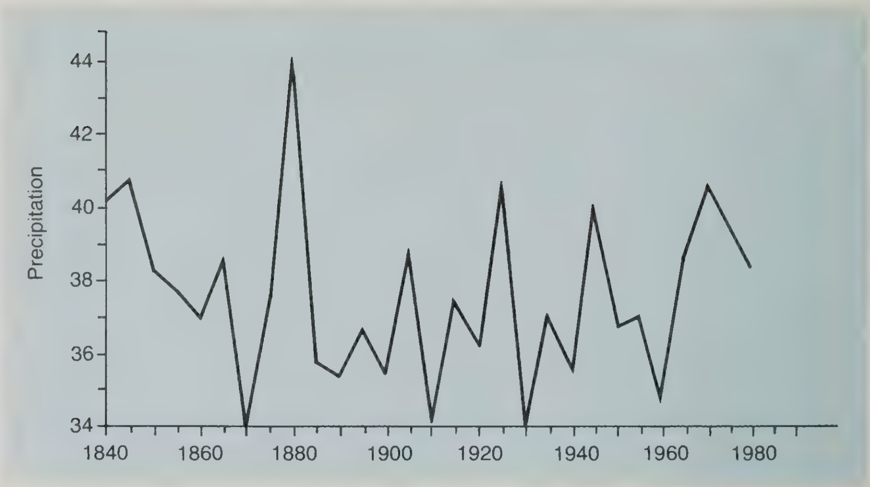


Figure 2. Five-year precipitation means (in inches) for Illinois. Source: Illinois State Water Survey.



Precipitation varies considerably from year to year. Mean annual precipitation in 5-year increments for the last 140 years in Illinois is shown in Figure 2. No overall trend is apparent; however, the 5-year means exhibit oscillations with a period of about 21 years for most of this record. No convincing evidence indicates that these periodicities have a physical basis, and future trends, therefore, cannot be predicted. *84, 225*

Frequency of Precipitation Extremes

Precipitation on any given day always varies from place to place, particularly in the warmer months when showers occur. One location on a certain day may receive substantial rain, while another a few miles away

Figure 3. Annual maximum precipitation (in inches) expected once in 5 years. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 4. Annual maximum precipitation (in inches) expected once in 50 years. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 3

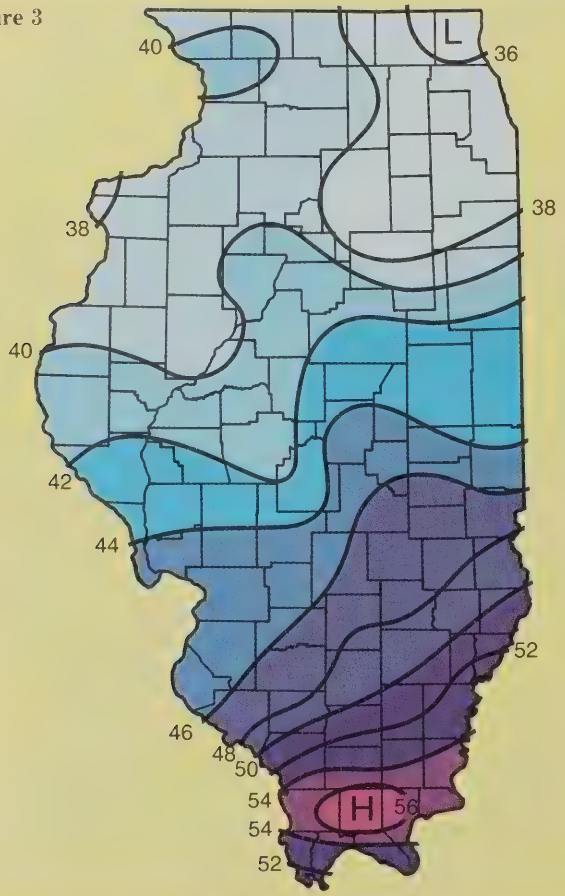
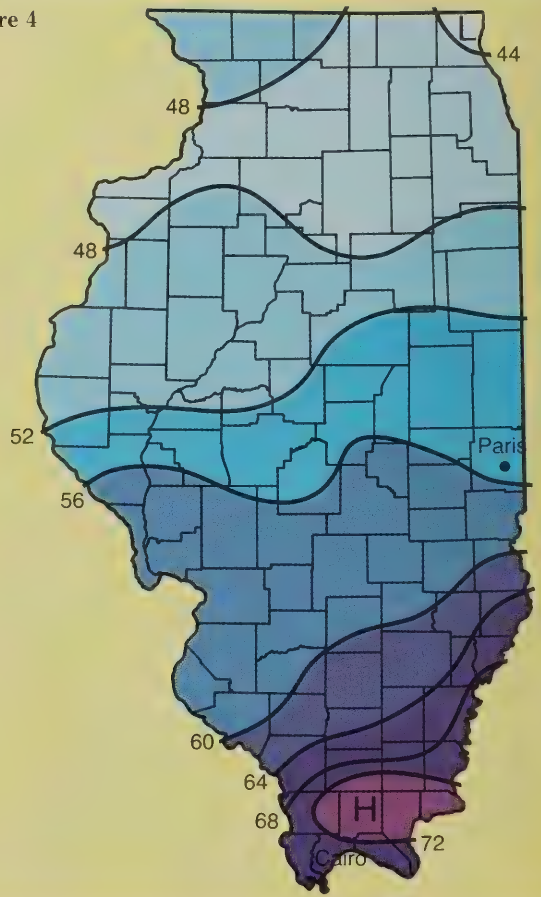


Figure 4



may receive none. Similarly, precipitation at one location varies from year to year. Normal annual precipitation is defined as a recent 30-year average of the annual totals. As a result, normal precipitation (either monthly or annually) is not representative of conditions to be expected in any particular month or year. To express this interannual variability and to estimate the confidence in any precipitation value, "once-in-5-years" and "once-in-50-years" extremes of precipitation are charted. Figures 3 and 4 show the annual maximum precipitation that can be expected once in 5 years and once in 50 years in Illinois. Figures 5 and 6 show the annual minimum precipitation that can be expected once in 5 and once in 50 years. Once in 5 years the citizens of extreme northeastern Illinois can expect an annual precipitation of as much as 36 inches (Fig. 3) and as little as 26 inches (Fig. 5). Residents of portions of southern Illinois, however, can expect an annual precipitation once in 5 years of as much as 56 inches and as little as 38 inches. Once in 50 years, however, the citizens of extreme northeastern Illinois can expect as much as 44 inches (Fig. 4) and as little as 22 inches (Fig. 6), while residents in portions of southern Illinois can expect as much as 72 inches and as little as 28 inches.

Since 1950, several once-in-50-years extremes of precipitation have occurred in Illinois. In 1957, Cairo received 72.98 inches, the wettest year in 86 years of record; Paris, with 63.90 inches, exceeded the once-in-50-years expected maximum for the first time in 57 years of record (Fig. 4). On the other hand, other locations in Illinois have experienced extremely dry years. Mt. Vernon received only 27.50 inches in 1953, the second year since 1901 with an annual total below 27.64 inches, the once-in-50-years expected low at the Mt. Vernon weather station (Fig. 6). In 1963, annual precipitation in Kankakee was only 21.53 inches, less than the once-in-50-years minimum value. The following year, annual precipitation (21.90 inches) in Kankakee

Figure 5. Annual minimum precipitation (in inches) expected once in 5 years. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 6. Annual minimum precipitation (in inches) expected once in 50 years. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 5

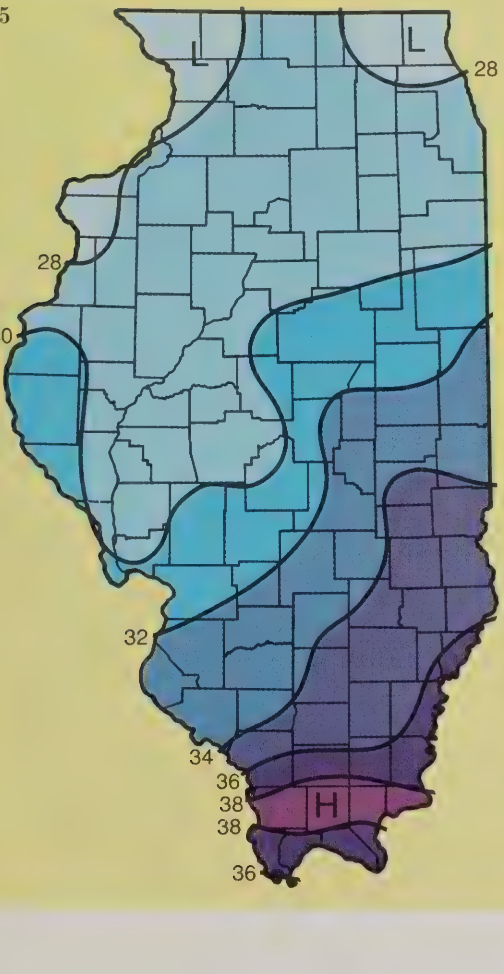
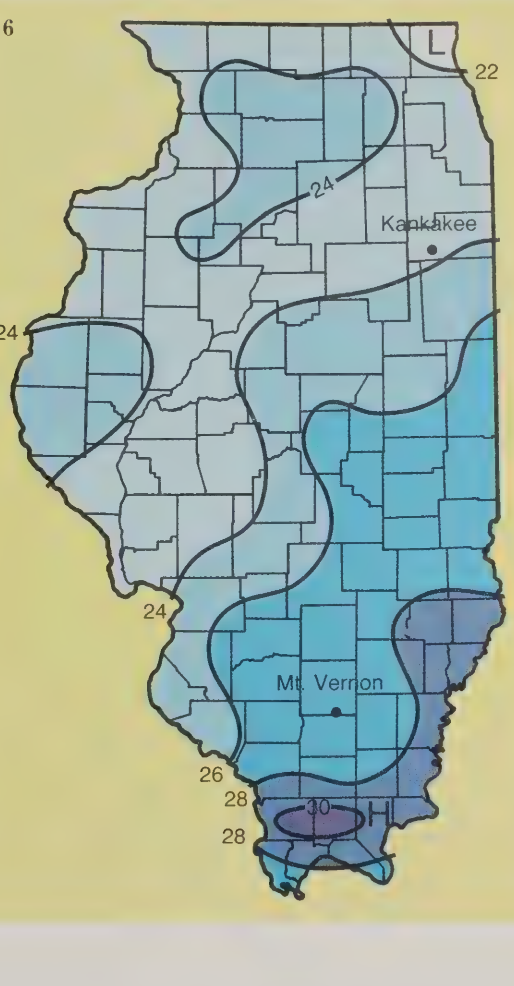


Figure 6



was again less than the 50-year expected minimum (Fig. 6). Not only did two minima occur within fifty years, but they also occurred in two consecutive years. *81, 193, 194, 225*

Drought

For the purposes of this discussion, drought is defined as the condition of less than normal precipitation. The intensity and frequency of drought exhibit great variability from decade to decade in Illinois, although droughts have historically been most frequent and most severe in the southern half of the State. Figure 7 shows the extent of summer drought (defined there as 50 percent of normal rainfall) over the past fifty years in Illinois. The summer drought of 1936 encompassed about 36 percent of the State. Al-

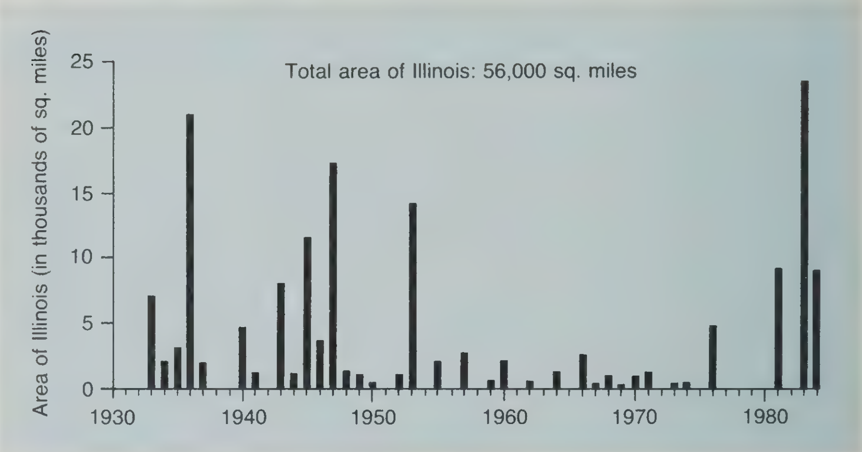


Figure 7. Area (in square miles) of Illinois that received 50 percent of normal rainfall (less than 3 inches) in July and August, 1933-1984. Source: Illinois State Water Survey.

Figure 8. Percent of normal precipitation expected during a 6-month drought once in 5 years. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 9. Percent of normal precipitation expected during a 6-month drought once in 50 years. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 8

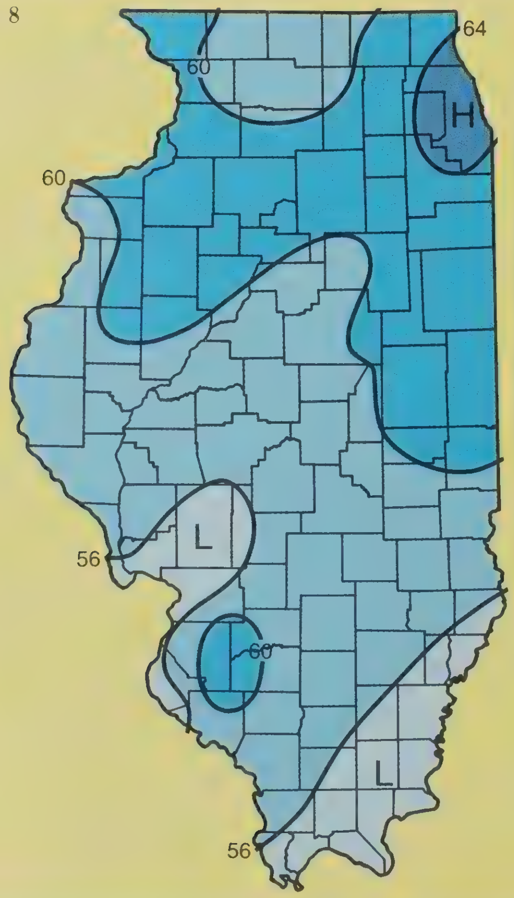
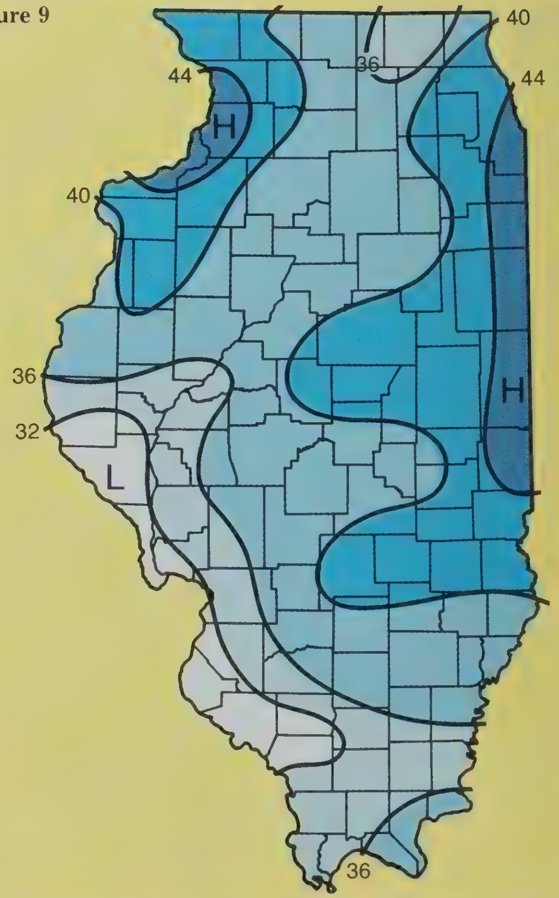


Figure 9



though extensive droughts occurred in the 1940s and 1950s, the drought of 1936 was not surpassed until 1983, when over 23,000 square miles of the State received less than half the normal July and August rainfall.

Precipitation frequencies can be charted to express the likelihood of below-normal precipitation once in a given number of years. Normal precipitation is determined by summing 30 years of data and dividing that sum by 30. Figures 8 and 9 show the percent of normal 6-month precipitation that can be expected in Illinois once in 5 and once in 50 years. Once every 5 years, residents of northern Illinois can expect the 6-month total precipitation to be only 60-64 percent of normal (Fig. 8). Residents of southern Illinois, however, can expect a 6-month period every 5 years in which precipitation is only 56 percent of normal. Once-in-50-year droughts are more intense than once-in-5-year droughts of the same duration. Once in 50 years, droughts of 6 months will reduce precipitation to 36-44 percent of normal throughout the State (Fig. 9). Droughts that persist for longer periods are not as intense as 6-month droughts, although their impact on climate-related activities such as agriculture may be severe. Figures 10 and 11 show the percent of normal 24-month precipitation that can be expected once in 5 years and once in 50 years in Illinois.

The impact of below-normal precipitation is exacerbated in southern Illinois by thin soils and a layer of clay found about one foot beneath the surface. This clay pan reduces the percolation of soil moisture to deeper levels and inhibits roots from reaching moisture that may be available beneath the clay pan. Soils in southern Illinois, therefore, are susceptible to rapid saturation and flooding and quick to dry. *81, 84, 194, 225*

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Illinois State Water Survey

Figure 10. Percent of normal precipitation expected during a 24-month drought once in 5 years. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 11. Percent of normal precipitation expected during a 24-month drought once in 50 years. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 10

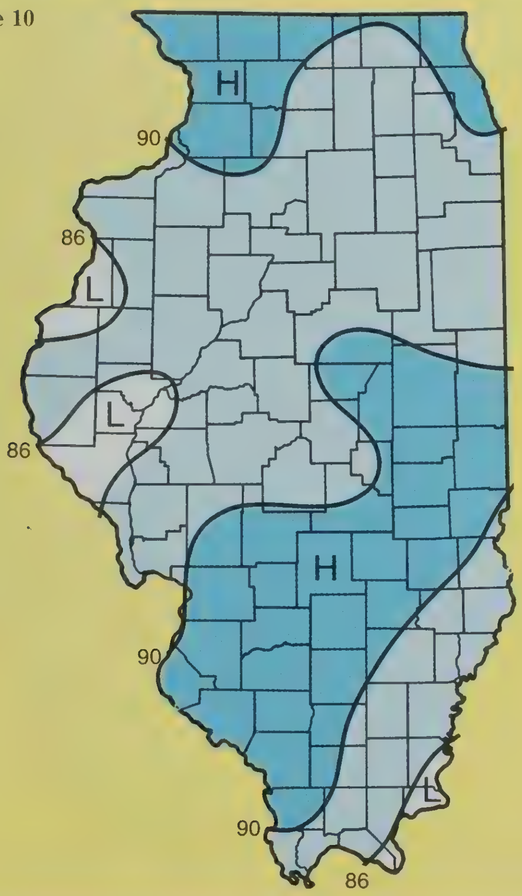
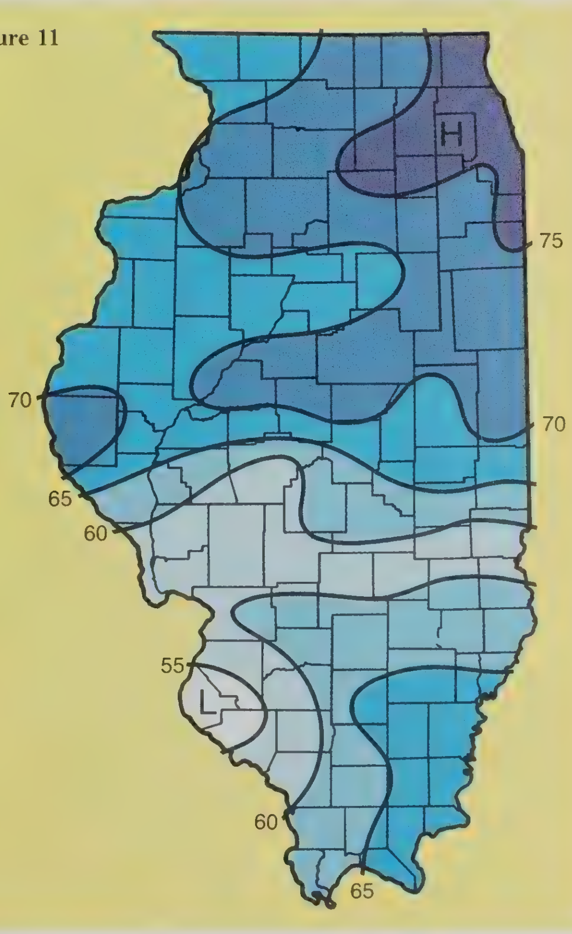


Figure 11



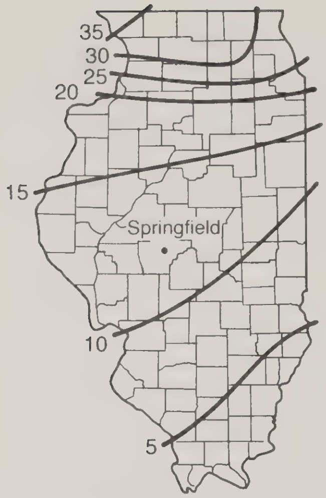


Figure 12. Mean annual number of days with 3 or more inches of snow on the ground. Source: Illinois State Water Survey.

Snowfall

Although most precipitation in Illinois, regardless of the season, begins in a frozen state in clouds, only hail in summer and sleet and snow in winter remain frozen while falling to earth. Extending almost 400 miles from its northern to its southern boundary, Illinois crosses a noticeable climate gradient. As a result, northern Illinois typically has stormier winters, experiencing two or three severe winter storms each year and 13 days with temperatures below 0°F. Southern Illinois typically has only one severe winter storm each year and only one or two days with temperatures below 0°F. The mean number of days with snow cover of 3 or more inches is shown in Figure 12. A resident of Springfield, for example, can expect a snow cover of this depth for 10 to 15 days a year. Snow cover of 3 or more inches decreases from about 35 days a year in the northwest to fewer than 5 in the south. Although northern Illinois typically receives more of its winter precipitation as snow than does southern Illinois, central Illinois receives more freezing rain than either the north or the south.

Mean annual snowfall is about 33 inches in northern Illinois and about 9 inches in southern Illinois (Fig. 13). Because of the State's position relative to the mean paths of storms, snowfall varies considerably from year to year. Sites in southern Illinois have experienced winters without snow but have also experienced winters with greater snowfall than that received by northerly sites. Northern Illinois knows no winter without snow, but annual snowfall may vary from 10 to 60 inches. More snow is received adjacent to Lake Michigan because the air receives moisture from the unfrozen surface of the lake. As the air cools, this moisture condenses and falls as snow.

The maximum and minimum snowfalls expected once in 50 years are shown in Figures 14 and 15, respectively. Once in 50 years, residents of

Figure 13. Mean annual snowfall (in inches). Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 14. Fifty-year maximum annual snowfall (in inches). Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 13

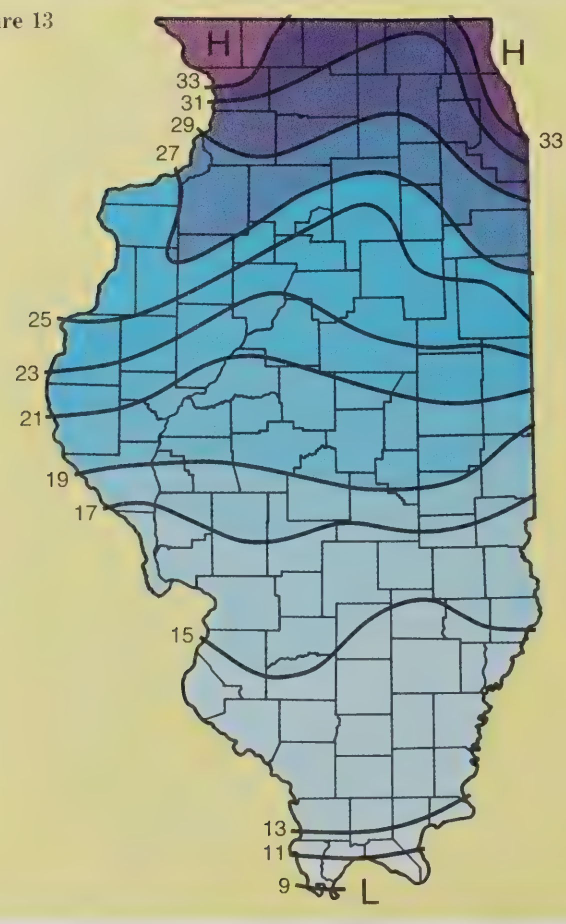
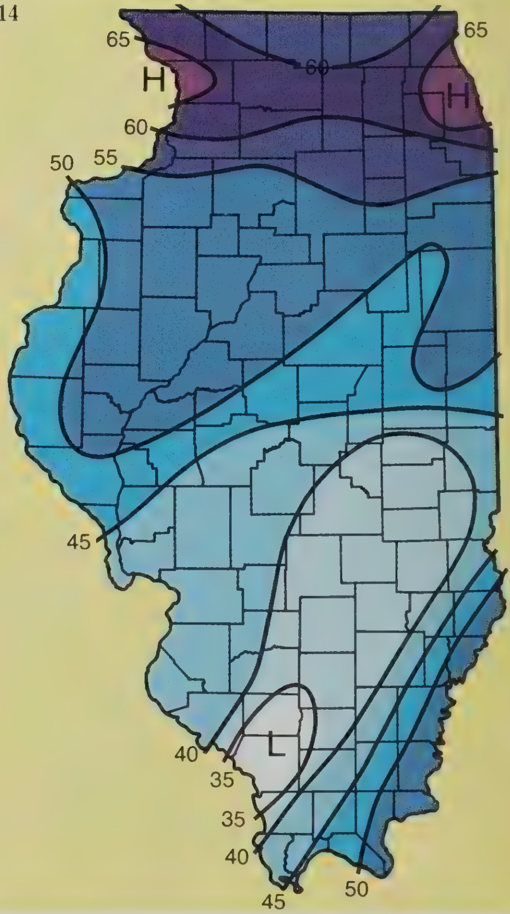


Figure 14



northeastern Illinois can expect as much as 65 inches of snow (Fig. 14) and as little as 10 inches (Fig. 15). Once in 50 years, residents of southern Illinois can expect as much as 50 inches and as little as a trace (less than an inch).

The depth of snow on the ground depends on snowfall, temperature, wind speed and direction, and cloud cover after the storm. With temperatures in the high 20s°F or under bright sun or both, snow depth decreases at a rapid rate. Often little snow actually melts or evaporates; it merely compresses, resulting in a denser snowpack. The maximum depth of snow ever reported on the ground in Illinois is shown in Figure 16.

Snow ablation (loss of snow) occurs by melting, by evaporation, or by sublimation. In spring, snow ablation can be a significant cause of flooding. If sublimation is the major process, little or no water runs off into rivers and streams because the snow is evaporated without passing through a liquid state. Sublimation is most likely to occur under clear skies and bright sun with temperatures below 32°F. If melting is the major process, the water is dissipated by runoff, which contributes to flooding, or percolates into the soil, a process that is inhibited by the presence of ground frost. The spring floods common along Illinois rivers are due in part to the snow melt these rivers receive from Wisconsin and Minnesota in addition to the snow melt from within the State. When extensive melting, heavy rainshowers, and persistent ground frost coincide, substantial flooding results, as recent experiences from the late winters of 1982 and 1985 attest. *82, 83, 225*

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Figure 15. Fifty-year minimum annual snowfall (in inches). Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 16. Record maximum snow depth (in inches) 1901-1985. Source: Illinois State Water Survey.

Figure 15

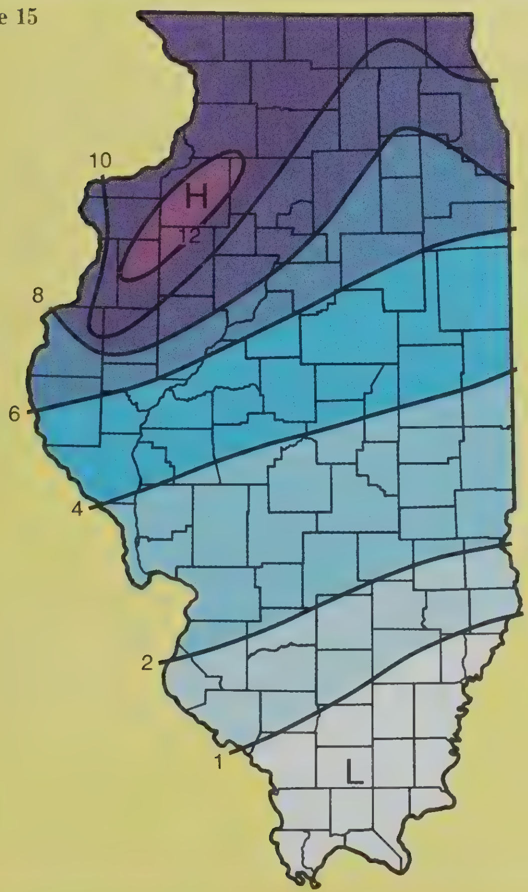
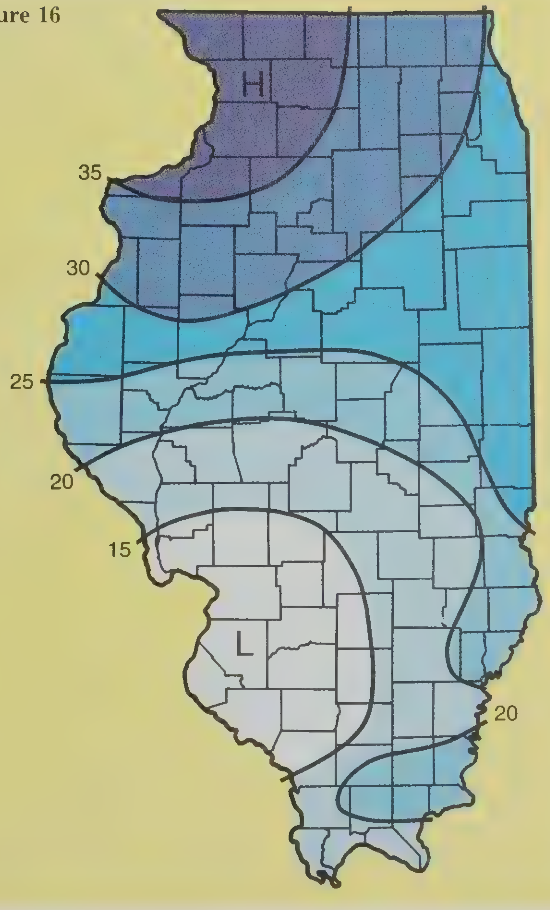


Figure 16



Temperature

Air temperature is primarily a function of sun angle, cloud cover, and wind direction and speed. Because the angle at which the sun strikes the earth is more oblique in the northern part of the State and more direct in the southern part, solar intensity is less and colder mean temperatures are realized in northern Illinois in all months compared to those of southern Illinois. Southern Illinois, in fact, is about 16°F warmer than northern Illinois. Cloud cover attenuates the amount of sunlight that reaches the ground, but it also reduces the nighttime loss of heat from earth to space. The former decreases the potential daytime temperature, and the latter increases the potential nighttime temperature. Wind direction and speed affect the local temperature by moving warmer or colder air into the local area, a process called advection.

Mean and Extreme Temperatures

The mean monthly temperatures in Figure 1 can be used with the values in Figure 2 to calculate maximum and minimum temperatures for the five temperature regions of Illinois. Consider, for example, the west region in the month of September. From Figure 1 we can determine that its mean temperature is about 68°F. Moving to Figure 2, we can calculate its mean maximum September temperature at about 78°F (i.e., 10°F higher than the mean). From Figure 2 we can also determine that the average record maximum temperature for September in the west region is 98°F (i.e., 30°F higher than the mean). Similarly, we can see that the daily September maximum exceeds 89°F only 10 percent of the time.

Mean annual temperatures in Illinois have changed with time, and the trend is similar to that for the northern hemisphere. Figure 3 illustrates the magnitudes of temperature change in Illinois since 1840. Mean temperature increased about 4°F from the mid-1800s to 1930; between 1930 and 1980 it declined about 3°F. Some argue that the warming trend was caused by increasing concentrations of carbon dioxide (the greenhouse effect). Since the concentration of carbon dioxide has continued to increase, however, other processes must have prompted the cooling noted during the last five decades. That cooling may be the result of increased atmospheric turbidity, either from volcanic eruptions or from human activity. Since carbon dioxide is expected to increase for at least the next few decades, many scientists believe that mean temperatures will again begin to rise. General hemispheric warming does not mean that all future years would be warmer than the present, but rather that the average temperature over 10 to 50 years would increase.

Figure 4 shows mean maximum and minimum temperatures in summer and winter. The cooling influence of Lake Michigan in summer is apparent from the southward trend of the isotherms in northeastern Illinois. The warming effect of Lake Michigan in winter is shown by the northward trend of the isotherms in northeastern Illinois.

In winter, objects in strong winds cool faster than objects in still air. This phenomenon, wind chill, explains why the air feels colder on windy days than it actually is. The air temperatures and wind speeds in Table 1 can be used to determine wind-chill temperatures. An air temperature of -10°F accompanied by a 20 mph wind, for example, cools a body at a rate equivalent to that of a temperature of -53°F in calm conditions. *80, 83, 225*

▶

Figure 1. Mean monthly temperatures (in degrees Fahrenheit) by region. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 2. Values used to determine extreme temperatures from the mean temperatures in Figure 1. Source: Illinois Technical Advisory Committee on Water Resources 1967.

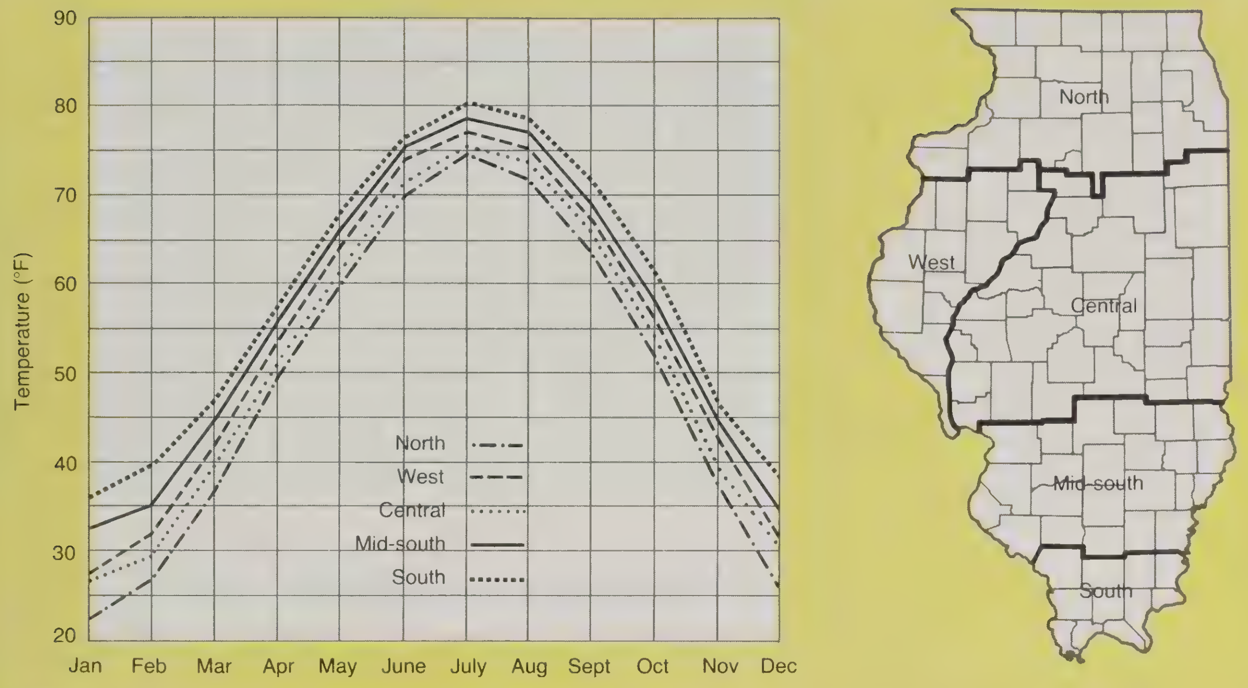


Figure 1

Figure 2

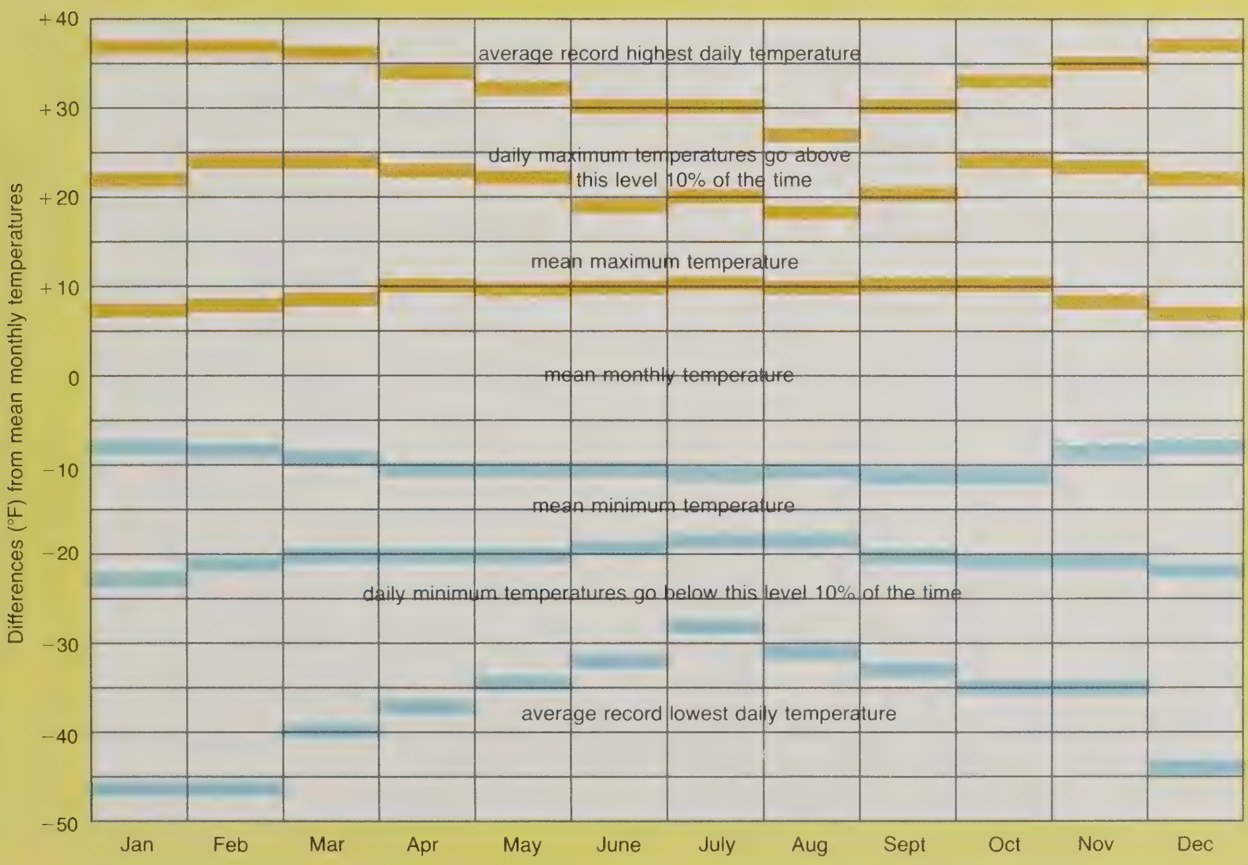
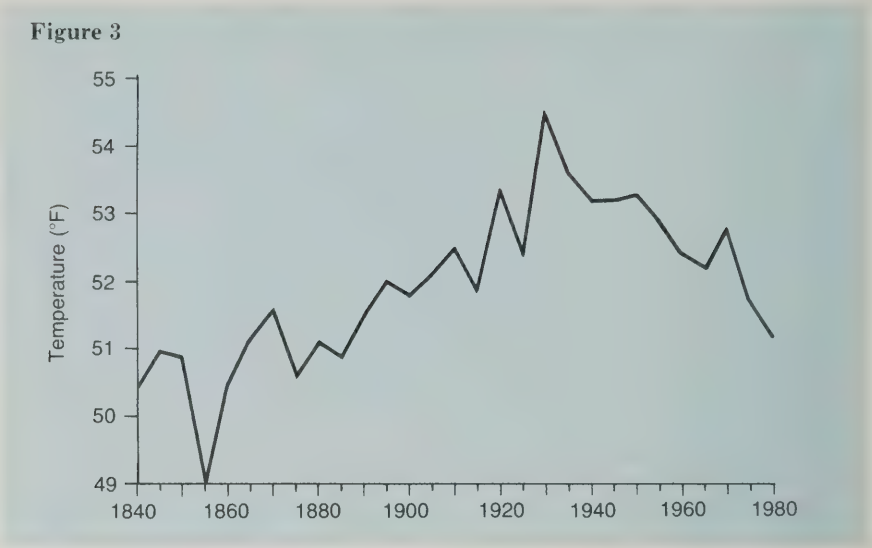


Figure 3. Five-year mean temperatures (in degrees Fahrenheit) for Illinois. Source: Illinois State Water Survey.



Heating-degree and Cooling-degree Days

Heating-degree days are used to estimate the heating needs of an area. Central Florida, for example, accumulates about 500 heating-degree days during an average year, central Illinois accumulates about 6,000, and International Falls, Minnesota, about 11,000. If identical houses were built at each location and if fuel costs were the same, the house in Illinois would cost 12 times (6,000/500) more to heat than the one in Florida; the house in Minnesota would cost 22 times more.

Figure 4. Mean maximum and minimum temperatures (in degrees Fahrenheit) in summer and winter. Source: Illinois Technical Advisory Committee on Water Resources 1967.

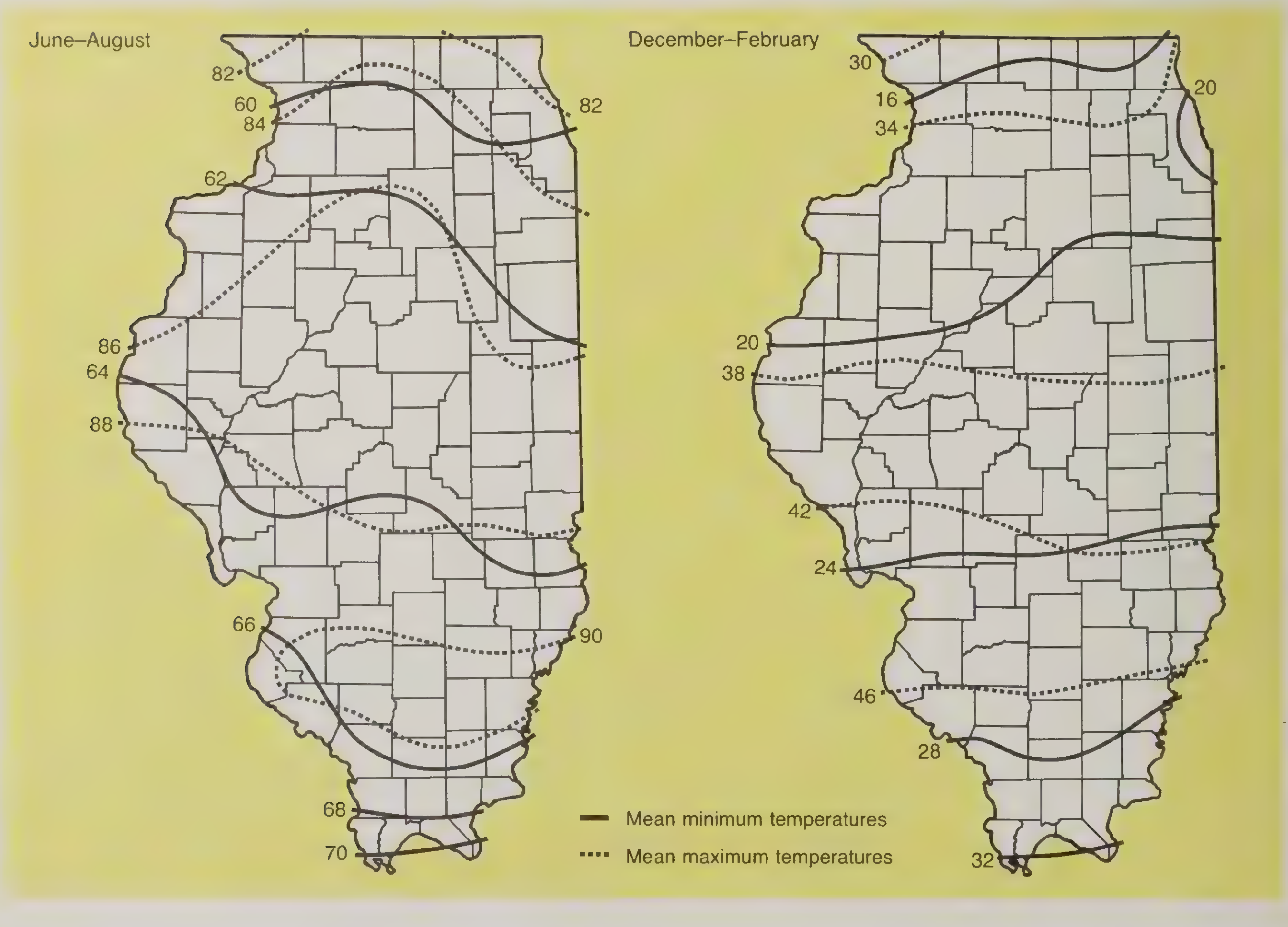


Table 1. Wind-chill temperatures.

Wind speed (mph)	Air Temperature (°F) 40	35	30	25	20	15	10	5	0	−5	−10	−15	−20
5	37	32	27	22	16	11	6	1	−5	−10	−15	−20	−26
10	28	22	16	10	4	−3	−9	−15	−21	−27	−33	−40	−45
15	22	16	9	2	−4	−11	−18	−25	−31	−38	−45	−51	−60
20	18	11	4	−3	−10	−17	−24	−31	−38	−45	−53	−60	−68
25	16	8	1	−6	−14	−21	−29	−36	−43	−51	−58	−65	−75
30	14	6	−1	−9	−17	−24	−32	−39	−47	−54	−62	−70	−78
35	12	5	−3	−11	−18	−26	−34	−42	−49	−57	−65	−72	−90
40	11	4	−4	−12	−20	−27	−35	−43	−51	−59	−66	−74	−94

To find the wind-chill temperature for a given air temperature and wind speed, follow the vertical column headed by the given air temperature down to its intersection with the horizontal row preceded by the given wind speed. The wind-chill temperature for an air temperature of −10°F and a wind speed of 20 mph is −53°F.

Source: Illinois State Water Survey

In calculating heating-degree days, we assume that at temperatures of 65°F or warmer buildings require no supplemental heat. If the mean temperature on a given day is 65°F or greater, no heating-degree days accumulate. Daily heating-degree days, therefore, are the positive residual of 65°F minus the day's mean temperature. If the mean is 55°F, 10 heating-degree days accumulate. Monthly or seasonal heating-degree days merely represent the sum of daily degree days. Total heating-degree days throughout Illinois are shown in Figure 5 along with the heating-degree days likely to be exceeded 17 percent of the time. Peoria, for example, typically accumu-

Figure 5. Heating-degree days. Source: Wayne M. Wendland, Illinois State Water Survey.

Figure 6. Cooling-degree days. Source: Wayne M. Wendland, Illinois State Water Survey.

Figure 5

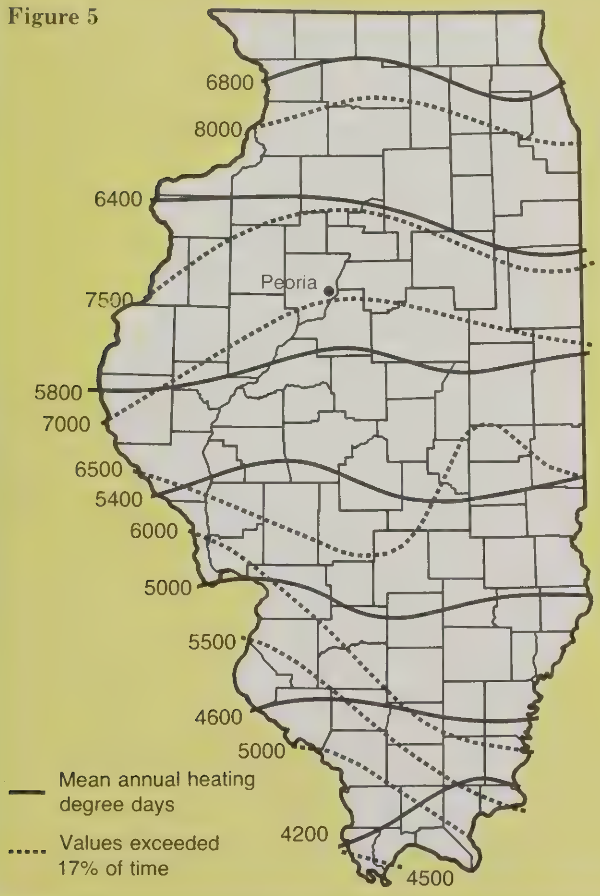


Figure 6

lates about 6,000 heating-degree days. Seventeen percent of the time, however, Peoria residents can expect 7,000 heating-degree days.

Cooling-degree days are used to compare the energy needed to cool buildings from place to place or time to time. The base temperature is again 65°F, and cooling-degree days accumulate only when the daily mean temperature is greater than the base temperature. Central Florida accumulates about 3,800 cooling-degree days during an average year, central Illinois about 1,000, and International Falls, Minnesota, about 175. Total cooling-degree days throughout Illinois are shown in Figure 6 along with the cooling-degree days likely to be exceeded 17 percent of the time.

Growing-degree Days

Growing-degree days are often calculated from a base temperature of 50°F, although other bases are sometimes used. With a base temperature of 50°F and a daily mean temperature of 65°F, 15 growing-degree days

Figure 7

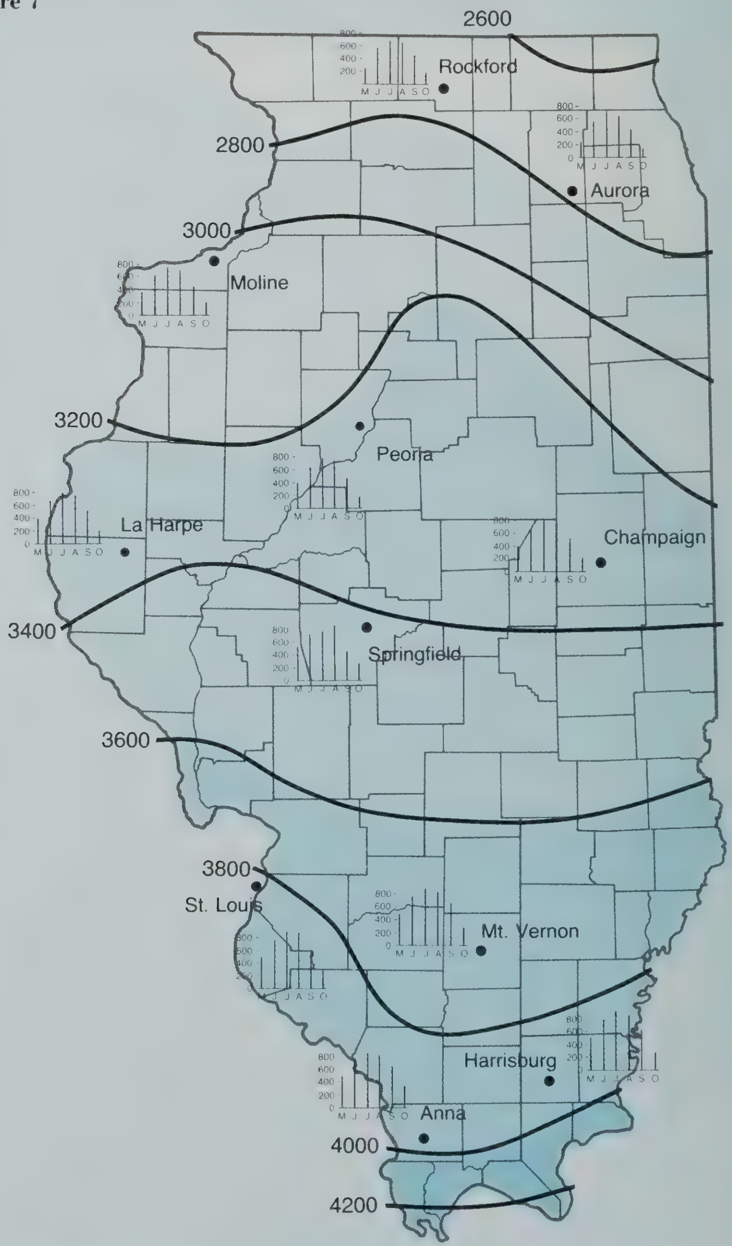


Figure 7. Mean growing-degree days from May to October, including monthly growing-degree days for selected locations. Source: Wayne M. Wendland, Illinois State Water Survey.

accumulate. When the daily maximum temperature exceeds 86°F, the daily mean temperature is calculated on the basis of a high of 86°F. When the daily minimum temperature is less than 50°F, the daily mean temperature is calculated on the basis of a low of 50°F. This accommodation is made because temperatures above 86°F and below 50°F inhibit plant growth. Total growing-degree days from May 1 through October 31 average about 2,500 in northern Illinois and 4,200 in southern Illinois. The distribution of mean growing-degree days in Illinois is shown in Figure 7. The bar graph inserts represent monthly accumulations of growing-degree days from May through October for representative sites throughout the State.

The mean length of the growing season is the number of days between the average date of the last frost (32°F) in spring and the average date of the first frost in fall. In Illinois, the frost-free season varies from about 155 days in the north to about 205 days in the south (Fig. 8). The mean date of the first fall frost is early October in the north and late October in the south. The mean date of the last spring frost may be found by subtracting the number of frost-free days (mean growing season) from the date of the first fall frost found in Figure 8. The earliest and latest frost dates ever recorded for a given site are typically 30 days before and 30 days after the mean date at that site.

Wayne M. Wendland, Illinois State Water Survey

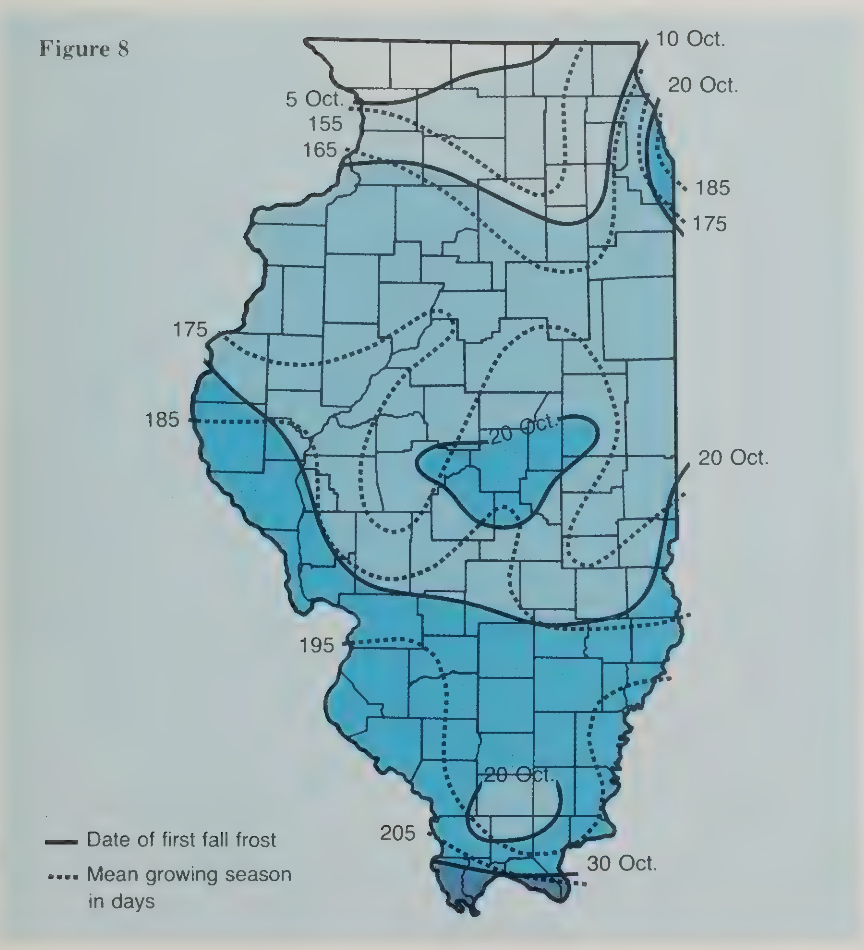


Figure 8. Date of first fall frost and mean growing season in days. Source: Wayne M. Wendland, Illinois State Water Survey.

Wind

Figure 1. Maximum wind speeds (mph) expected once in 50 years. Source: Changnon 1980.

Figure 2. Percent of annual hours when wind speeds exceed 8 miles per hour at 66 feet. Source: W. M. Wendland, 1982. Wind power as an electrical energy source in Illinois. *Journal of Applied Meteorology* 21(3):423-428. Copyright ©1982 by the American Meteorological Society. Reprinted by permission of the American Meteorological Society.

Wind direction and speed at any location are functions of the distribution of atmospheric pressure and local topography; the greater the difference in pressure between two points, the greater the wind speed. Surface winds circulate outward from high-pressure centers (anticyclones) in a clockwise direction in the northern hemisphere and flow into low-pressure centers (cyclones) in a counterclockwise direction. The opposite is true in the southern hemisphere. In summer, a high-pressure center tends to be located over the southeastern United States; as a result, Illinois most often experiences southwesterly winds during that season. In winter, wind directions in Illinois are more variable, but northwesterly winds are most common because of the frequent incursions of Canadian air.

On the average, surface-wind speeds in Illinois are greatest during the day, during late winter and spring, and along a band from the Chicago area southwestward toward St. Louis. Within this area, wind speeds average about 9 mph in summer and about 12 mph in winter. Over the rest of the State, summer wind speeds average 6 to 7 mph, and winter speeds average 9 to 11 mph. Although about 70 mph is the greatest wind speed ever recorded at one of the five National Weather Service first-order stations in Illinois, wind speeds elsewhere in the State have doubtless been greater.

Figure 1

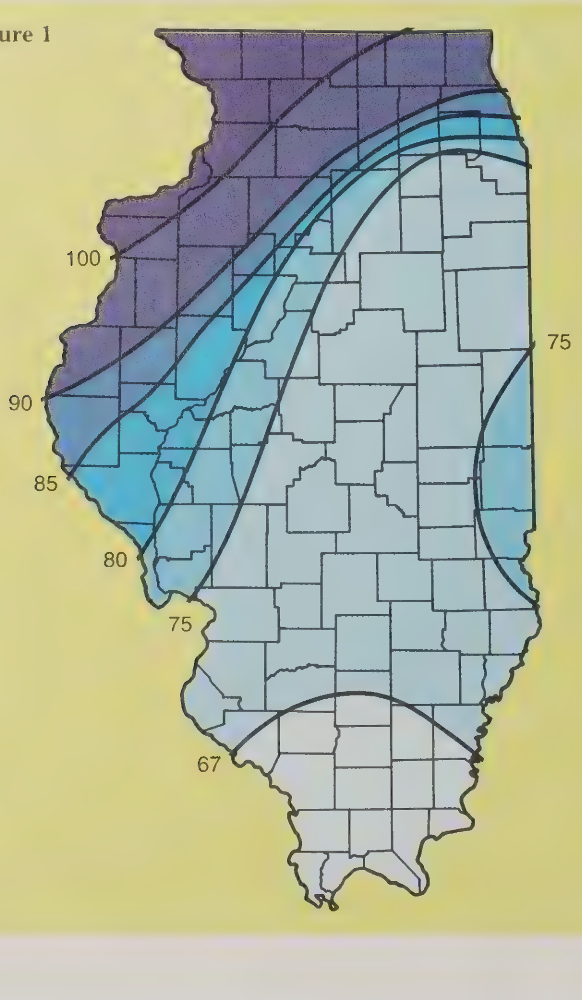
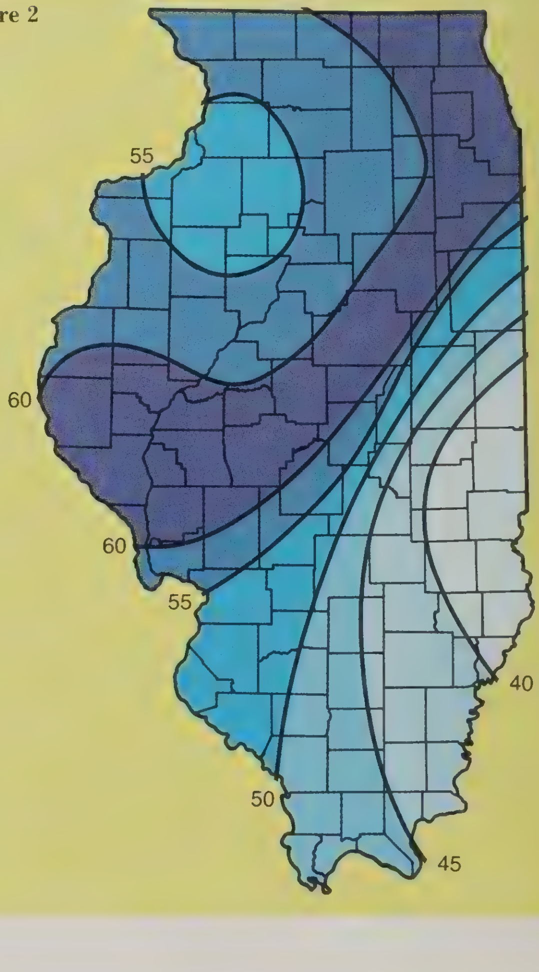


Figure 2



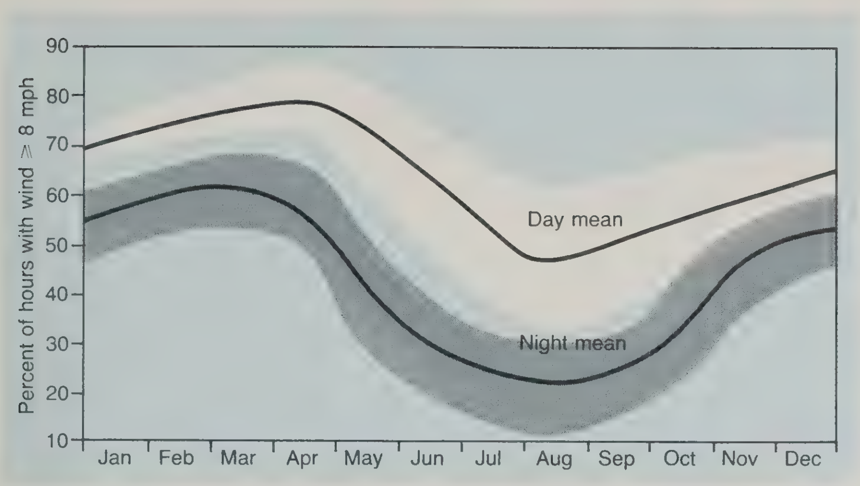


Figure 3. Percent of hours throughout the year when daytime (7am-6pm) and nighttime (7pm-6am) winds exceed 8 miles per hour at 66 feet. Source: W. M. Wendland, 1982. Wind power as an electrical energy source in Illinois. *Journal of Applied Meteorology* 21(3):423-428. Copyright ©1982 by the American Meteorological Society. Reprinted by permission of the American Meteorological Society.

The strongest winds are often associated with very small-scale weather features such as thunderstorms and tornadoes, which are inadequately sampled.

Figure 1 shows the distribution of maximum wind speeds that can be expected at least once every 50 years in Illinois. In general, winds of 100 mph in the northwest and winds of 67 mph in the south can be expected once every 50 years. Maximum winds to be expected once in 100 years are about 10 percent greater than those shown in Figure 1.

In the past, windmills routinely pumped water to the surface, and interest in wind as an alternate energy source has recently reemerged. Figure 2 shows the percent of hours each year when wind speed is greater than 8 mph. This value was chosen because many wind-powered electrical generators begin to function at that speed. Wind speeds capable of producing electricity, therefore, are present within the band from northeastern Illinois to St. Louis over 60 percent of the hours in a year. Northwestern and southeastern Illinois, however, offer less potential for wind-generated power.

Figure 3 charts the mean percentage of hours with wind speeds greater than 8 mph during the daytime and nighttime hours for all months of the year. Sixty-seven percent of all wind speeds observed lie within the bands shown for days and nights. The narrower bands in winter relative to the bands in summer show that winter wind speeds tend to be less variable than summer wind speeds. Figure 3 also illustrates that wind speeds greater than 8 mph are about half as likely at night as during the day, and 20 to 30 percent more common in winter and spring than in summer.

Of course, local wind direction and speed vary with topography and distance from buildings, trees, and other obstructions. Mean wind at a specific location, therefore, may differ from the data reported here. *78, 440*

Wayne M. Wendland, Illinois State Water Survey

Solar Radiation

Solar radiation provides the major energy input to the surface of the earth and, directly or indirectly, is the driving force for the physical processes in the earth-atmosphere system. Although the sun would provide a nearly constant energy flux on an imaginary surface normal to the solar beam at the top of the atmosphere, solar flux at the earth's surface varies considerably. The rotation of the earth upon its axis causes a diurnal variation, and the fixed orientation of its axis relative to the stars during its revolution about the sun results in seasonal variations. The spherical shape of the earth leads to latitudinal variations. Weather-dependent factors such as the presence of clouds and the extent of atmospheric moisture also affect solar flux. Finally, the tilt and azimuth (aspect) of receiving surfaces on earth influence the amount of solar flux received.

Solar radiation is widely considered and increasingly utilized as an alternative energy resource. This renewable resource can meet a wide range of needs, from the heating and cooling of buildings to the drying of grain and wood. Systems can be active or passive and stationary or tracking. Typically, collection surfaces are stationary and mounted either vertically or at an angle about equal to the latitude of the site. The maps in Figure 1 show the average daily solar flux in four months chosen to represent the

Figure 1. Mean daily solar radiation (megajoules per square meter) on horizontal and tilted surfaces for selected months. SI (Système International) units are used in this presentation. Source: Hendrie 1983; Solar Energy Research Institute 1981.

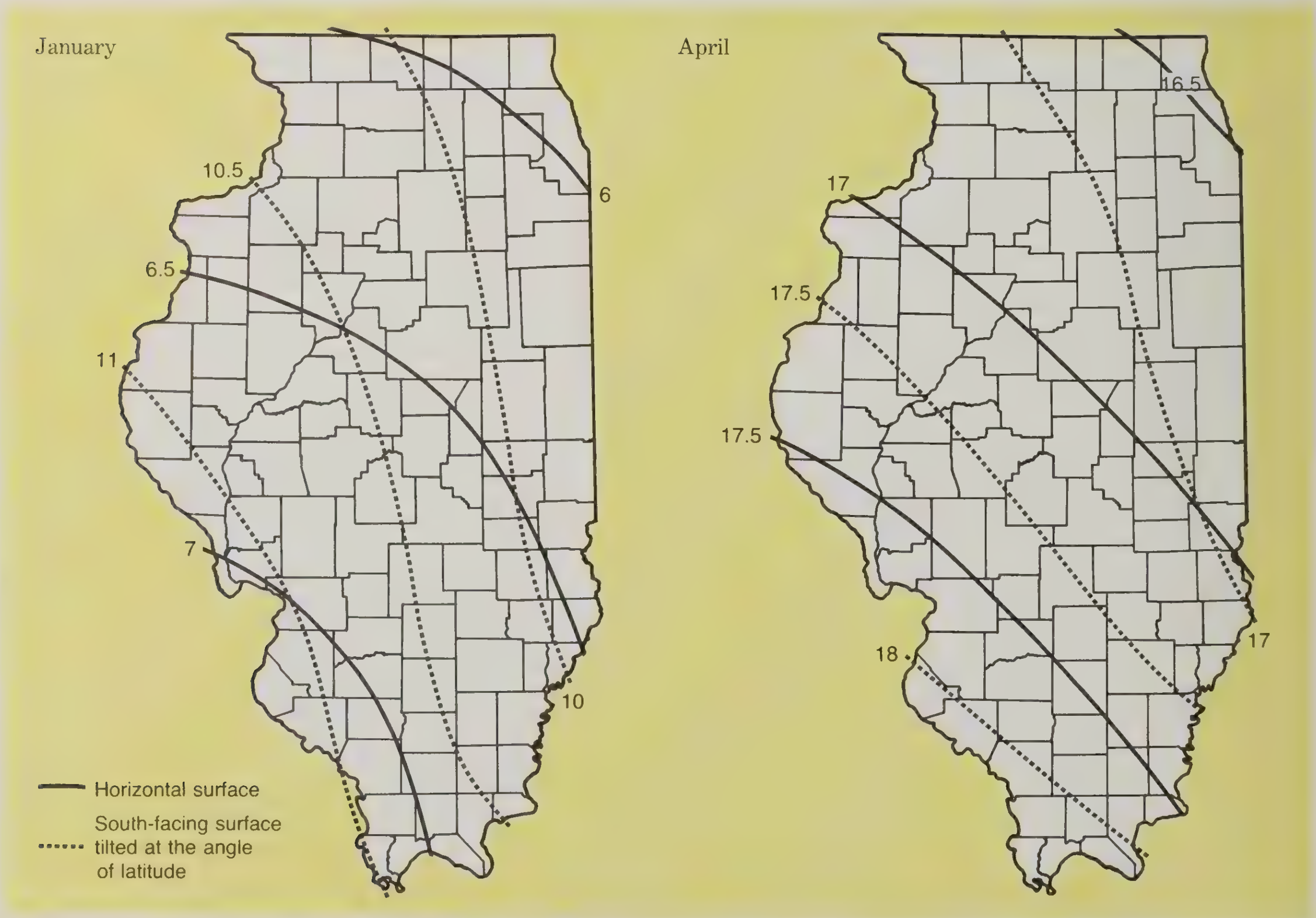


Table 1. Monthly values of solar flux (megajoules per square meter per day) received on surfaces in northeastern, central, and southern Illinois.

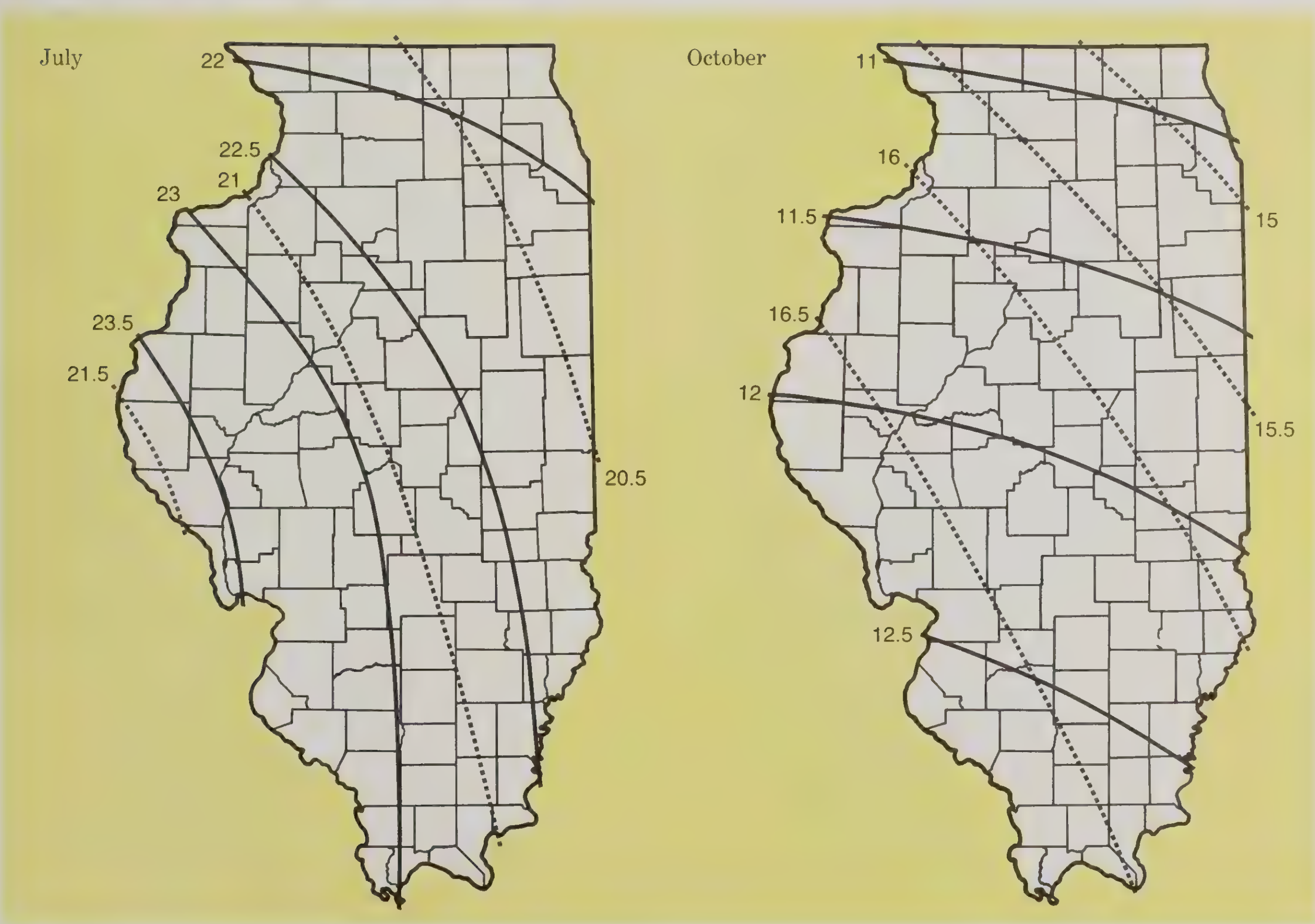
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
Horizontal surface													
Northeast	6.0	9.0	12.5	16.6	20.1	22.7	22.0	19.6	15.5	11.1	6.5	4.8	13.8
Central	6.7	9.3	13.3	17.3	20.9	23.5	23.0	20.4	16.5	12.1	7.6	5.7	14.7
South	7.0	9.9	13.7	17.7	21.3	23.7	23.1	20.5	16.7	12.7	8.1	6.1	15.0
Tilted surface													
Northeast	9.6	12.4	14.6	16.8	18.9	20.3	20.3	19.9	17.5	15.0	10.0	7.6	13.4
Central	10.5	12.8	14.8	17.4	19.2	20.6	21.0	20.5	18.3	16.3	11.2	8.8	14.3
South	10.9	13.0	15.2	18.0	19.4	20.7	21.2	20.5	18.3	16.7	12.1	9.5	14.4

SI (Système International) units are used in this presentation. Source: Hendrie 1983; Solar Energy Research Institute 1981

seasons. Each map shows the solar flux received on a horizontal surface and on a south-facing surface tilted at the angle of latitude. Differences between these two sets of values indicate which position is more effective during a given season.

Table 1 provides monthly values of the average daily solar flux received on horizontal surfaces and on south-facing surfaces tilted at the angle of latitude in the general vicinity of Cook County (northeast), Sangamon County (central), and Jackson County (south). Maximum values occur in June and July and minimum values in December. Solar fluxes received on tilted surfaces exceed those received on horizontal surfaces from September to March. In May, June, and July, however, solar fluxes received on horizontal surfaces exceed those received on tilted surfaces. As a result, yearly values are highly similar for both surfaces. *77, 175, 374*

L. Keith Hendrie, Illinois State Water Survey



Weather Hazards

Certain forms of weather threaten lives and damage property in Illinois. Among these are thunderstorms, which often generate lightning and may create conditions favorable to the formation of tornadoes; severe winter storms, which bring heavy snow or freezing rain to large areas of the State; and unusual atmospheric conditions, which are responsible for fog and blowing dust.

Thunderstorms, Hail, and Tornadoes

Thunderstorms are typical of warmer months (March to November) but may occur infrequently in winter. Thunderstorms, which contribute 70 percent of the average annual precipitation in Illinois, are most frequent in the south and southwest because of warmer temperatures and least frequent adjacent to Lake Michigan because of the cooling effect of the lake (Fig. 1). Because cities have higher temperatures than the surrounding areas, thunderstorms are more frequent in and downstream of Chicago and St. Louis. Late spring and summer maxima of thunderstorms are apparent from the monthly frequencies shown for representative sites on the thunderstorm map (Fig. 1).

Figure 1. Average annual occurrences of thunderstorms, including average monthly occurrences at selected locations. Source: Changnon 1958.

Figure 2. Average annual number of days with hail. Source: Changnon 1958.

Figure 1

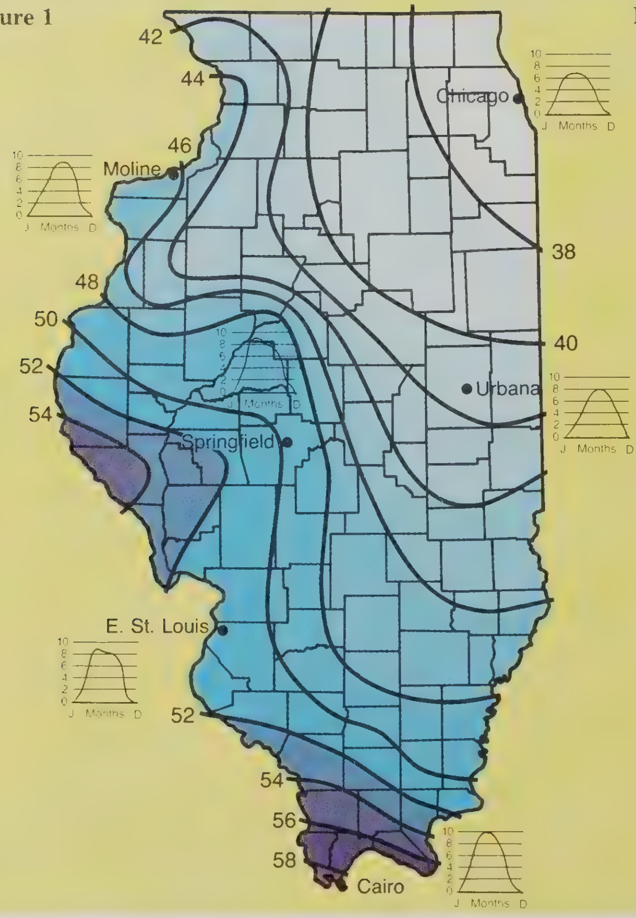
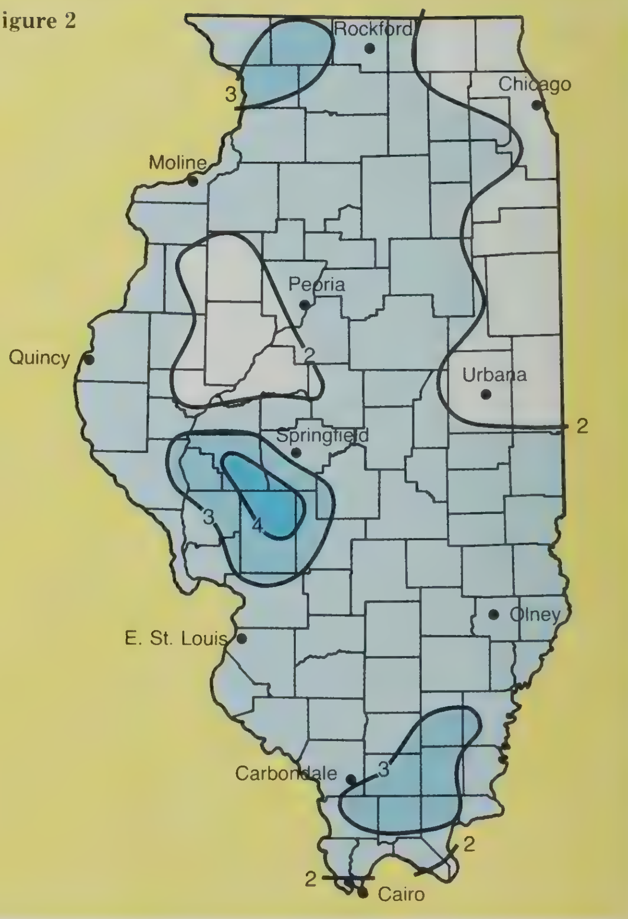


Figure 2



Thunderstorms are responsible for five damaging weather conditions: 1) hail, which damages property and crops; 2) heavy rainfalls, which cause flooding; 3) lightning, which kills animals and plants and initiates fires; 4) strong, straight-line winds, which cause crop and property damage; and 5) tornadoes, which kill and cause extensive property damage. Lightning kills more people than any other form of severe weather in Illinois, but flooding due to heavy rainstorms and spring melt is responsible for the greatest amount of property damage. Figure 2 shows the mean frequencies of hail days throughout the State; the greatest frequency occurs southwest of Springfield. Figure 3 plots the number of heavy rainstorms (3 inches or more in a 24-hour period) over 50 years. Rainfalls of this magnitude are unlikely to occur every year. In southern Illinois, the area of their greatest frequency, only 30 such rainfalls occurred over a 50-year period. Figure 4 shows reported tornadoes per 100 square miles over a 25-year period. The maximum frequency was found in four relatively small areas: the northeastern counties, the area around Rock Island, the area from Bloomington-Normal to the northwest, and the area around Springfield. *75, 85, 453*

Heavy Snow and Freezing Rain

Severe winter storms occur when more than 6 inches of snow and/or freezing rain extend over more than 5,000 square miles within a one-to-two-day period. Such storms plague Illinois between late November and early April, and each storm typically affects about 30 percent of the State. Five to six severe winter storms may be expected each year in Illinois and will contribute approximately 15 percent of the average annual precipitation. Freezing precipitation falls as a liquid, although the temperature of the droplets is less than 32°F, and freezes when it hits the surface of objects. During prolonged freezing rain, thick, clear, heavy ice accumulates on road surfaces, on trees and shrubs, and on such objects as power poles and wires.

Figure 3

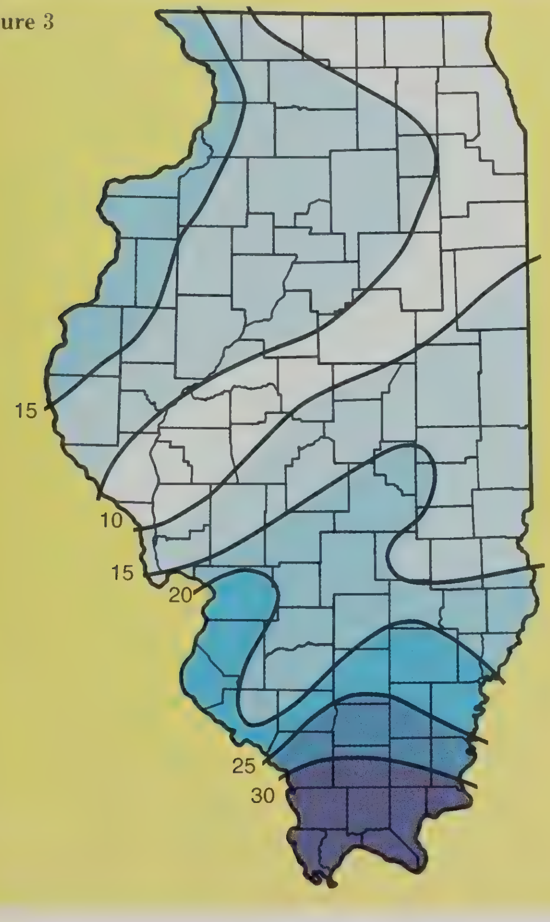


Figure 4

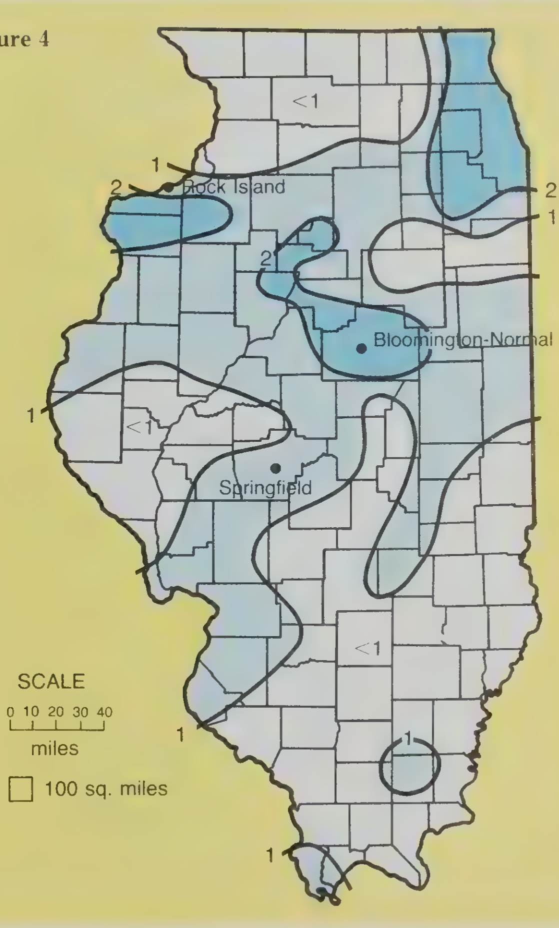


Figure 3. Number of heavy rainfalls (3 or more inches in 24 hours) in 50 years. Source: Wayne M. Wendland, Illinois State Water Survey.

Figure 4. Number of reported tornadoes per 100 square miles in 25 years (1960-1984). Source: Wayne M. Wendland, Illinois State Water Survey.

The distribution of heavy snowfalls (6 inches or more) over a 60-year period is shown in Figure 5. Heavy snowstorms occur most frequently in northern Illinois, with some areas having more than 60 such snowfalls in 60 years. The annual frequency of freezing rainstorms is shown in Figure 6. The maximum number of days with freezing rain occurs in central Illinois because the warmer air to the south supports less freezing precipitation and the colder air to the north tends to support heavy snowfall (Fig. 5) rather than freezing rain. *82, 83*

Fog and Blowing Dust

Fog, another weather hazard in Illinois, seriously limits visibility, affects transportation, and causes accidents on the highways. Fog is primarily an autumn and winter phenomenon in Illinois. Dense fog occurs on 25 days a year in the north and decreases southward to an average of 10 days (Fig. 7).

Dry conditions during major periods of drought coupled with high sustained winds produce the blowing dust typical of spring in Illinois. Although blowing dust occurs infrequently, it greatly limits visibility and causes damage to life and property. *79, 195*

John L. Vogel and Stanley A. Changnon, Jr.,
Illinois State Water Survey

Figure 5. Number of heavy snowfalls (6 or more inches) in 60 years (1900-1960). Source: Illinois State Water Survey.

Figure 6. Average annual number of days with freezing rain (ice). Source: Illinois State Water Survey.

Figure 5

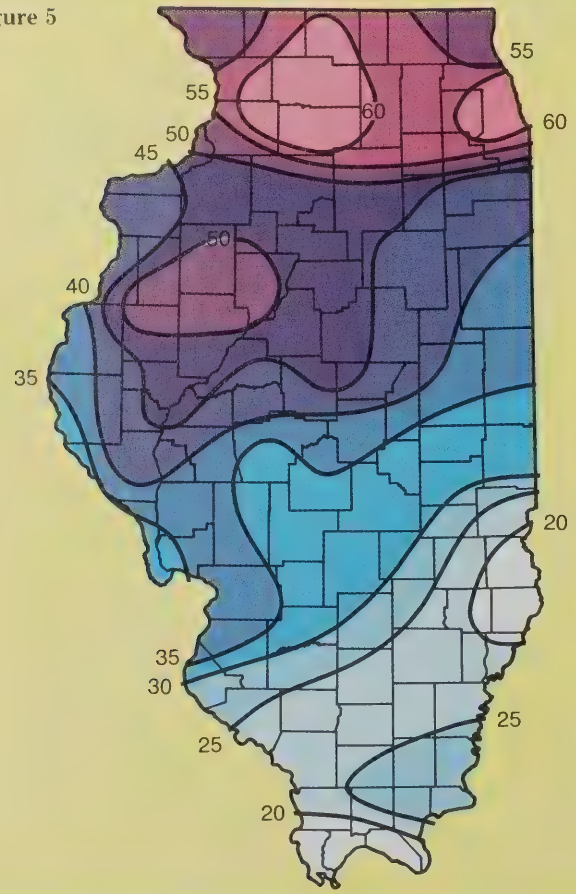


Figure 6

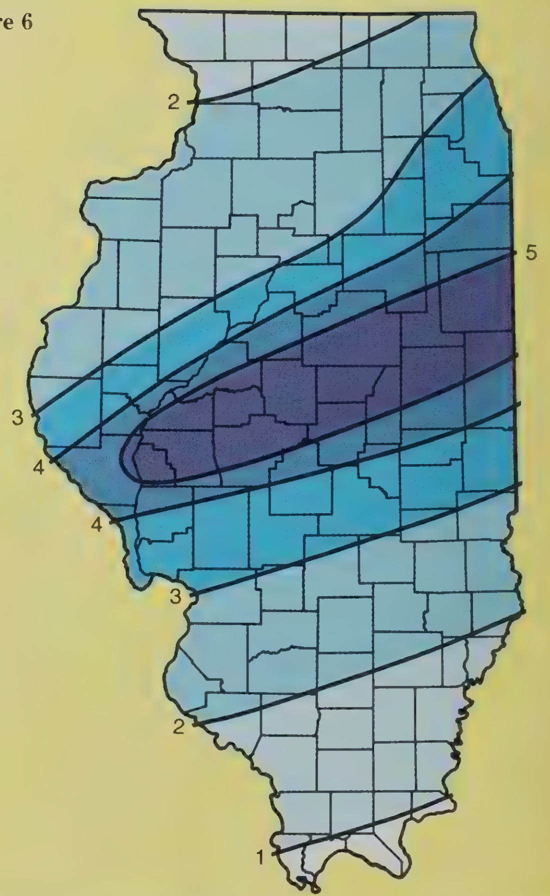


Figure 7

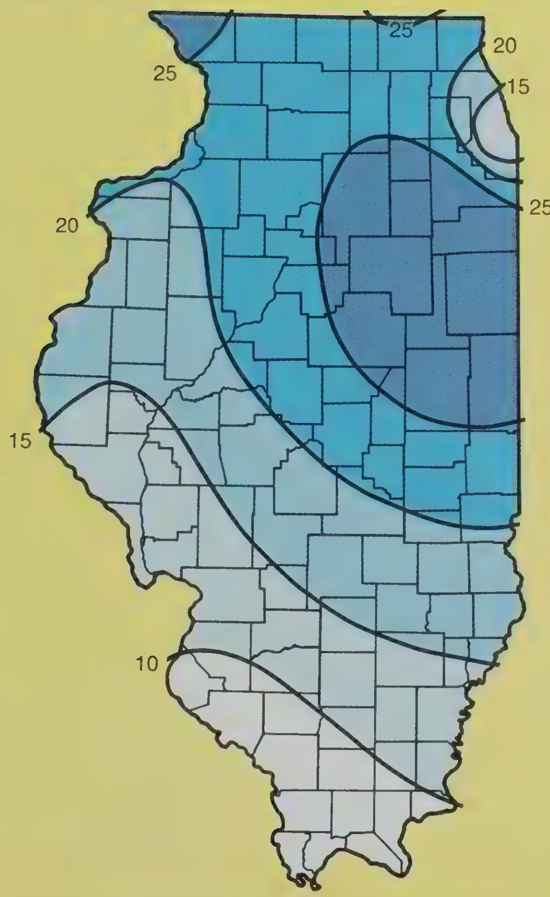


Figure 7. Average annual number of days with dense fog. Source: Illinois State Water Survey.

Water Resources

Illinois has abundant natural resources, including one of the most precious–water. The water of Illinois is available in the atmosphere, within streams and lakes, and in underground formations. About 5 percent of the approximately 2,000 billion gallons of atmospheric water passing over the State is delivered as precipitation. This precipitation, in turn, flows as surface water, is stored within the ground, is consumed by users, or is returned to the atmosphere through evapotranspiration. The substantial amount of water stored in the major streams and lakes of Illinois (including Lake Michigan) is used for public water supplies and for recreational, industrial, and navigational purposes. In addition, underground aquifers provide considerable quantities of water to wells and springs. Water resources in Illinois are not evenly distributed, however, and many man-made lakes and reservoirs have been constructed to store water.

Illinois is also fortunate in the number of agencies that work together to collect and interpret data about the water resources of the State. The U.S. Geological Survey, the Illinois Department of Transportation (Division of Water Resources), and the Illinois State Water Survey cooperate to maintain a stream-gaging network. Ground-water levels at various locations are monitored by the Water Survey, and water-quality monitoring stations are maintained by the Illinois Environmental Protection Agency. Benchmark stations are also operated by the Water Survey to collect climatic, sediment, and ground-water data, and the Illinois Department of Conservation inventories water resources important to aquatic and fish habitats. The majority of this data, either in printed form or within computer retrieval systems, is available from the Illinois State Water Survey, the Illinois Division of Water Resources, the U.S. Geological Survey, and the District Engineers Office of the U.S. Army Corps of Engineers (Appendix B).

Current management practices, however, have not solved all of the problems associated with the water resources of Illinois. Extensive soil erosion due to intensive land use continues to degrade the surface water of the State. Increased sediment deposition in ditches, drainage ways, streams, and lakes adversely affects the quality of water and its availability for useful purposes. Stream turbidity can also destroy the biological integrity of these bodies of water and limit the recreational use of lakes and streams. Even the ground water of the State at some locations may be threatened by the discharge of toxic and hazardous waste.

In the following section, the water resources of Illinois are described–their quality, availability, and uses as well as such related phenomena as soil erosion, sediment load, runoff, and evaporation. *15, 89, 124, 172, 219, 225, 272, 379, 409, 418*

Nani G. Bhowmik, Illinois State Water Survey

Photograph: Larry Kanfer

Water Use in Illinois

Illinois is considered a "water-excess" state. Virtually surrounded by freshwater, the State is endowed with an impressive interior network of rivers. In addition to these surface water sources, Illinois has an abundance of ground water, but this resource is finite and unevenly distributed.

During 1982 Illinois public water supplies, self-supplied industries (excluding those that generated electric power), rural users, and fish and wildlife withdrew 2,801.2 million gallons per day (mgd) of water. Ground water provided 975.6 mgd and surface water supplied 1,825.3 mgd. The largest water user, industries that generate electric power, withdrew 30,447.0 mgd (approximately 91 percent of the total). Hydroelectric flows accounted for 21,894.4 mgd of the surface water withdrawal, and thermoelectric generation accounted for another 8,543.0 mgd; the remaining 9.7 mgd were provided from ground water. Total withdrawals for 1982 were 33,248.3 mgd, of which 985.3 mgd were ground water and 32,263.0 mgd were surface water (Fig. 1).

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 (Table 1). In addition, the acreage of agricultural land irrigated has substantially

Figure 1. Surface water and ground water withdrawals in Illinois, 1982. Source: Illinois State Water Survey.

Figure 1

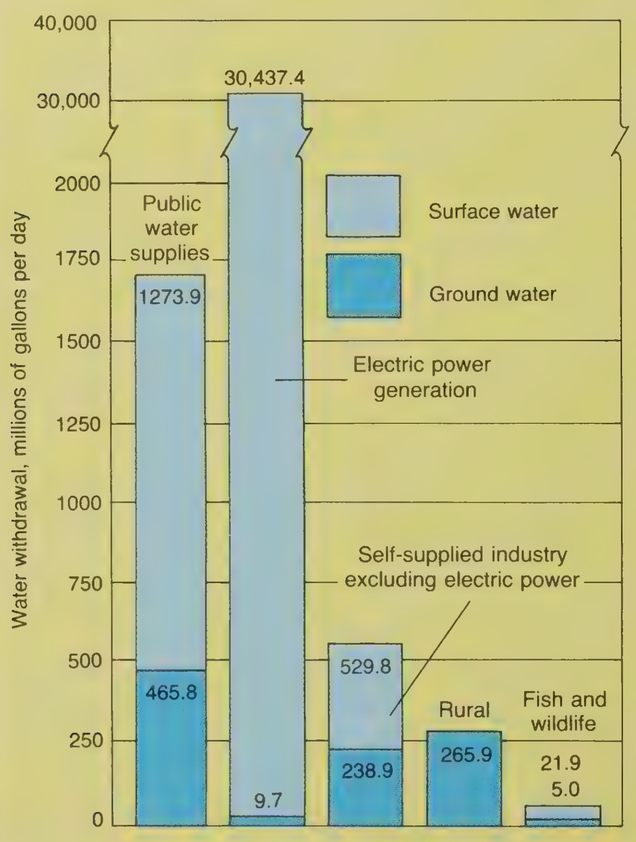


Table 1. Irrigation withdrawals for counties averaging over 1000 gallons per day per square mile, 1982.

County	Gallons per day per square mile	Million gallons per year
Adams	1,424.9	450.4
Carroll	2,955.1	504.8
Cass	2,181.1	294.6
Clark	1,190.1	219.4
Cook	6,587.0	2,293.7
DuPage	14,462.2	1,747.3
Gallatin	3,085.4	369.4
Greene	1,307.6	259.2
Henderson	7,448.8	1,035.9
Henry	2,147.7	647.5
Kane	2,624.0	494.2
Kankakee	16,098.5	3,995.7
Lake	7,288.8	1,215.8
Lawrence	5,291.4	722.3
Lee	7,240.1	1,926.5
McHenry	4,095.6	913.6
Madison	1,277.7	340.9
Mason	96,336.4	19,023.1
Ogle	1,268.2	350.4
Putnam	1,468.9	88.7
Rock Island	1,435.7	220.1
St. Clair	1,432.8	350.4
Scott	1,254.0	115.3
Tazewell	12,042.9	2,870.4
White	2,117.8	387.3
Whiteside	10,920.3	2,750.3
Will	1,656.8	511.0
Winnebago	2,278.8	432.5

Source: Illinois State Water Survey

increased over the past 30 years, from 9,000 acres in 1950 to an estimated 165,000 acres in 1982. Over one-third of this acreage is in Mason County, where irrigation accounts for about 95 percent of the county's withdrawal of ground water.

Although many commercial and industrial water users purchase water from public water supplies, a number of large users develop their own water supplies. The withdrawals by county of self-supplied industries are shown in Figure 2. Since major manufacturing areas generally coincide with major population centers, self-supplied industries necessarily compete with domestic users for the same water supplies.

Water withdrawals by county in 1982 excluding electric power generation and mineral extraction (uses with high recirculative flows) are shown in Figure 3. In northeastern Illinois, competition for water was and remains intense. Many suburban communities obtain their water from the deep sandstone aquifer system. Their rate of withdrawal is about three times faster than the rate of natural recharge. As a result, water from this aquifer system is being "mined." About two-thirds of this withdrawal must be transferred to new sources, either by competing for a share of Lake Michigan water (held to a diversion of 2,068 mgd or 3,200 cubic feet per second by a federal court decision) or by competing for a share of water from underused shallow aquifers. Some counties withdraw large amounts of water relative to their population densities. The large withdrawal in Franklin County is explained by the transfer of surface water to parts of nine neighboring counties served by the Rend Lake Conservancy District. Much of the large withdrawal of ground water in Henderson County is transferred to the Galesburg water system in Knox County. *244, 245, 246, 257, 336, 415*

James R. Kirk and Kenneth J. Hlinka, Illinois State Water Survey

Figure 2. Water withdrawals by county of self-supplied industries, 1982. Source: Illinois State Water Survey.

Figure 3. Water withdrawals by county excluding electric power generation and mineral extraction, 1982. Source: Illinois State Water Survey.

Figure 2

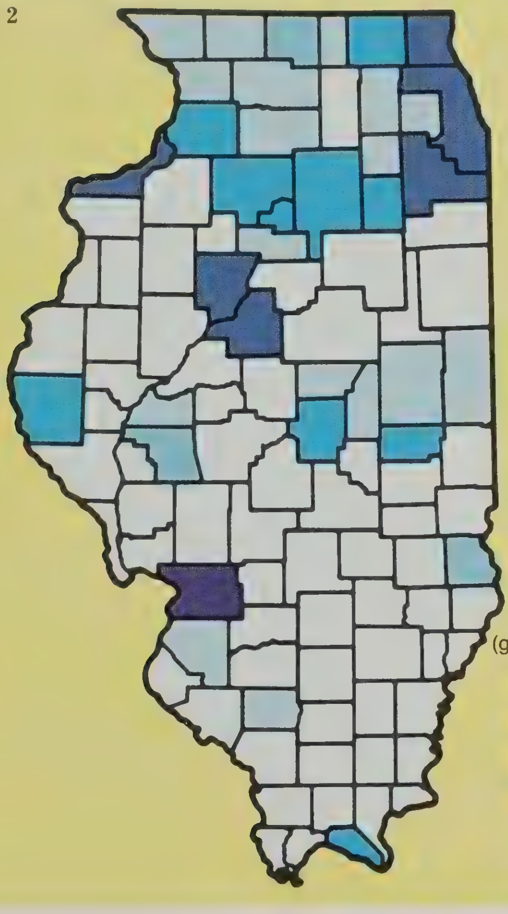
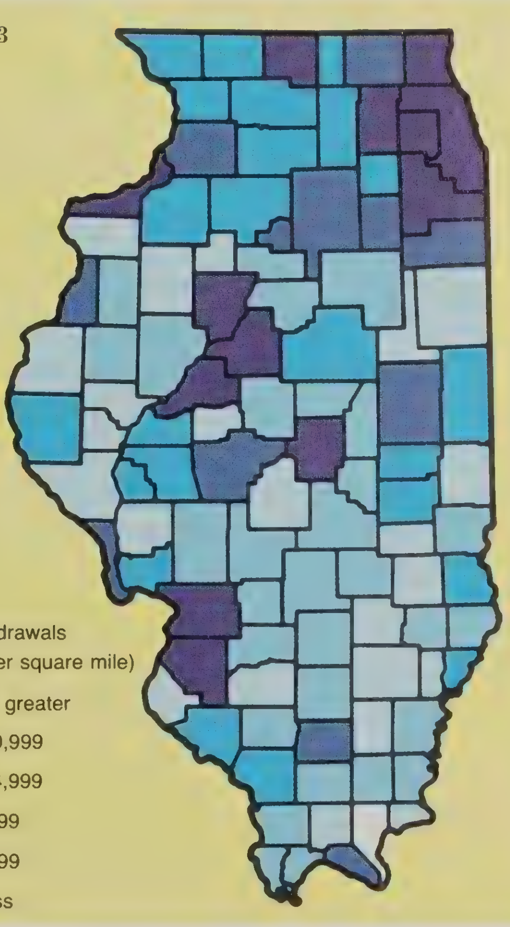


Figure 3



Availability and Quality of Surface Water

The outline of the state of Illinois has largely been defined by major bodies of surface water: the Mississippi River to the west, the Ohio and Wabash to the south and east, and Lake Michigan to the northeast. In addition, the Illinois Waterway cuts diagonally through the State from Lake Michigan to Grafton, a distance of over 300 miles. Other major rivers within the State include the Fox, Rock, Kankakee, Sangamon, Spoon, Kaskaskia, Big Muddy, Embarras, and Little Wabash.

Although Illinois is endowed with ample surface water compared to many other states, the distribution of this water is uneven and numerous artificial lakes, reservoirs, and ponds have consequently been created. The extent of dam construction is indicated in Figure 1, which plots the locations of dams inspected in a recent safety survey. The three largest man-made lakes in Illinois–Rend, Carlyle, and Shelbyville–are operated by the U.S. Army Corps of Engineers, but many others are owned and operated by cities and communities for public water supplies and local recreation. Table 1 presents the drainage areas, capacities, and surface areas of 15 Illinois lakes, including the three largest. The potential for the creation of new lakes and reservoirs throughout the State is indicated in Figure 2, which plots 800 potential sites. Many of these sites, in spite of the availability of

Figure 1

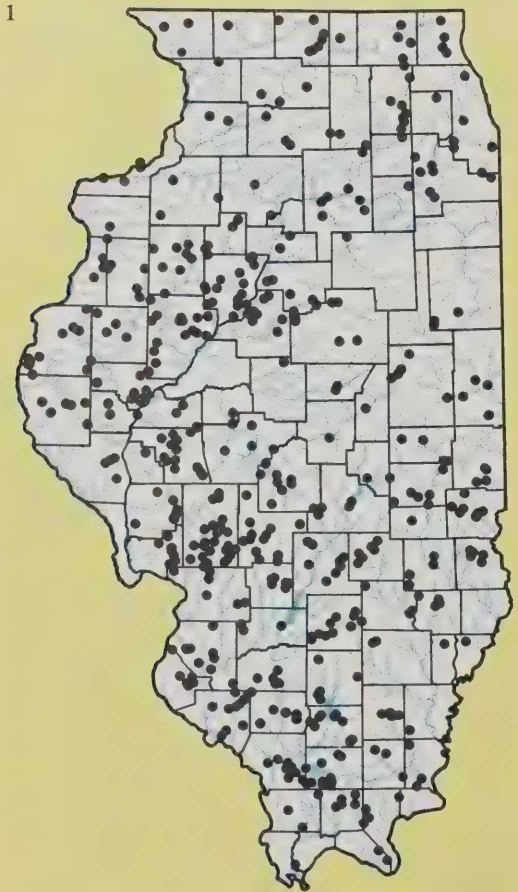


Figure 1. Locations of dams inspected for safety. Source: Illinois State Water Survey.

Figure 2

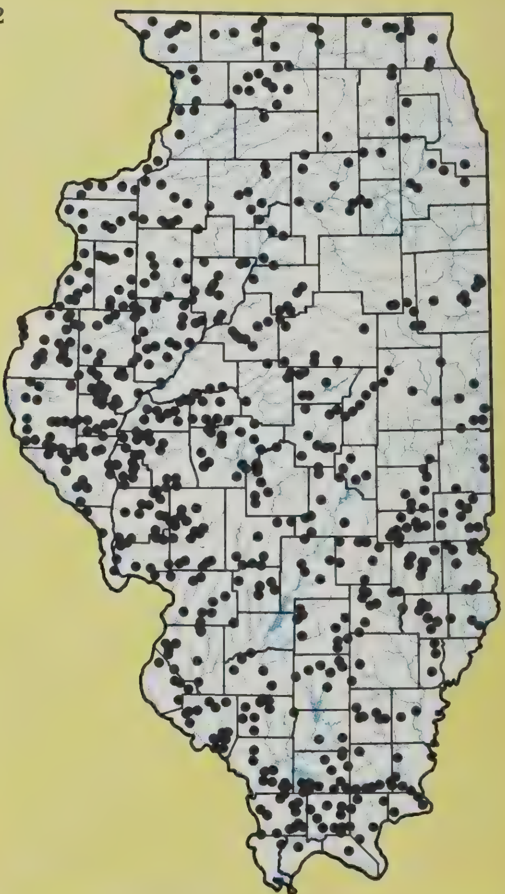


Figure 2. Potential sites for lakes and reservoirs. Source: Illinois State Water Survey.

Table 1. Characteristics of 15 Illinois lakes

Name of lake	Drainage area (sq. mi.)	Capacity and year surveyed (acre-feet)		Surface area at normal pool (acres)
Carlyle Lake	2,680	267,140	(1979)	26,000
Rend Lake	488	177,100	(1980)	18,900
Lake Shelbyville	1,054	199,759	(1980)	11,100
Crab Orchard Lake	196	67,320	(1951)	6,965
Lake Springfield	265	52,200	(1984)	4,170
Lake Decatur	925	18,800	(1983)	3,072
Lake Lou Yaeger	115	13,906	(1977)	1,315
Taylorville Lake	131	7,914	(1977)	1,148
Lake Vermilion	298	4,641	(1976)	608
Highland Silver Lake	48	6,220	(1984)	598
Lake Bloomington	61	5,863	(1955)	487
Lake Charleston	811	865	(1974)	404
Canton Lake #36	15	3,000	(1960)	218
Spring Lake	20	242	(1962)	48
Georgetown Reservoir	120	106	(1976)	32

Source: Illinois State Water Survey

water and their acceptability in geologic terms, are unlikely to be developed, however, because of adjacent urban areas, the construction of highways, and other conflicting land uses.

The quality of water in the lakes, rivers, and streams of Illinois has been lowered by the sediment, excessive nutrients, and toxic materials washed into them from their watersheds. Municipalities, industries, and agriculture have all contributed to this deterioration of water quality. Sediment-caused turbidity and sediment deposition are the most common problems in lakes, but excessive aquatic plant growth and algal blooms resulting from high phosphorus concentrations also impair water quality and limit the usefulness and aesthetic value of lakes. Low dissolved-oxygen content, turbidity, and high fecal coliform content are common indicators of degraded water quality in rivers and streams. *31, 74, 168, 169, 213, 224*

Nani G. Bhowmik, Illinois State Water Survey

Lakes

Approximately 2,900 of the 84,000 water bodies in the State have surface areas over 6 acres and are thus classified as lakes. These lakes account for 81 percent of the total surface area of the water bodies in Illinois; about 75 percent of these lakes are man-made. Almost all of the lakes in Illinois are used for recreation and many have multiple uses. One hundred ten are used for public water supplies; others are cooling lakes for power plants, and still others supply water for industrial purposes or serve as flood-control reservoirs.

The water clarity of 56 lakes was sampled in a lake monitoring program conducted by the Illinois Environmental Protection Agency (IEPA) in 1982-1983. The depth to which a Secchi disk (an eight-inch metal plate with alternating black and white quadrants) remained visible was used as the measure of water clarity. Figure 3 shows the average transparency for each of the 56 lakes. Mean Secchi-disk transparency values less than the 48-inch minimum recommended for bathing beaches were found in 78 percent of the lakes. Transparency values less than 24 inches are generally associated with impaired recreational use and were found in 52 percent of the lakes.

Clay, silt, particulate organic matter, plankton, microorganisms, and water color all contribute to the turbidity of lakes. Water turbidity can be measured with a nephelometer, a device that passes a beam of light through a water sample and yields a reading proportional to the scattering of light by particles in suspension. Figure 4 indicates the average turbidity in nephelometric turbidity units (NTU) for each of the 56 lakes in the IEPA monitoring program. Although 38 percent of the lakes had relatively low turbidity with readings of 5 or below, 22 percent fell in the highest category with readings of 15 or above. The overall average was 15.3 NTU, but the range was wide; two lakes in northern Illinois had readings of 1, and three in the State had readings over 50.

Phosphorus, one of several essential nutrients for plant and animal growth, is necessary for energy transfer during cell metabolism. Lakes with more than 0.2 parts per million of total phosphorus are considered eutrophic; that is, they are likely to have excessive amounts of dissolved nutrients, a seasonal deficiency of dissolved oxygen, and excessive algal blooms and aquatic plant growth. Total phosphorus concentrations for each of the 56 lakes in the IEPA study are shown in Figure 5. Only four lakes had average concentrations less than 0.02 parts per million. In an effort to reduce phosphorus concentrations, the State has established a general-use standard of 0.05 parts per million, a concentration high enough to meet the needs of aquatic plants and animals yet low enough to avoid eutrophication. That standard was met by 38 percent of the lakes.

Carlson's Trophic State Index (TSI) is another way of classifying lakes according to their trophic state. The TSI value for a given lake is based on

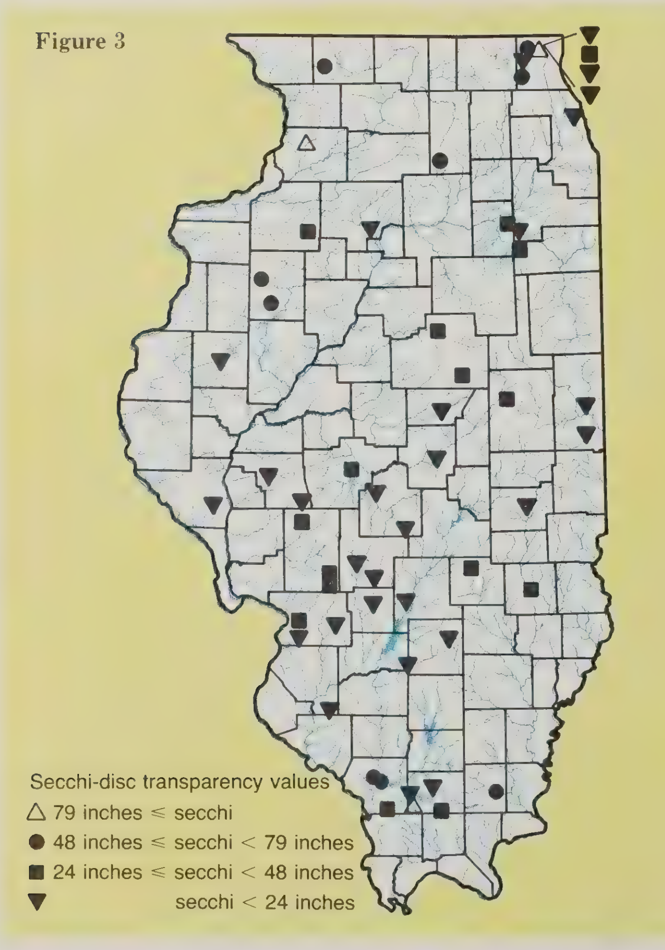


Figure 3. Average transparency of 56 lakes, 1982-1983. Source: Illinois Environmental Protection Agency 1984.

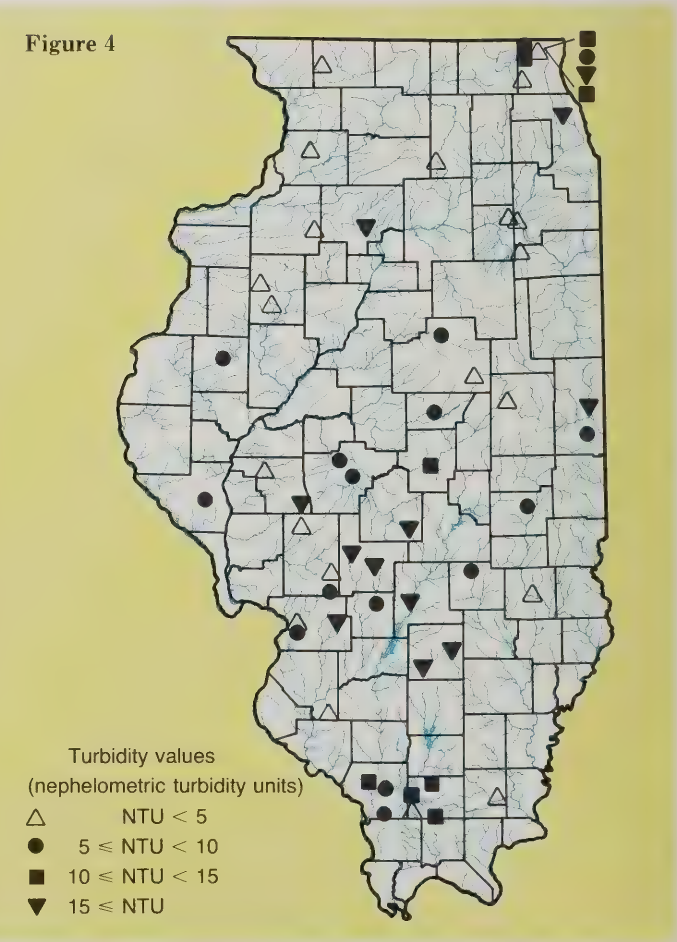


Figure 4. Average turbidity of 56 lakes, 1982-1983. Source: Illinois Environmental Protection Agency 1984.

its Secchi transparency reading, its phosphorus concentration, and its biomass (the amount of living matter present). Eutrophication is indicated by a TSI value over 50. Fifty-one of the 56 lakes sampled in the IEPA program were classified as eutrophic by this index (Fig. 6). The values ranged from 41 to 85, with a mean of 63.2. *96, 97, 98, 174, 213, 337, 354, 355, 361, 379*

J. Rodger Adams, Illinois State Water Survey

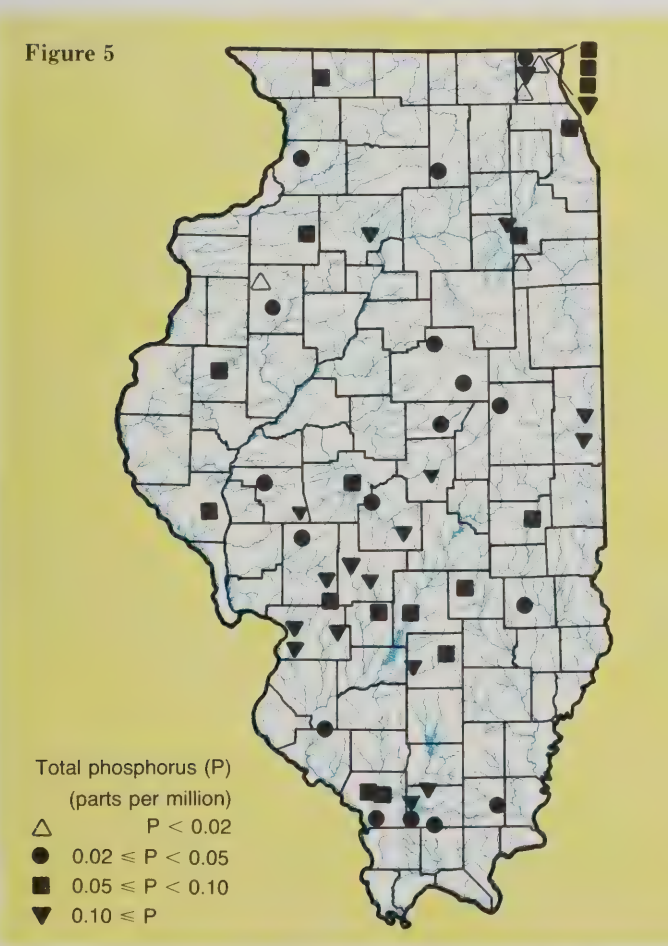
Illinois Waterway

The Illinois Waterway, which includes the Illinois River, is the most significant water resource in the State. It flows from Lake Michigan to Grafton, a distance of approximately 327 miles, and its watershed drains 29,010 square miles of which 24,810 are in Illinois. The degradation of this impressive waterway began with its opening to steamboats in 1828. Large-scale developments along the Illinois River followed, and the wildlife along and near the waterway began a long decline. The opening of the Illinois and Michigan Canal in 1848 spurred growth along the valley by connecting Chicago-area water courses directly to the river at La Salle-Peru. More important, however, the canal provided an avenue by which organic pollution reached the lower Illinois River from the rapidly expanding Chicago area. The continued growth of Chicago in the later 1800s prompted the building of the Sanitary and Ship Canal and provided a hydraulically efficient means of pouring Chicago-area wastes downstream. The stage had been set for a long-term deterioration of water quality and for the devastation of the fish and wildlife that inhabited the lower river and its wetlands.

No longer a free-flowing waterway, the Illinois has been leveed, straightened, drained, and dammed until it now consists of eight "stepped"

Figure 5. Average total phosphorus in 56 lakes, 1982-1983. Source: Illinois Environmental Protection Agency 1984.

Figure 6. Trophic State Index of 56 lakes, 1982-1983. Source: Illinois Environmental Protection Agency 1984.



navigation pools (Fig. 7). These physical alterations have placed serious constraints upon the ability of the waterway to assimilate organic, oxygen-consuming wastes and to purge itself of inorganic and organic particulate loads. Water velocities have slowed and channel water depths have increased, both conditions detrimental to the natural processes of waste assimilation. Although the dams initially increased the water depths of the backwater lakes, the result over the last forty years has been a significant net loss in water depth and water surface area due to sedimentation.

Although the water quality of the Illinois Waterway has improved significantly in the last thirty years, the extensive and irreversible physical alterations that have taken place since the turn of the century prevent the watershed from ever again becoming a true mecca for fish and wildlife. One indication of this improvement is the increased amount of dissolved oxygen as a result of modern procedures for the treatment of water (Fig. 8). The organic waste load carried by the Illinois Waterway decreased nearly 70 percent between 1962 and 1980 (Butts 1983). At river mile 290 (Lockport) the average ammonia load, a principal component of waste, dropped from 107,600 pounds per day in August 1971 to 53,200 pounds per day in August 1982, a decrease of over 50 percent during the decade (Butts 1983). A decreased waste load means that less oxygen is needed for the decomposition of waste and more oxygen remains in the waterway to meet its biological demands. Low dissolved-oxygen levels continue to persist, however, because the capacity of the Illinois Waterway to assimilate waste has been reduced by alterations of its natural flow regime–including such activities as dredging and the construction of dams, locks, and channels. In addition, bottom sediments create high oxygen demands, not only to supply the oxygen needed by the aquatic life that lives in the sediment but also for the decomposition process that is continuously at work in the sediment itself. *38, 42, 62, 63, 64, 65, 124, 129, 190, 249, 271, 290, 331, 350, 403*

Thomas A. Butts, Illinois State Water Survey

Streams

Approximately 13,200 miles of streams are found in Illinois. In addition, the State is bordered by 880 miles of the Wabash, Ohio, and Mississippi rivers. These streams and rivers provide habitat for many plants and animals, are used for recreation and navigation, and supply water for domestic, industrial, and agricultural purposes. Each category of use requires water of a different quality.

The Illinois Environmental Protection Agency (IEPA) currently maintains two networks for monitoring the water quality of streams: the ambient water-quality monitoring network, which includes 204 stream stations, and a subnetwork of 38 stations, which is part of the National Water Quality Surveillance System. These stations are monitored on a six-week cycle to obtain base-line data, to identify and quantify water-quality problems, and to define trends in the quality of Illinois streams.

Acceptable levels for a number of parameters of water quality are listed in the Illinois Water Quality Standards. The uses that a given water can support are directly related to its quality. The most stringent standards apply to public water supplies and to water used in food processing. Less stringent standards govern primary-contact use (swimming), secondary-contact use (boating and fishing), and aquatic habitats. Two of these parameters, dissolved oxygen and fecal coliform, are discussed here.

Dissolved oxygen is necessary for fish and other aquatic animals, and low levels indicate pollution by materials with high biochemical oxygen demands. The Illinois water-quality standards for dissolved oxygen are 4 parts per million for the support of indigenous aquatic life and 5 parts per million for use in public water supplies. Only 1.5 percent of the 204 stream stations monitored in 1982-1983 failed to meet the standard of 4 parts per million; 94 percent of the streams exceeded 5 parts per million.

Fecal coliform bacteria generally indicate pollution by municipal waste water or by surface runoff from animal feedlots or pastures. The maximum level allowed in public water supplies is 200 bacteria per 100 milliliters of water (about 60 bacteria per fluid ounce); for secondary contact and for the support of aquatic life, a level of 1,000 bacteria per 100 milliliters (about 300 bacteria per fluid ounce) is allowed. The widespread presence of municipal effluents and feedlot runoff is apparent in data collected at 204 stream stations in 1982-1983. Only 10.7 percent of the sites met the standard for public water; about 25 percent exceeded the standard for secondary contact.

Figure 7

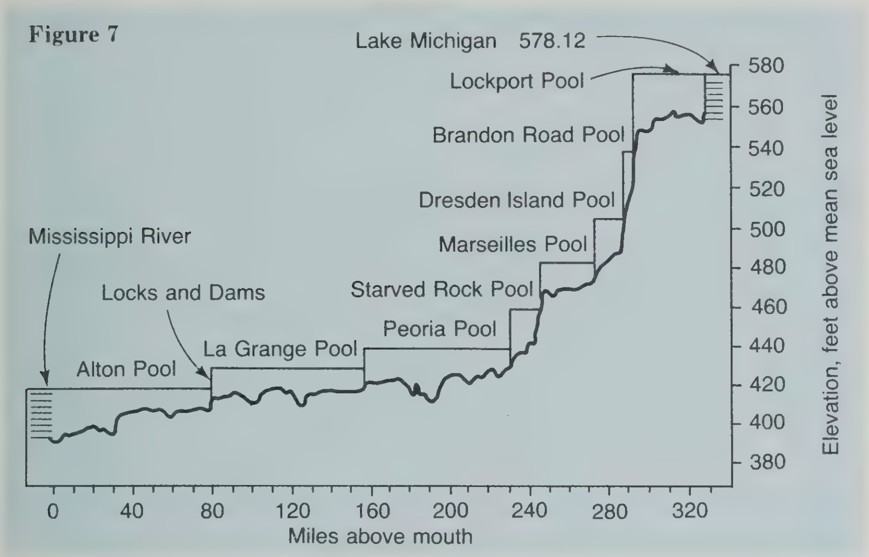
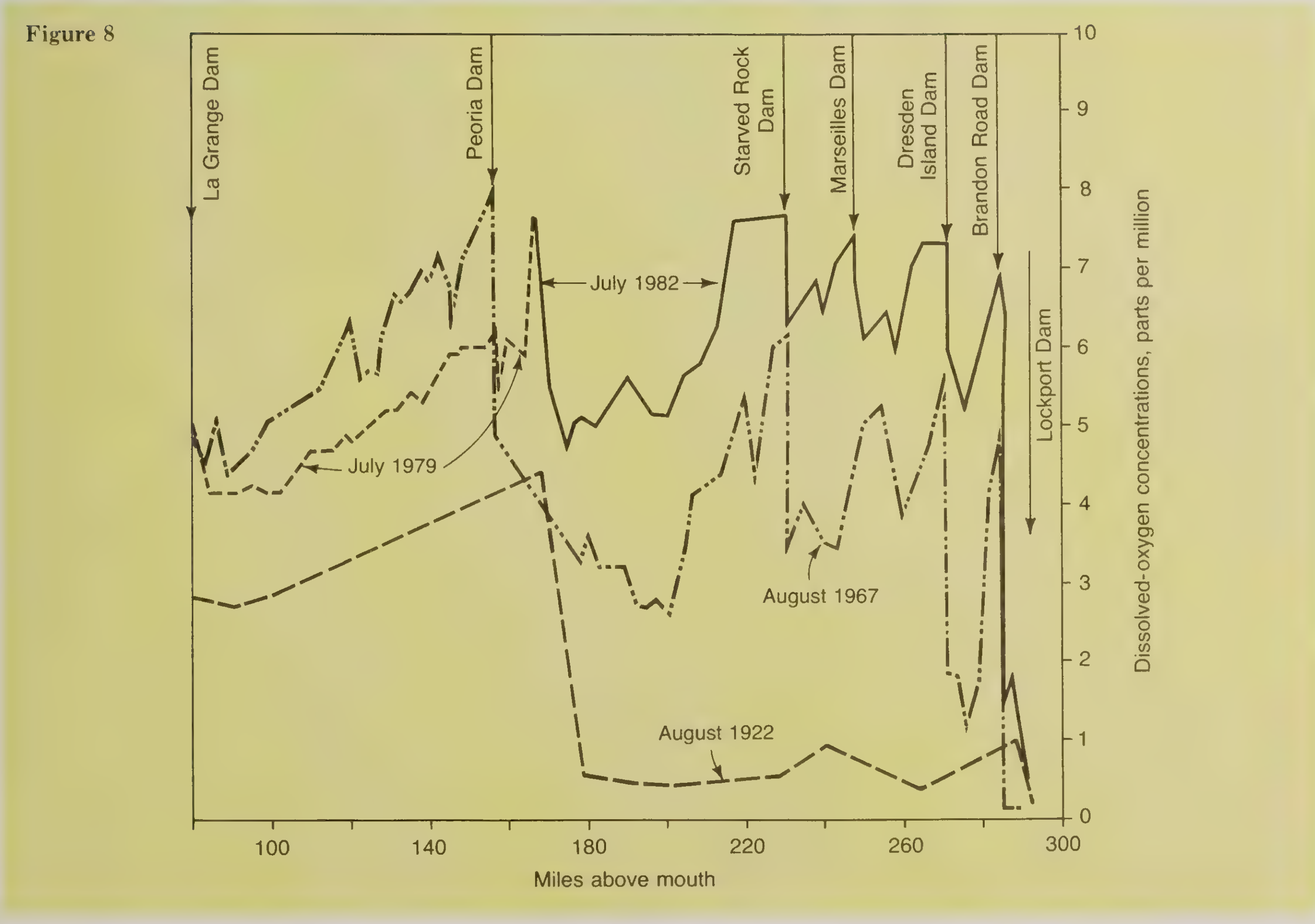


Figure 7. Profile of the Illinois Waterway. Source: U.S. Army Corps of Engineers, Chicago District, 1978.

Figure 8. Dissolved-oxygen concentrations in the Illinois Waterway. Source: Butts 1983.

Figure 8



The extent to which standards are violated can be calculated based on the total number of measurements of a particular parameter. Twenty percent of the dissolved-oxygen values recorded at stations in the Big Muddy Basin violated the standard; the Des Plaines and Mississippi South basins had violation rates over 10 percent; all other basins had rates under 10 percent. Violation rates for fecal coliform ranged from 40 to over 80 percent.

The Clean Water Program recently compared the water quality of Illinois streams in 1982 with that in 1972. This assessment of 7,270 miles of the major streams in the State found that water quality had improved in 35 percent of the stream miles and deteriorated in only 1 percent. In 1972, 11.3 percent of the stream miles had severe problems (Fig. 9); only 3.4 percent of the stream miles had problems of that magnitude in 1982 (Fig. 10). Moderate problems had also decreased, from 26.5 to 9.6 percent.

Although the findings of the 1982 study are encouraging, many miles of Illinois streams do not consistently meet standards. Many stream reaches

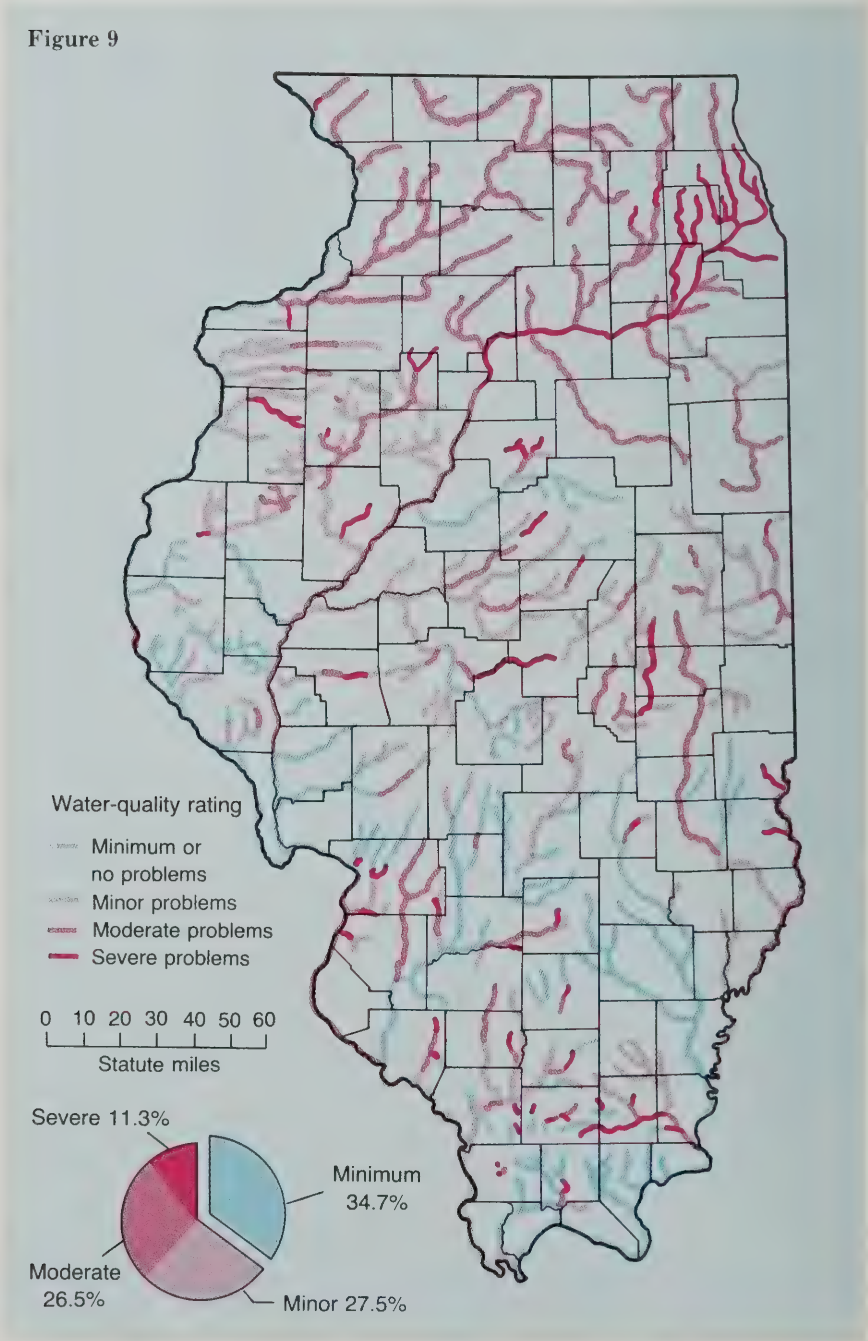


Figure 9. Water quality of Illinois streams, 1972. Source: Illinois Environmental Protection Agency 1984.

are affected by effluents from municipal waste water treatment plants (point pollution), and these effluents cause the amount of dissolved oxygen in the water to drop below the concentration needed by fish and other aquatic animals and the fecal coliform count to rise above recommended values. The impact depends on the volume of stream flow and on the quantity and quality of the effluent; improved treatment of wastes before discharge reduces the severity of the impact and the length of the affected reaches. Degradation due to nonpoint pollution (for example, fertilizer in the runoff from croplands) usually follows heavy precipitation and is limited in time. *47, 213, 228, 237, 363, 368, 369, 379*

J. Rodger Adams, Illinois State Water Survey

Figure 10

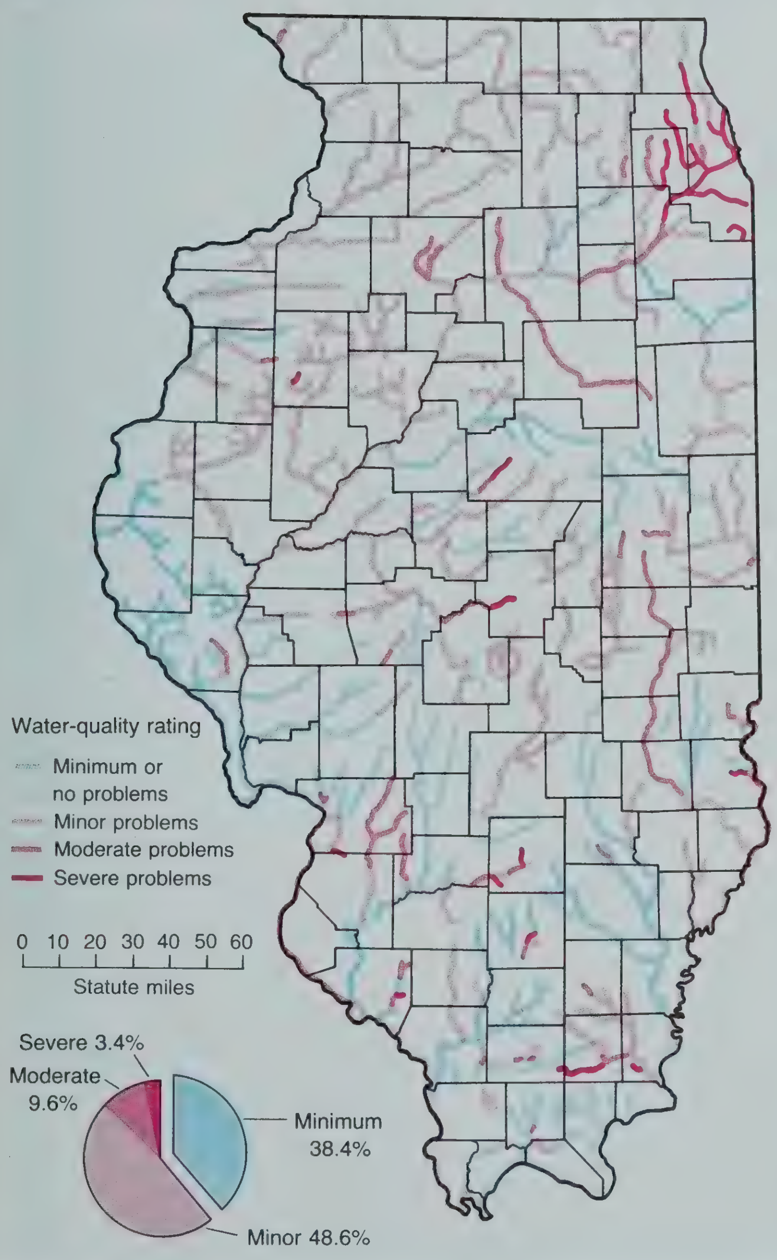


Figure 10. Water quality of Illinois streams, 1982. Source: Illinois Environmental Protection Agency 1984.

Availability and Quality of Ground Water

Ground water is pumped from strata of permeable rock, sand, and gravel that are capable of yielding water to wells or springs. These water-bearing strata are called aquifers and in Illinois have been generally classified as sand-and-gravel aquifers and shallow or deep bedrock aquifers. Approximately 985 million gallons of ground water were used each day (mgd) in Illinois in 1982. Most of this water was withdrawn by public water systems (466 mgd) and by industries that owned and operated their own wells (249 mgd) (Kirk et al. 1984).

Aquifers are recharged (resupplied with water) by precipitation and snow melt. Sand-and-gravel aquifers are recharged as water percolates down through the glacial drift (clay, silt, sand, and gravel deposited by glaciers and glacial streams). Bedrock aquifers, in turn, are recharged primarily from the vertical leakage of water through the glacial drift and through the overlying formations of bedrock. The deep bedrock aquifers beneath northeastern Illinois are recharged in areas of southeastern Wisconsin and in areas to the west and northwest in Illinois.

The principal sand-and-gravel aquifers in the State are located in alluvial deposits along major rivers or in major bedrock valleys, such as the Mahomet Valley in east-central Illinois. (These are readily seen in map a, which accompanies Figure 3.) The Cambrian-Ordovician aquifers in the Chicago area are the principal bedrock water supply for that region. These deep bedrock aquifers have been overpumped since the late 1950s, however, and declines in water levels have been severe in major centers of pumpage. Two-thirds of the estimated total potential yield of bedrock aquifers is available from the shallow bedrock aquifers, mainly dolomites, in the northern third of the State. (These are seen in map b, which accompanies Figure 3.) In western, southwestern, and extreme southern Illinois, bedrock aquifers are limestone and sandstone formations of Mississippian Age; in central and southern Illinois, they are thin beds of sandstone and limestone in rocks of Pennsylvanian Age. Chances are poor for the development of large supplies of ground water from Pennsylvanian and Mississipian rocks, except for some Mississippian rocks in extreme southern Illinois. Flow rates are low and the quality of the water is poor. The estimated potential yields of the sand-and-gravel and bedrock aquifers in Illinois are shown in Figures 1 and 2.

The potential yield of an aquifer is defined as the maximum amount of ground water that can be continuously withdrawn from a reasonable number of wells and well fields without creating critically low water levels or exceeding the natural rate of recharge. Calculations of the potential yield of sand-and-gravel aquifers are based in part on the assumption of their full development. Pumping from these aquifers, however, reduces recharge to the underlying bedrock aquifers and therefore reduces their potential yield, a factor that must be taken into consideration in estimating total potential yields.

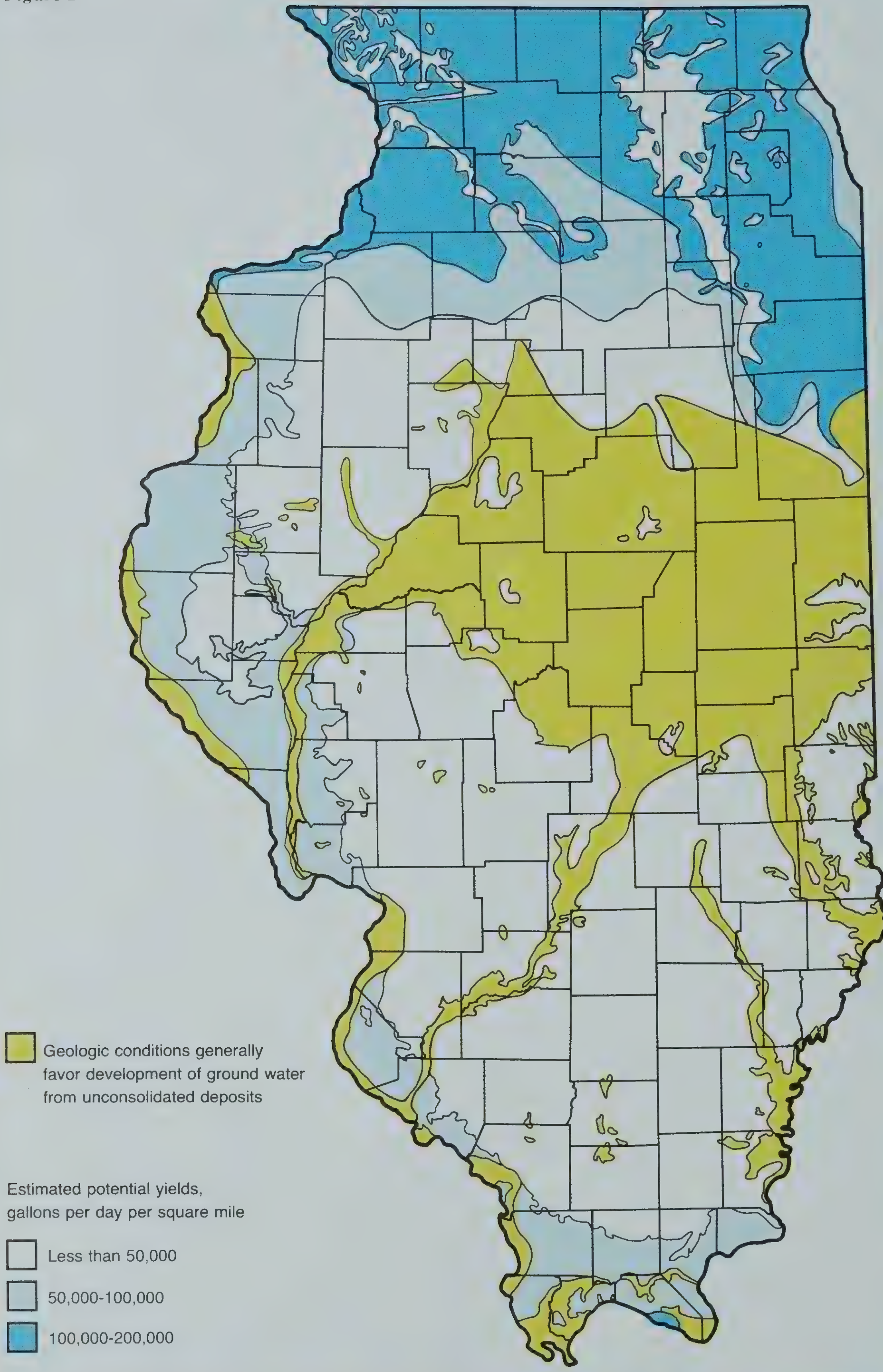
The principal sand-and-gravel and bedrock aquifers in Illinois are estimated to have potential yields of 4.8 and 2.5 billion gallons per day, respectively. In combination, however, these figures produce an inflated total since only the sand-and-gravel or the bedrock aquifers could be fully developed. The total ground water potential in Illinois, therefore, is somewhat lower and is estimated to be 7 billion gallons per day (Illinois Technical

▶
Figure 1. Estimated potential yields of sand-and-gravel aquifers. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 1


Areas where municipal and industrial water supplies are usually developed from other sources
Estimated potential yields, gallons per day per square mile
Less than 50,000 (Areas where small industrial and municipal water well development in thin sand-and-gravel aquifers may be possible)
100,000-200,000
200,000-400,000
1,000,000-5,000,000

Figure 2



Geologic conditions generally favor development of ground water from unconsolidated deposits
Estimated potential yields, gallons per day per square mile
Less than 50,000
50,000-100,000
100,000-200,000

Advisory Committee on Water Resources 1967). In terms of the ratio between ground water withdrawals and ground water supply, approximately 1:7, Illinois can be considered a water-surplus state. The uneven distribution of usable aquifers, however, means that the citizens of southern Illinois do not generally have access to this water resource. In addition, distribution problems are created by the heavy demands made of aquifers near large population centers. In such settings, aquifers are "mined" for water, and withdrawal rates exceed the rate of recharge.

The quality of ground water depends largely on the composition of the geologic materials through which the water moves. Water falling as precipitation is generally very low in mineral content. As water percolates through the soil, however, it comes in contact with various minerals and gases and carries them downward in solution. In general, as water penetrates more deeply into the ground, it becomes more mineralized.

The amount and type of mineralization determines water treatment practices, and water softening and iron removal are common in Illinois because of the relative abundance of calcium, magnesium, and iron in the ground water of the State. In water sample analyses, calcium and magnesium levels are expressed as "hardness" and are shown as such for sand-and-gravel and for shallow and deep bedrock aquifers in Figure 3.

Chloride, sodium, and sulfur (the latter normally occurring as sulfate in ground water) are also usually present under natural conditions in the ground water of Illinois (Fig. 3). The presence of these chemicals in local areas of the State, however, are sometimes related to such anthropogenic activities as coal mining or the salting of roads.

The total dissolved-solids content of ground water, also shown in Figure 3, is a general measure of all the mineral constituents in the water. Although water with a high mineral content may taste salty or brackish, depending on the types of minerals and their concentrations, levels in Illinois ground water are generally not high enough to cause such problems. Water supplies developed from deep bedrock aquifers in western Illinois, however, are affected by a high mineral content and are sometimes unpalatable.

A common chemical constituent of ground water that does not generally occur naturally in elevated concentrations is nitrate. High concentrations are usually found in association with livestock operations, septic systems, or waste water treatment facilities. The presence of other pollutants in ground water may not be indicated by high levels of mineralization, but many of these are considered harmful even at relatively low concentrations, including lead, cadmium, zinc, nickel, silver, selenium, mercury, cyanide, ammonia, barium, and radium. The presence of mercury and cyanide is associated with industrial activity but has not been found to any great extent on a regional basis in Illinois. Naturally occurring barium and radium, however, pose an important regional problem in the deep sandstone aquifers of northern Illinois, and water treatment has been required to remove them.

Recently, organic chemicals related to industrial activity have been found in ground water near sites that handle hazardous materials, around waste disposal facilities, and adjacent to illegal dumping sites. As a result, these areas have become a major focus of ground water monitoring efforts. Figure 4 is based on a general assessment of industrial activity throughout the State and indicates the distribution of facilities that may handle hazardous materials. Although such factors as the type and volume of substances handled and the management practices used may be as important or more important than the distribution of the facilities themselves, the density of potential contaminant sources is a significant factor to consider in estimating the risk for contamination of ground water. *28, 29, 74, 225, 246, 356, 358*

A.P. Visocky, H. Allen Wehrmann, and Michael D. Broten,
Illinois State Water Survey

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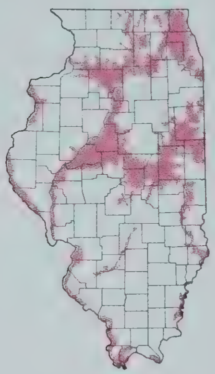
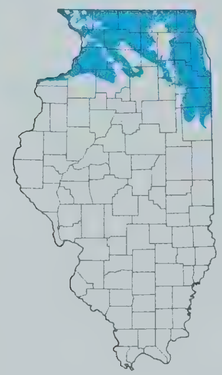
Figure 2. Estimated potential yields of bedrock aquifers. Source: Illinois Technical Advisory Committee on Water Resources 1967.

Figure 3

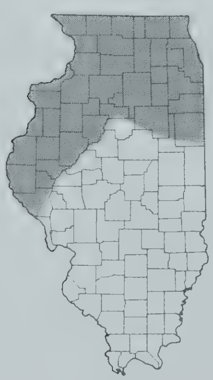
a. Principal sand-and-gravel aquifers



b. Principal shallow bedrock aquifers



c. Principal deep bedrock aquifers



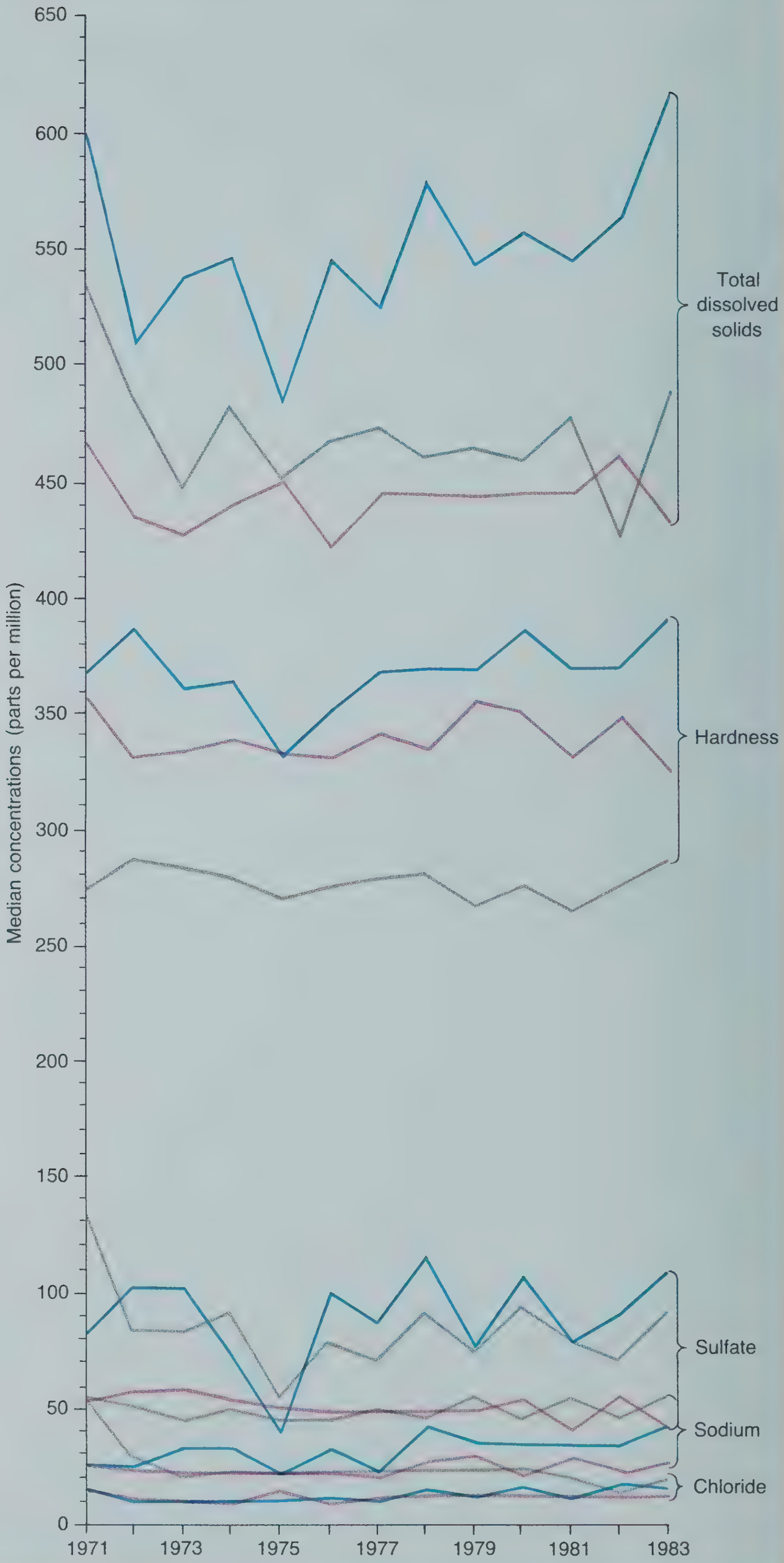


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Figure 3. Mineral content of water in principal sand-and-gravel, shallow bedrock, and deep bedrock aquifers. Source: Illinois State Water Survey.

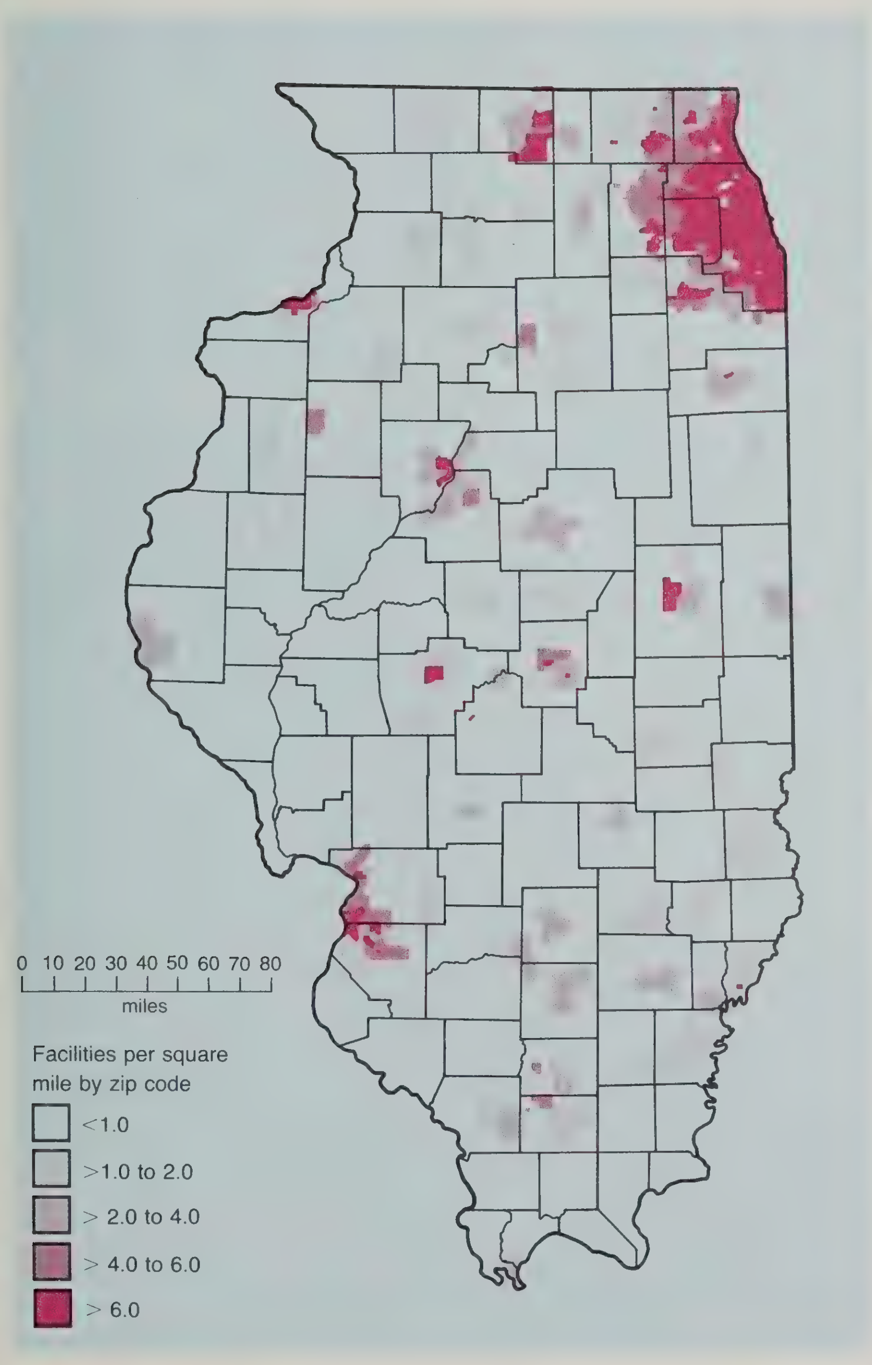


Figure 4. Distribution of facilities that may handle hazardous materials. Source: Shafer 1985.

Stream Flow

Although many factors govern the rate of flow of a given stream at a given time, surface runoff, which occurs at an average rate of 25 billion gallons a day in Illinois, is one of the most significant. Stream flow is measured by a network of gaging stations on streams throughout the State. The maximum flow, or flood, observed at each station each year is recorded in the annual flood series, and over the years these data allow us to predict the probable magnitude of future floods and the season in which they are most likely to occur. Both runoff and floods are discussed below.

Runoff

The main source of water, precipitation, is estimated to be 100 billion gallons per day in Illinois. Most precipitated water is lost back to the atmosphere through the processes of evaporation and evapotranspiration. The remaining precipitation either becomes surface runoff, which is eventually collected by streams, or subsurface runoff, which is infiltrated into the ground to replenish the ground water and may, by traveling underground, ultimately enter surface streams. Runoff, therefore, consists of that portion of the precipitation that eventually ends up in exposed stream channels as stream flow.

Figure 1

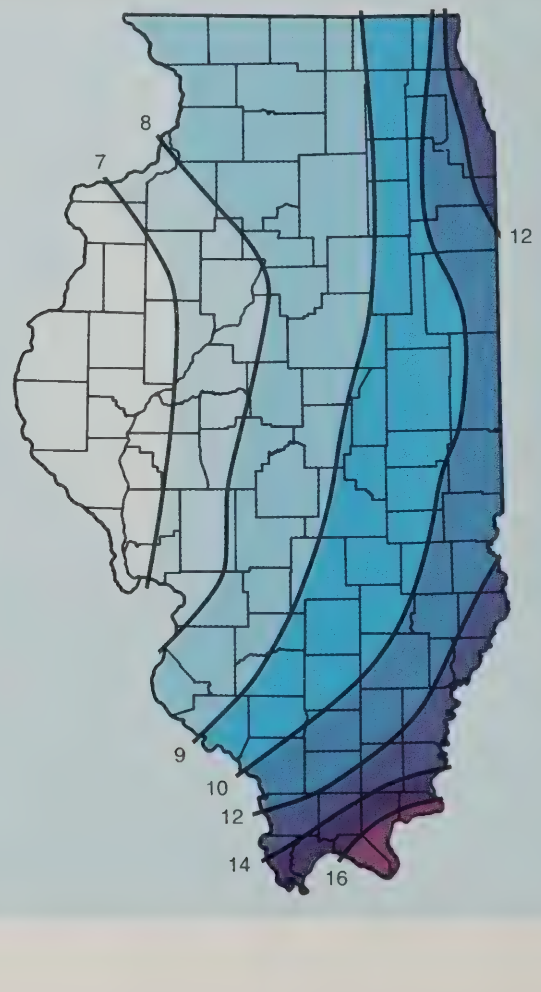


Figure 1. Average annual runoff in inches. Source: U.S. Geological Survey.

Runoff is measured by a network of stream-gaging stations throughout Illinois. The average runoff from the State is approximately 25 billion gallons per day (39,000 cubic feet per second). Seventy-eight percent (20 billion gallons per day) drains into the Mississippi River; the remaining 22 percent (5 billion gallons per day) drains into the Ohio River. The Illinois River, the single most important outlet for runoff within the State, transports about 47 percent of the total runoff from the State into the Mississippi River.

The variability of annual runoff throughout Illinois is shown in Figure 1. The lines of equal runoff run from north to south, with a slight convexity facing east. A number of factors help to explain this pattern. Weather in Illinois is primarily determined by cold fronts from the Northwest and warm fronts from the Southwest, which bring rain from the Gulf of Mexico. These two fronts move eastward over Illinois, and their effect on each other creates the eastward facing bulge. Topography also affects runoff patterns. Water moves slowly over the flatlands of central Illinois and is more likely to percolate into the ground, but it tends to move more quickly over the higher gradients in the north and south of the State. Although the forests of southern Illinois retain water and thereby reduce the gradient effect, its consequences are nevertheless apparent in the high runoff (12 to over 16 inches) in the south. Finally, precipitation levels obviously influence runoff, and the southernmost part of the State receives about 12 more inches of precipitation than does the northern part.

The monthly variability of runoff in Illinois is shown by histograms for seven selected gaging stations (Fig. 2). In general, the highest runoff occurs in March and April and correlates with spring rains. Important differences, however, are found between streams located in northern and southern Illinois. Streams in the south (Cache, Shoal Creek, and Little Wabash) have extremely low flows during August, September, and October; how-

Figure 2

Figure 2. Monthly variability of runoff at selected stations. Histograms show the percent of annual flow for each month at those stations. Source: Illinois State Water Survey.

ever, streams in the north (Pecatonica and Des Plaines) have relatively higher flows during the same period. In part, these differences are explained by the ability of ground water to replenish streams in northern Illinois. Less ground water is available in the southern part of the State, and streams there show the effects of reduced rainfall more dramatically.

Low-flow characteristics of Illinois streams are further illustrated in Figure 3. For purposes of comparison, streams are categorized as those that never experience seven consecutive days without flow in a ten-year period and those that do experience periods of no flow for as long as seven days at least once in a ten-year period. Most of the streams in the first category are found in northern Illinois. In the central and southern part of the State, few streams, chiefly the main stems of major rivers, are likely to maintain flows with such consistency. *84, 89, 362, 363, 379*

Misganaw Demissie, Illinois State Water Survey

Floods

Floods are caused by a number of factors, which may act singly or in combination: intense precipitation, wet soil conditions prior to heavy rains, rainfall over areas covered with snow, melting snow, moderate or major storms in rapid succession, and the failure of dams, which results in a quick release of large quantities of water. A stream is said to be in flood stage when it overflows or is about to overflow its banks. In Illinois, the "bank-full stage" for most streams tends to occur every two or three years. Although flooding is a natural event, the damage caused by floods has increased as the lowlands and plains adjacent to streams and rivers have been taken for human habitation and agricultural and industrial development.

Figure 3

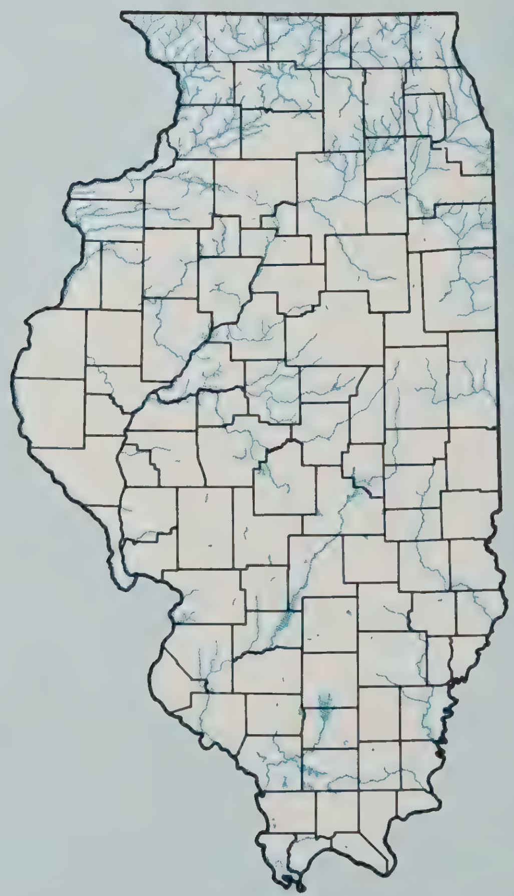


Figure 3. Streams that experience flow on at least one day during the seven consecutive days of lowest flow in a ten-year period. The dramatic differences in low-flow characteristics among Illinois streams can be seen by comparing the streams shown here with the stream network shown on page 24. Source: Singh and Stall 1973.

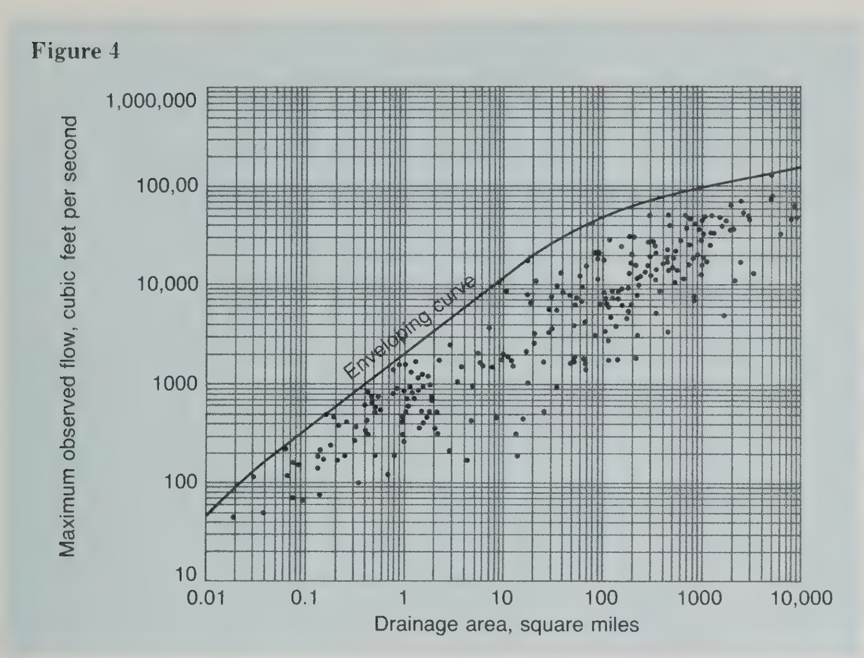


Figure 4. Relation between maximum flow and drainage area with the exception of the Illinois River. Source: Curtis 1977.

The U.S. Geological Survey, in conjunction with other federal and state agencies, maintains gage stations on various creeks, streams, and rivers in Illinois and publishes the average daily flow at each station. The highest flow recorded for the year at a given gage station becomes part of the annual flood series for that station. The maximum flows, or floods, over a number of years are then used to compute the magnitude of flood likely to occur at that station once in 50 or 100 years. Although flows higher or lower than the estimated maximum can occur during any 50- or 100-year period, these estimates nevertheless provide valuable insight into the distribution of floods throughout the State.

The maximum observed flow, or flood, from each gage station in Illinois (with the exception of stations on the Illinois River) is plotted along with its respective drainage area in Figure 4. The enveloping curve, or the curve below which all incidences fall, indicates the maximum flood that may be expected for a given drainage area. The slope of the curve suggests that the flood peak per square mile decreases as the drainage area increases. Several factors contribute to this phenomenon. First, storms that cause floods tend to be localized and typically cover only about 40 or 50 square miles. As a result, stations with extensive drainage areas are less likely to show the flood impact of those storms. Second, large drainage areas provide more storage for storm runoff than do smaller drainage areas and this runoff in turn requires more time to reach the gage station. Figure 4 also illustrates the considerable variation in maximum flow for drainage areas of similar size. These variations can be attributed to differences in storm characteristics (intensity, duration, and distribution of precipitation), differences in basin soils and slopes, and differences in the configurations of drainage networks.

The probability of high floods occurring in winter (mid-December through March) is indicated in Figure 5. In the northwestern part of the State, for example, at least 50 percent of the 8 to 10 maximum flows recorded over the years in the annual flood series occurred in winter; the probabilities are that this pattern will repeat itself. Although many variables are at work, the frozen ground in the northern part of the State contributes to the likelihood of winter floods in that region. Spring rains, which come earlier in the southern part of Illinois than they do in the northern part, contribute to the likelihood that at least 50 percent of the high floods in the southeastern part of the State will also occur between mid-December and the end of March.

The channels of streams have been carved and are maintained by the streams themselves to accommodate the low, medium, and high flows experienced in average years. The floodplains adjacent to streams are created by occasional high floods; however, they also play an important role in the moderation of floods. During flooding, the low-lying floodplains are able to store large quantities of water which later, when the flood subsides, are returned to the stream. In addition, floodplains retain the nutrient-rich sediments left by receding floods. As a result, many valuable forest resources are located in floodplains, which are enormously productive biologically.

Flood-control measures are divided into three categories–structural, nonstructural, and a combination of the two. Structural measures include the construction of dams, reservoirs, floodwalls, levees, and floodways, the straightening of channels, and the floodproofing of buildings. Zoning and other restrictions on land use are typical nonstructural measures. A park, for example, may be an appropriate use of low-lying land adjacent to a river; the building of residential structures may not. Flood insurance is a somewhat indirect nonstructural method of flood control. Developers may discover that they are unable to obtain flood insurance or that it is extremely costly; thus they are deterred from encroaching on the floodplains, which continue undisturbed in their natural role of providing adequate passage for the flood. *73, 91, 252, 301, 362, 379*

Krishan P. Singh, Illinois State Water Survey

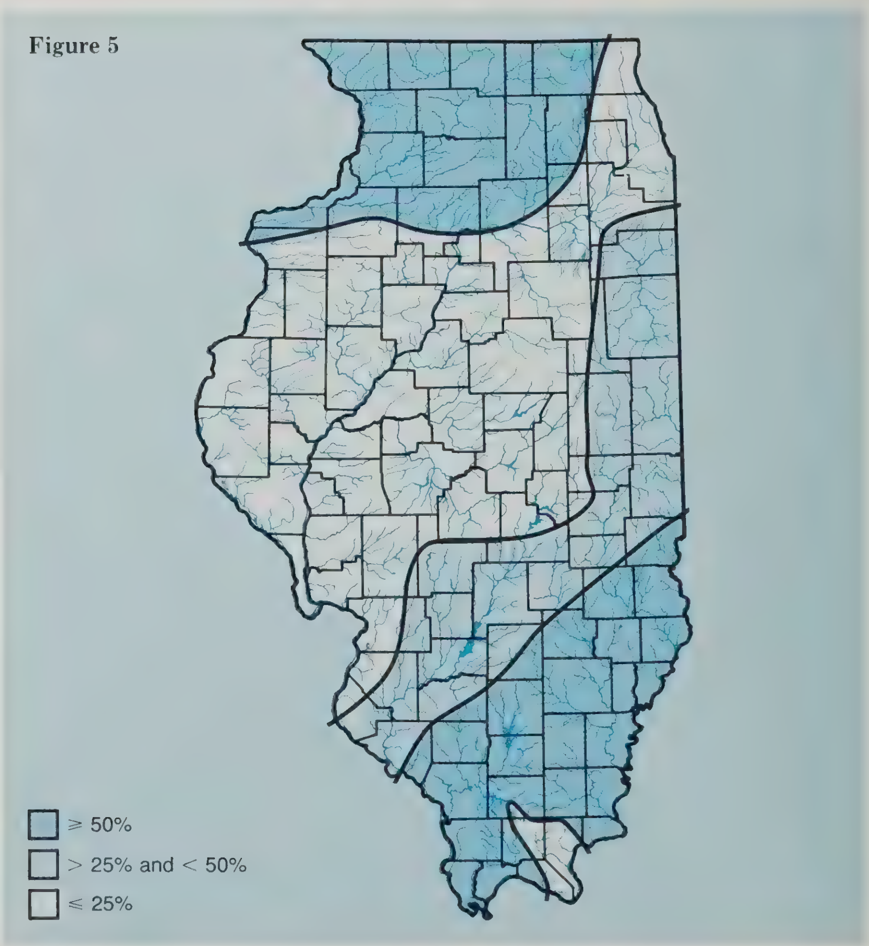


Figure 5. Probability in percent of high floods occurring in winter (mid-December through March). Source: Singh 1982b.

Erosion and Sedimentation

Soil erosion is the process by which soil particles are dislodged and carried away by water or wind. These particles may then be deposited as sediment in lakes, rivers, or streams. Both erosion and sedimentation are natural processes that have been in effect over geologic time. The effects of each, however, are mitigated by other natural processes: the effects of erosion by the chemical and biological process of new soil formation, the effects of sedimentation by renewed erosion and by the removal of sediment during floods or high winds. On balance, however, these natural processes result in a slow net transfer of soil particles by erosion from land surfaces and in sediment deposition in lakes, streams, and oceans.

Though erosion and sedimentation are natural processes, human activities have drastically increased their rates. As a result, topsoil is lost from farms, lakes accumulate deep layers of sediment, and rivers and streams carry heavy loads of eroded soil particles. The current average annual soil loss in Illinois (6.7 tons per acre) is 2.5 to 6 times greater than the natural rate. At this rate, 1.5 bushels of topsoil are lost for every bushel of corn produced in the State. In parts of Illinois nearly 70 percent of the topsoil has been lost to wind and water erosion.

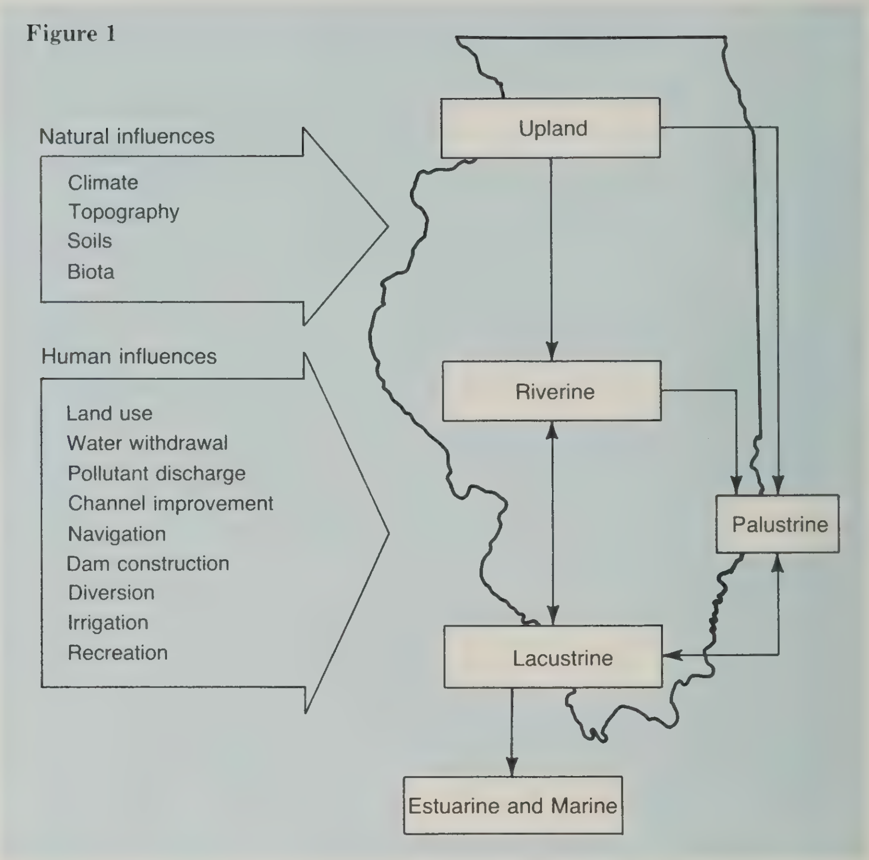
Although the model shown in Figure 1 is general in nature, it identifies the major systems of the environment and the natural and human factors that govern erosion and sedimentation. In this model, Illinois is divided into four environmental systems that serve as the major sources of and sinks for sediment and organic and inorganic material: Upland, Riverine (streams and rivers), Palustrine (wetlands), and Lacustrine (lakes and reservoirs). Two systems absent in Illinois–the Estuarine and Marine Systems–are represented by the lowermost box. Most sediment and adsorbed materials are eventually deposited into these two systems and carried to the Gulf of Mexico.

The Upland System, by definition, consists of land surfaces that are not inundated by water from rivers, lakes, or reservoirs even during periods of extremely high water. This system includes most urban and agricultural land as well as land used for mining or occupied by forests. The Riverine System includes stream and river channels with either a continuous or periodic flow of fresh water; their border areas are also included. The Lacustrine System refers to natural lakes and man-made reservoirs, including border areas flooded during periods of high water. The Palustrine System consists of nontidal wetlands, which may be situated on the fringes of Riverine, Lacustrine, or Estuarine Systems. This system also includes the temporary or permanent water bodies often called ponds.

The movement of sediment, nutrients, biota, and chemical pollutants from one system to the other is indicated in Figure 1 by arrows. The direction is generally from the Upland to the Riverine, from the Riverine to the Lacustrine, and finally to the Estuarine or Marine Systems. Two-way arrows indicate the potential two-way movement of material. If, for example, a dam is built on the main channel of a river, material from the newly created reservoir may move from the Lacustrine to the Riverine System as well as from the Riverine to the Lacustrine.

The processes of soil erosion, sediment transport, and sedimentation within each of the four systems in Illinois and the interactions among those

Figure 1. Model for the transport by water of sediment, biota, nutrients, and chemical pollutants. Source: Bhowmik et al. 1984a.



systems are controlled by natural and human influences exerted on the entire environment. Among the natural factors are soil characteristics, topography, vegetation, and seasonal and long-term changes in climate. Human factors include patterns of land use such as agriculture, mining, and urban development and patterns of water use such as water withdrawal, water diversion, and water pollution. *36, 40, 41, 42, 79, 108, 122, 135, 160, 161, 196, 211, 212, 251, 292, 323, 386, 402, 406, 408, 429, 430*

Soil Erosion Rates

Erosion rates of Illinois soils can be estimated with the Universal Soil Loss Equation, which is expressed as A = RKLSCP. A is the average annual soil loss in tons per acre, R is a factor based on the intensity and distribution of rainfall, K is a factor based on the erodibility of the soil, L and S are factors based on length and grade of slope, C and P are factors based on crop-management and erosion-control practices. The erosion rates shown in Figure 2 were computed with this equation. Soil losses from Illinois cropland varied from nearly 4 to over 25 tons per acre per year. In general, erosion rates of croplands were higher in the southwest and southern parts of the State.

The Universal Soil Loss Equation can also be used to evaluate the severity of erosion and to suggest the best approach for reducing erosion in a given area. For these calculations, A is replaced with T, a tolerance value based on the erosion rate that a given soil can sustain or tolerate. The ratio of T (soil tolerance) to K (soil erodibility) can then be used as a yardstick to determine not only the severity of erosion but also the impact of conservation practices. Figure 3 shows average T/K values for the soils of Illinois. Soils with low T/K values that are used for cropland are difficult to protect, and long rotations, including several years of hayland, are often needed to reduce erosion significantly. Soils with high T/K values are the easiest to protect because of their ability to sustain erosion (high T value) and their low erodibility (low K value).

▶

Figure 2. Average soil erosion rates of Illinois croplands. Source: U.S. Department of Agriculture, Soil Conservation Service, 1984a.

Figure 2

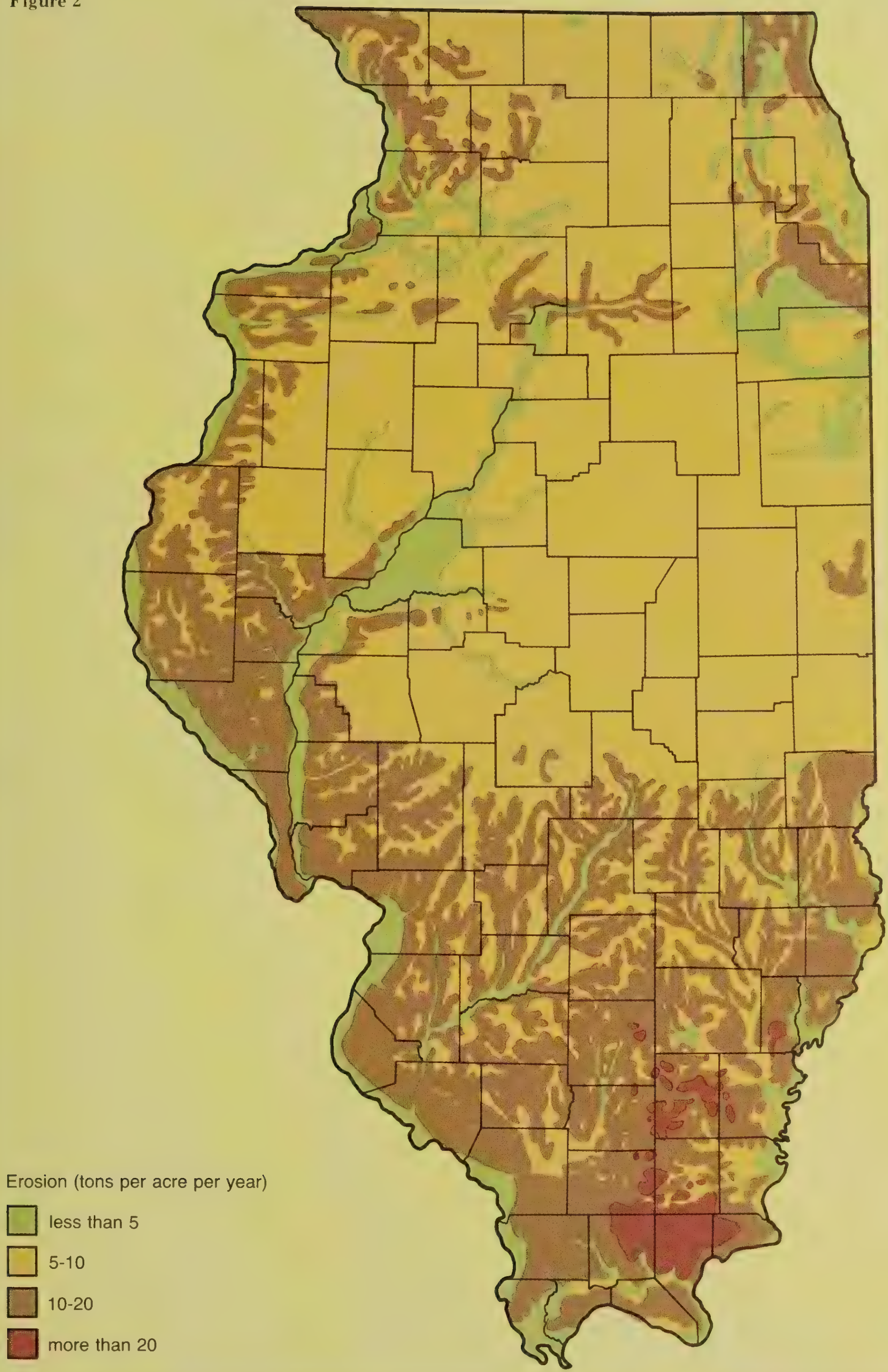

Erosion (tons per acre per year)
less than 5
5-10
10-20
more than 20

Figure 3

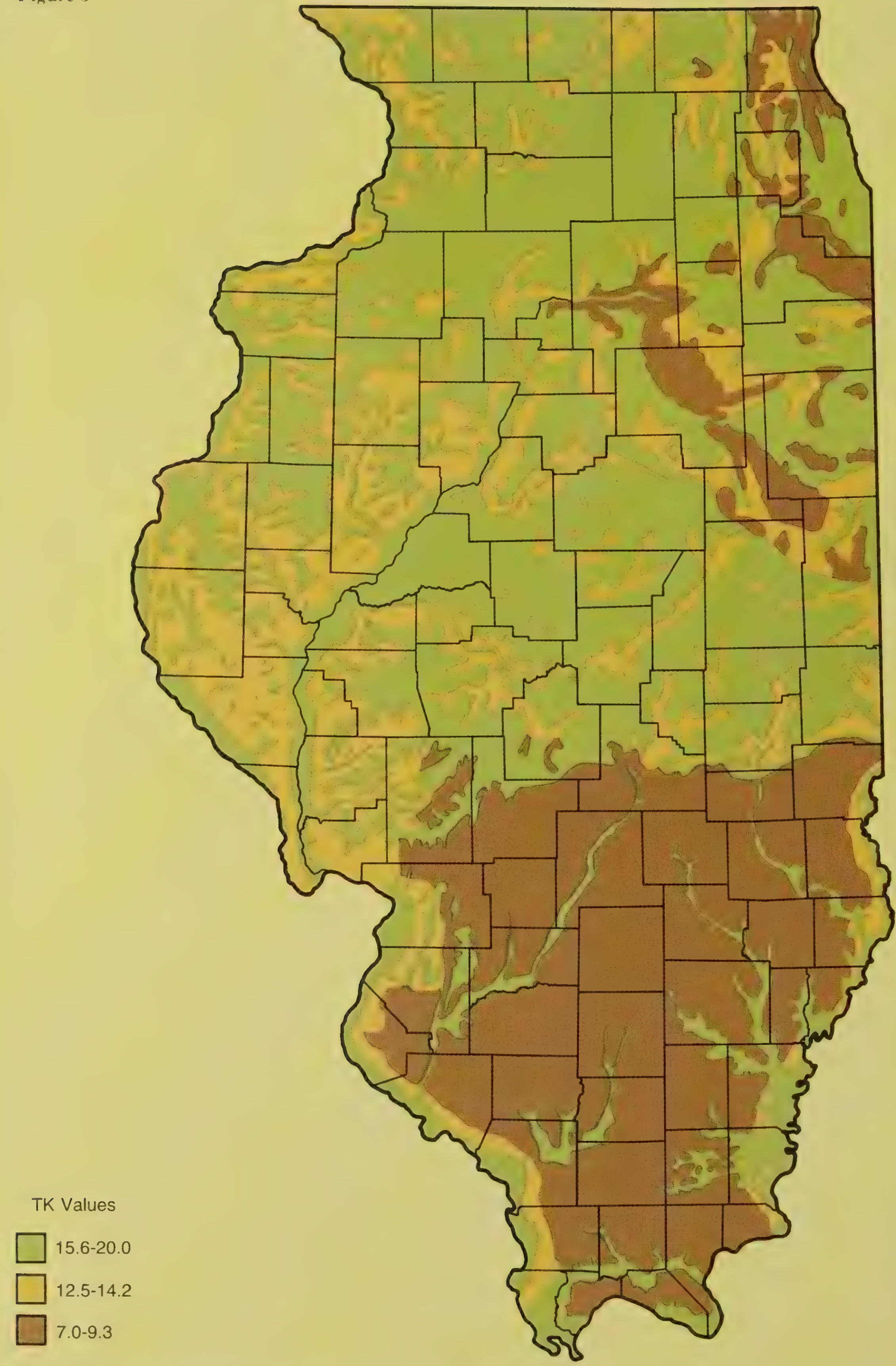


Figure 4 compares the average thicknesses of the present topsoil of Illinois to the topsoil present over a century ago. Although the floodplains of major rivers show a general pattern of deposition, clearly significant erosion of topsoil has taken place throughout the State. The current thickness of topsoil in parts of southern and western Illinois, for example, is only 5 or 6 inches compared to a thickness of 13 or 14 inches about a hundred years ago. In extensive areas of the State the present thickness of topsoil is less than 50 percent of its earlier thickness. *133, 212, 406, 431.*

◀ **Figure 3.** Soil erosion tolerance and erodibility (T/K values) for Illinois soils. Source: U.S. Department of Agriculture, Soil Conservation Service, 1984a.

Stream Sediment Load

The characteristics and behavior of rivers and streams differ depending upon whether they flow through steep gradients such as those found in mountainous areas or through flat terrains such as those found in the Midwest. The materials through which a river flows, the rainfall-runoff pattern of its basin, constraints imposed by human activity, and the characteristics of the watershed, including its geology, are among the factors that determine the hydraulics of flow and the sediment load of a river.

The Illinois State Water Survey, in cooperation with other state and federal agencies, initiated an in-stream sediment monitoring network of fifty stations in the fall of 1980. Although generalized analyses should only be made on data accumulated over five or ten years, a preliminary analysis was made to determine variabilities and trends in the sediment loads of Illinois streams. Data from all stations indicate that average daily water flow correlates highly with daily sediment load. This correlation is shown, for example, in the data from a station on the Mississippi River (Fig. 5). An excellent correlation between total yearly water flow and total yearly sediment load also exists and is shown in Figure 6 for four river basins

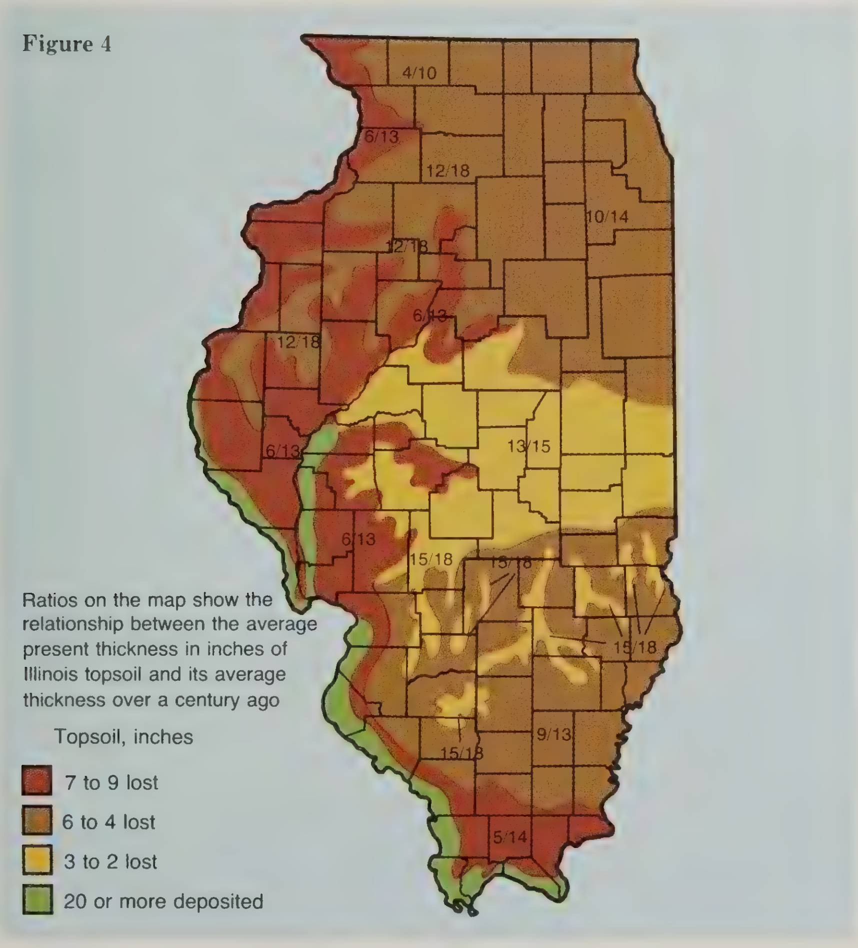


Figure 4. Average topsoil losses and ratio between present topsoil thickness and thickness over a century ago. Source: Illinois Environmental Protection Agency 1979.

where data for three or more years are available. Even at points of identical flow, however, sediment loads between rivers may vary considerably; an example of this variability can be seen in Figure 6, where the Spoon River carries a higher load than the Sangamon when identical flows are compared. Obviously, flow is not the only determinant of sediment load, and the variability among rivers suggests the importance of defining and evaluating the regional relationships that contribute to sediment load–such factors as basin gradient and composition and the nature and extent of human activity.

Based on physical, hydraulic, and geological factors, eleven sediment yield areas have been identified in Illinois (Fig. 7). The sediment load for a given stream in any area can be estimated based on the relationship between the average annual sediment load for that area and the drainage area of the basin at the point where the sediment load is to be estimated. Figure 7 shows these relationships for five of the eleven sediment yield areas. In general, streams in west and southwest Illinois, areas 3 and 4,

Figure 5

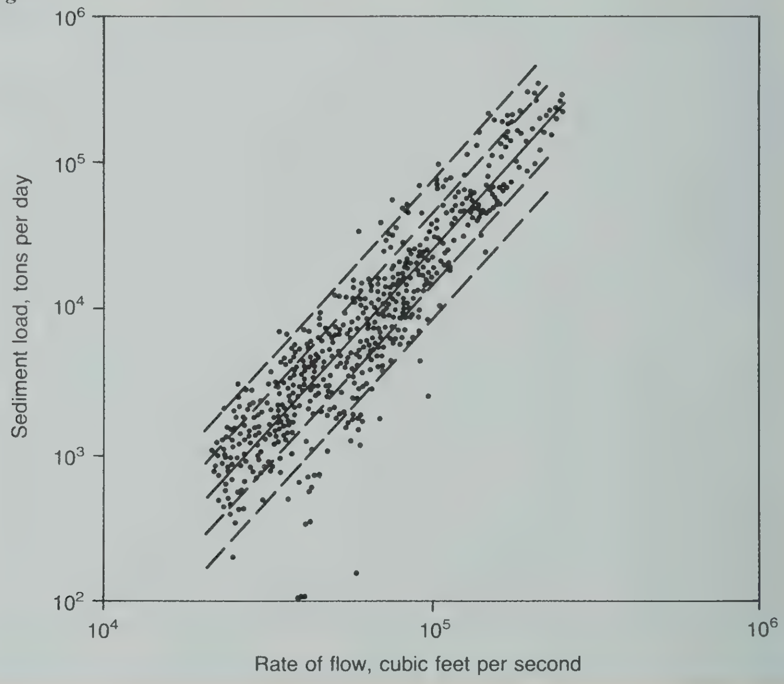


Figure 5. Correlation between rate of flow and sediment load for the Mississippi River at Keokuk, Iowa. Source: Illinois State Water Survey.

Figure 6

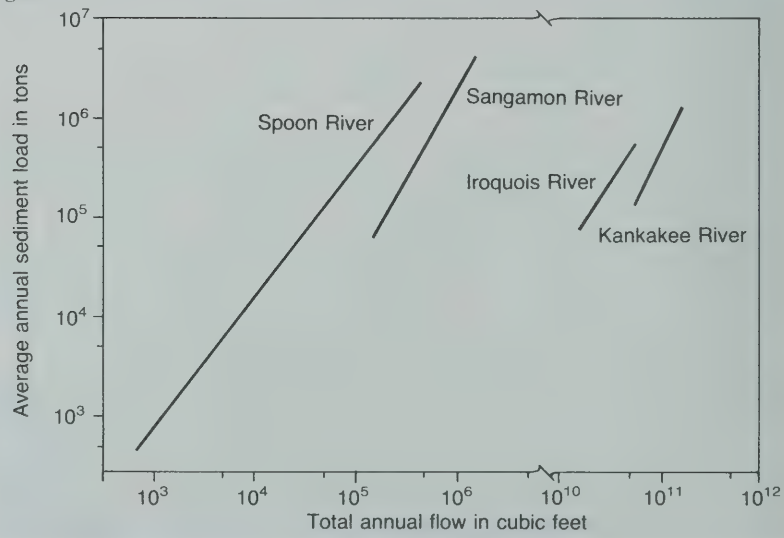


Figure 6. Relationship between average annual sediment load and total annual water flow for the Spoon, Sangamon, Iroquois, and Kankakee rivers. Source: Illinois State Water Survey.

carry higher sediment loads than streams in other regions. The lowest loads are carried by streams in regions 9, 10, and 11. Sediment loads in the remaining six areas fall between these highs and lows. Regional variability is a useful index in identifying areas of the State where topsoil losses are excessive or where aquatic habitats are threatened and where land conservation practices that reduce sediment loads should be implemented. *31, 37, 38, 39, 47, 134, 162, 191, 228, 237, 239, 240, 264, 271, 324, 379, 392, 421, 422, 455*

Lake Sedimentation

Soil erosion represents a major threat to the water resources of the State. Its impact on the quantity and quality of water stored in Illinois lakes is only beginning to be documented, however, as scientists examine the close relationship between watershed erosion and lake sedimentation.

In the 1930s the Water Survey in cooperation with other agencies initiated sedimentation surveys to evaluate the condition of Illinois lakes. Over the years, data have been accumulated from approximately 180 surveys of more than 130 man-made lakes located primarily in western and southern Illinois, where ground water is either unavailable or its use is economically infeasible. Approximately 15 backwater lakes along the Illinois River have also been surveyed. As Figure 8 shows, 5 of 85 lakes with drainage areas greater than one square mile are losing water-storage capacity by more than 2 percent each year. If this rate were to continue, these lakes would lose about 50 percent of their capacities in the next 25 years, although lakes tend to show a decreasing rate of loss with time.

Losses in water-storage capacity for Lake Springfield and Lake Decatur and for Mississippi River Pool 19 at Keokuk are shown in Figure 9.

Figure 7. Relationship between average annual sediment load and drainage area for the sediment yield areas of Illinois. Source: Illinois State Water Survey.

Figure 7

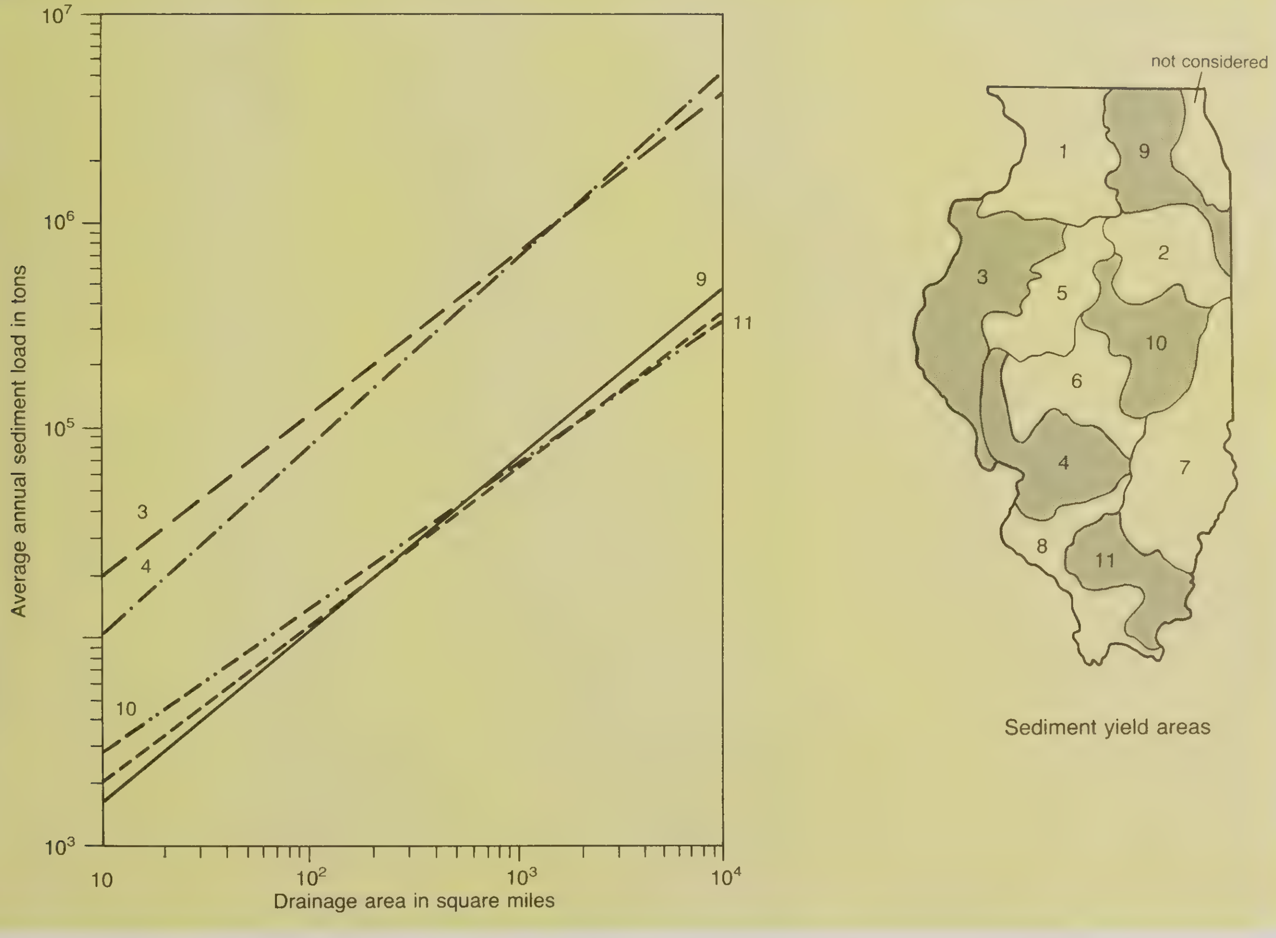


Figure 8. Storage capacity losses of Illinois lakes with drainage areas greater than one square mile. Source: Illinois State Water Survey.

Figure 8

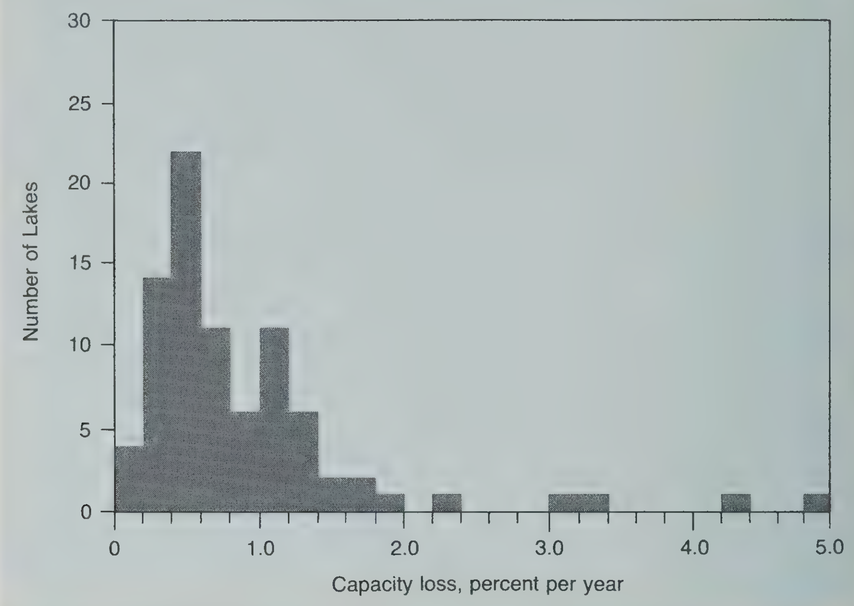


Figure 9. Capacity losses with time for Lake Springfield, Lake Decatur, and Mississippi River Pool 19. Source: Illinois State Water Survey.

Figure 9

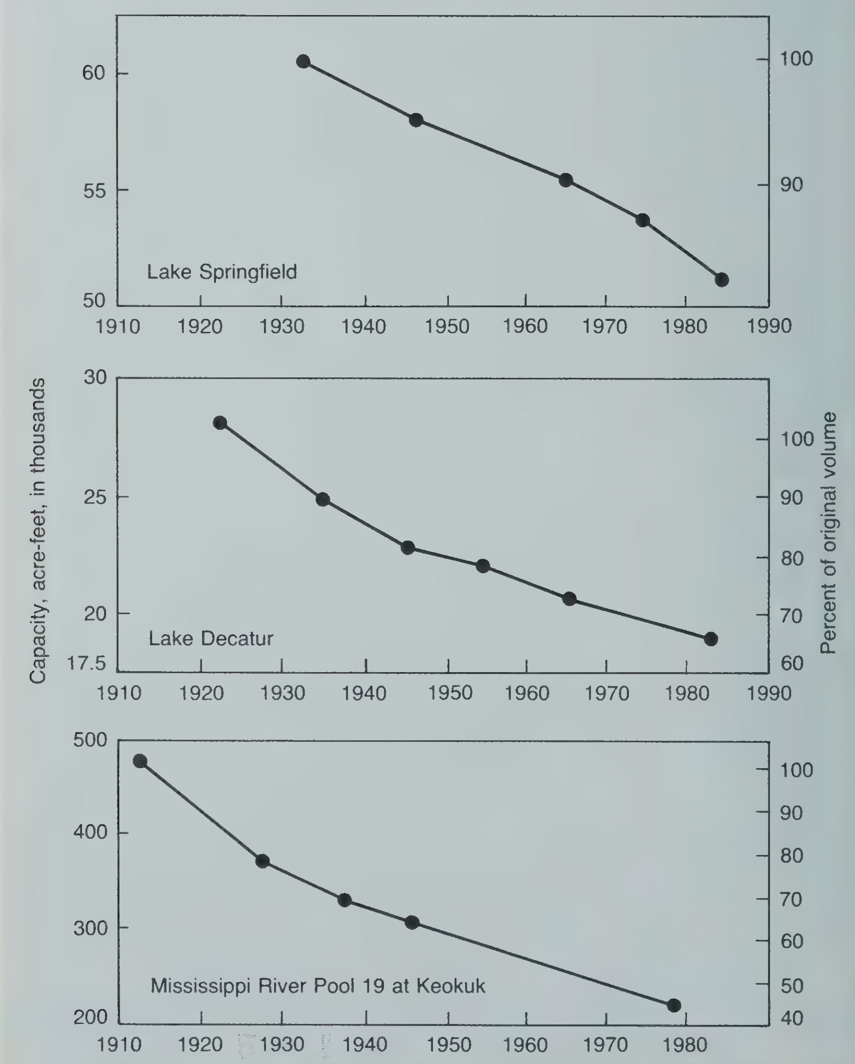


Figure 10

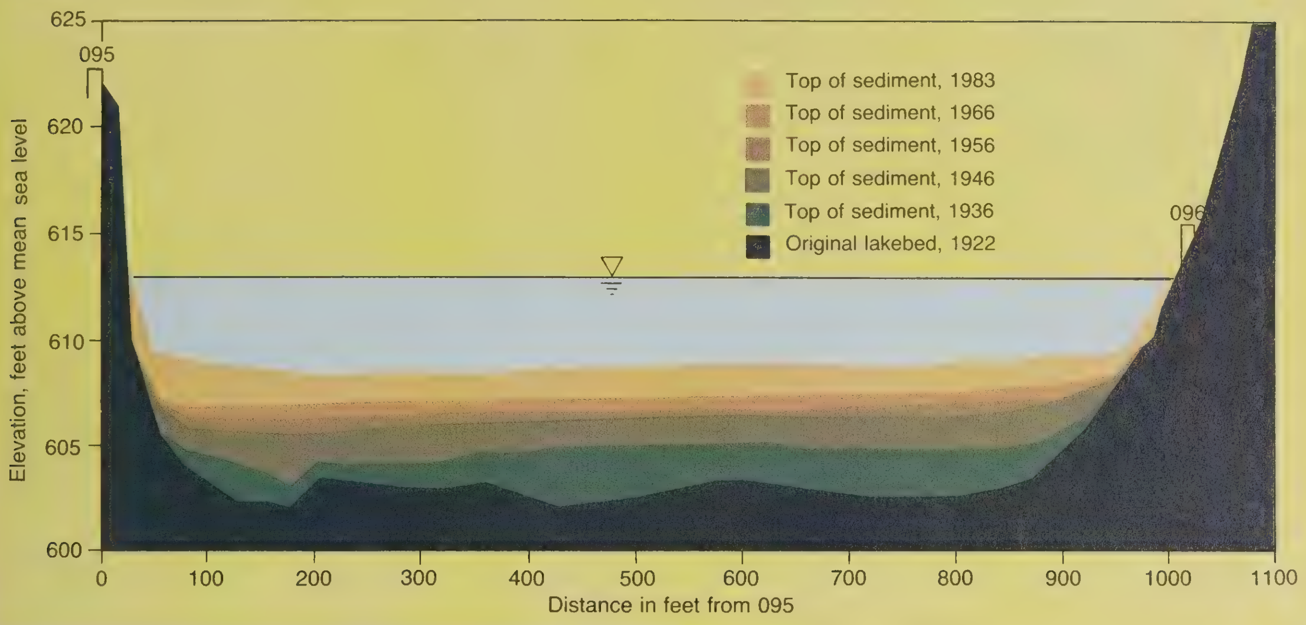


Figure 10. Sediment deposition over 50 years on cross section 095-096 of Lake Decatur. Source: Bogner et al. 1984.

Although the storage capacities of these man-made lakes continue to decrease, the rate of loss has slowed. All man-made lakes lose storage capacity more rapidly immediately after construction than they do later on. Lake Decatur, for example, lost about 20 percent of its volume in the first 24 years of its existence. Initially, a man-made lake has a higher storage capacity compared to the amount of water entering it than it will have later on. As a result, entering water is retained in the lake relatively longer and has more time to deposit its sediment. As the sediment level of the lake builds and its storage capacity decreases, however, entering water moves through the lake more rapidly and has less time to deposit its sediment. Eventually, when the sediment level is high enough and the storage capacity sufficiently reduced, virtually no sedimentation occurs; the lake, in fact, begins to act like a stream.

Figure 10 shows a cross section of Lake Decatur with lake-bed elevations plotted for the five sedimentation surveys taken between 1936 and 1983. In 1922 the maximum depth of the cross section was 10 feet; currently it is less than 5. An average of 3 feet of depth was lost during the first 24 years of the lake's existence; approximately 2.5 feet were lost in the next 37 years. Cross-section elevations changed little between 1946 and 1956, a phenomenon that can largely be attributed to the drought of the early 1950s. The impact of the drought was twofold. First, large portions of the lake bed became dry and the exposed sediments lost volume due to dehydration and compaction. As a result, the water-storage capacity of the lake increased. Second, inflow to the lake was very low during the drought and the amount of sediment brought by the river was substantially reduced. After the drought, these conditions tended to reverse themselves.

Figures 9 and 10 illustrate how long-term data enable us to manage our water resources more judiciously. Few new lakes are likely to be built in Illinois in the near future, and much of the State must depend on existing lakes for potable water. If severe droughts occur, many public water supply lakes may become dry or inadequate. Regular sedimentation surveys identify those lakes that are losing water-storage capacity at the fastest rate and can benefit most from rehabilitation. *45, 69, 157, 174, 354, 355, 361, 379*

Nani G. Bhowmik, Illinois State Water Survey

Evaporation from Natural Bodies of Water

On an average day, about 2,000 billion gallons of moisture flow over Illinois. Only about 5 percent of this moisture, or 100 billion gallons per day, precipitates. About 44 billion gallons of this precipitation are evaporated directly to the atmosphere from land and water surfaces.

Evaporation transforms water from its liquid or solid state to a water vapor or gas that mixes with the atmosphere. Evaporation includes sublimation, the transformation of snow and ice directly into water vapor. The rate of evaporation is controlled primarily by the temperature of water and land surfaces, the temperature of the air, the degree to which the air is saturated with moisture, and wind speed.

The annual evaporation from natural, free bodies of water in Illinois, those into which no artificial or extraneous heat has been introduced, varies from 32 to 38 inches (Fig. 1). The relatively uniform southward progression is primarily a result of increased solar radiation and higher temperatures. Although most man-made lakes are included in these data, cooling lakes used in conjunction with the generation of electric power are not. The recycled water returned to them has an inflated temperature, and as a result, evaporation from cooling lakes is greater. Natural convection is also

Figure 1

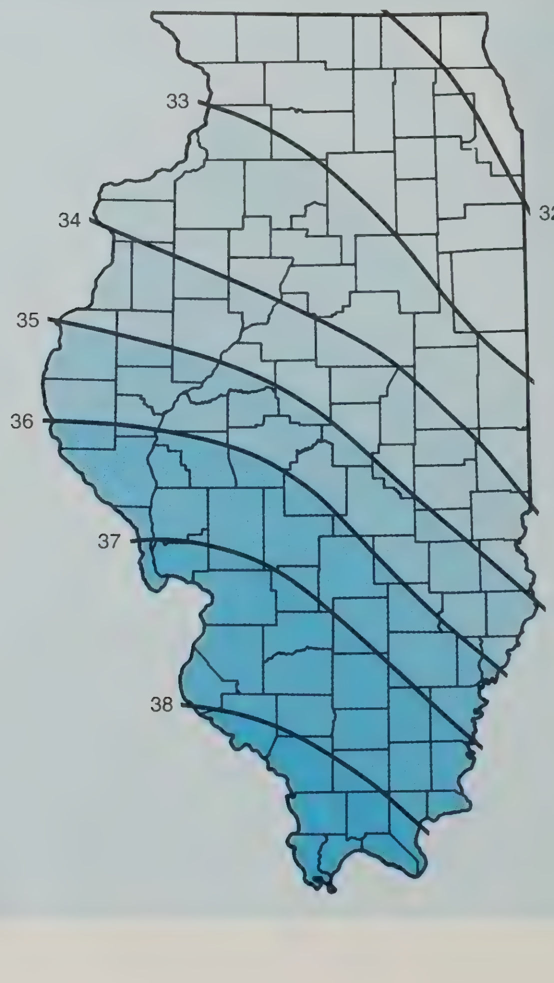


Figure 1. Annual evaporation in inches from natural water bodies. Source: Illinois State Water Survey.

inflated over cooling lakes since air rises over warmer surfaces. This effect is especially evident when the water temperature is greater than the air temperature and when the relative humidity of the air is low. Thus actual evaporation over cooling lakes is higher in all seasons, and especially in winter, than evaporation over natural water bodies.

During the warmer part of the year, from April through September, evaporation varies from 25 inches in the northeastern part of Illinois to nearly 29 inches in the southwest (Fig. 2a). During these six months, 75 to 80 percent of the annual evaporation takes place, and more water leaves the surface of water bodies in Illinois than enters them. During the colder months, October through March, when water recharges, only about 25 percent of the annual evaporation occurs (Fig. 2b), and water bodies replace the water lost during the summer.

Table 1 indicates the percent of annual evaporation that takes place each month in northern, central, and southern Illinois. Approximately 30 percent of the evaporation for an average year takes place during June and July throughout the State.

To compute evaporation in inches for a particular body of water during a particular month (or combination of months), the percent of evaporation for that month (or the sum of the percents for a combination of months) is multiplied by the annual average evaporation given in Figure 1. Assume, for example, that the body of water is located in the northern part of the State and that you wish to compute its evaporation loss for June and July. Begin by adding from Table 1 the percents of annual evaporation that occurred in June and July (15.7 + 15.9 = 31.6%). Next, convert this percent to a decimal (.316) and multiply by 32, the annual evaporation for water bodies in northern Illinois (Fig. 1). On average, then, about 10 inches of water will evaporate during June and July from a natural, free body of water situated in northern Illinois. *117, 118, 337*

John L. Vogel, Illinois State Water Survey

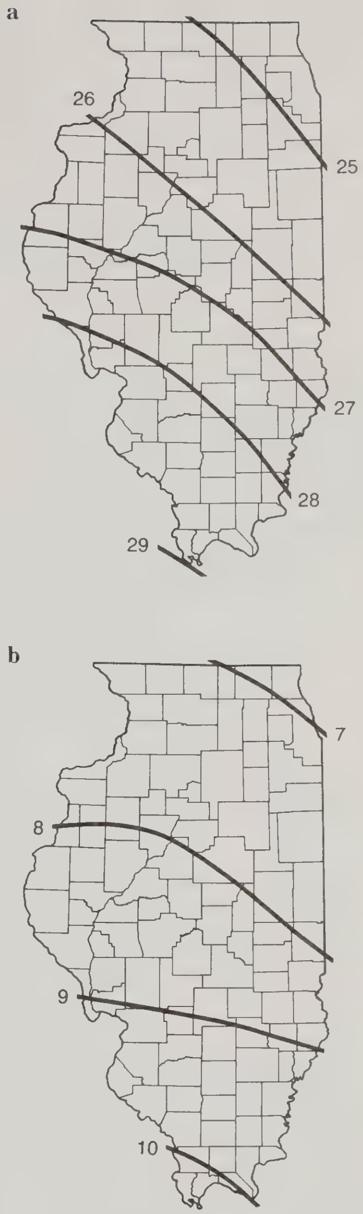


Figure 2. Evaporation in inches from natural water bodies: a. April through September and b. October through March. Source: Illinois State Water Survey.

Table 1. Percent of annual evaporation by month from natural water bodies in Illinois.

Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North	1.8	2.4	5.2	9.2	13.2	15.7	15.9	13.9	9.8	7.4	3.6	1.9
Central	2.1	2.6	5.2	9.2	13.9	15.2	15.3	12.6	10.2	7.4	4.0	2.2
South	2.5	3.2	5.8	9.7	12.9	14.5	14.8	13.2	9.8	7.1	3.9	2.6

Source: Illinois State Water Survey

Geological Resources

Geological resources have provided a source of wealth for Illinois since the State was created, and they have left their mark on the map of Illinois as well. Over fifty communities bear mineral names, from Galena in the northwest to Carbondale in the south. In addition, there are Coal City, Coaler, and Coalton; Oilfield, Oil Center, Derrick, and Petrolia; Quarry, Rock, Boulder, Sands, and Stones. Coal was the first major mineral industry in Illinois, with production under way as early as 1833. By the mid-nineteenth century, sizable operations had developed for clay, lime, silica sand, portland cement, tripoli, fluorspar, and building stone. As Illinois embarked on the twentieth century, oil and gas recovery increased, and major production was in progress before 1910.

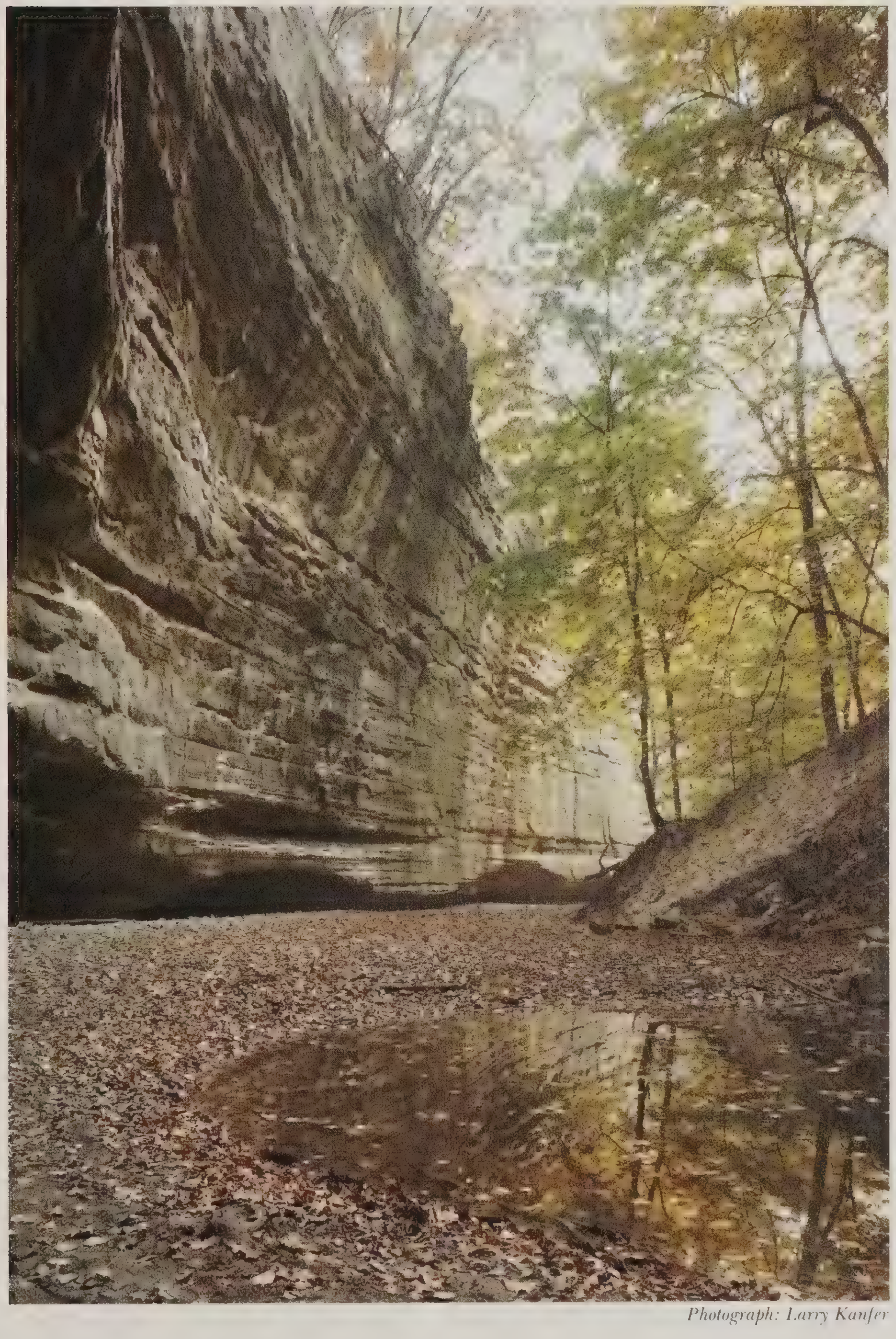
Illinois has achieved national stature as a mineral producer. One-tenth of the coal resources of the United States lies under Illinois soil. No state has larger reserves of bituminous coal, prized both for its high heating value and its richness in potentially useful chemicals. Currently, Illinois, with an annual production of 60 to 65 million tons, ranks fifth among coal-producing states. Given the fully developed transportation network of the State, its ample supplies of water, its proximity to industrial and population centers, and strong midwestern and southern markets, Illinois has the potential to assume an even larger role as a supplier of energy in the future.

Although coal is the major mineral industry of Illinois, the production of crude oil, natural gas, and minerals such as fluorspar and clay is significant. In 1984, the production of crude oil in Illinois was 28.9 million barrels, and the State ranked fourteenth among crude-oil producing states. New test holes drilled for oil and gas in 1984 numbered 2,732 and resulted in 1,575 oil wells, 21 gas wells, and 1,136 dry holes. Illinois leads the nation in the production of fluorspar, tripoli, and industrial sand and is one of the top five producers of stone, peat, and fuller's earth.

In 1983, the mineral industries of Illinois employed 158,900 persons. Mining, quarrying, and the extraction of oil and gas accounted for 24,100 of this number. The processing of minerals employed 90,400, and the manufacture of mineral products accounted for 44,400. The average hourly wage of these workers ranged from about $9 to slightly over $15.

The following pages review recently published data on Illinois mineral production. For more detailed studies of minerals and for other geologic information, the publications of the Illinois State Geological Survey, a division of the Illinois Department of Energy and Natural Resources, should be read on a continuing basis. *7, 15, 172, 208, 219, 272, 320, 333, 342, 409, 419, 433, 448, 449*

Heinz H. Damberger, Illinois State Geological Survey



Photograph: Larry Kanfer

Coal

About one-tenth of the total coal resources of the United States are found in Illinois. Only a few western states have more coal than Illinois, and no state has more bituminous coal with its relatively high heating value.

During the 1970s, the American public became acutely aware of the importance of reasonably priced, secure sources of energy. As a consequence, interest in the large domestic deposits of coal has grown substantially. Coal currently supplies only one-fifth of the nation's total energy demands, but since it represents over two-thirds of the fossil energy resources, it could contribute a much larger share. *94, 208, 209, 210, 223*

Major Seams

The coal-bearing rocks, or coal measures, of Illinois were deposited during the Pennsylvanian period 280 to 320 million years ago. The Pennsylvanian strata underlie about two-thirds of the State. Only the northern fourth of Illinois and narrow belts along the Mississippi, Ohio, and Illinois rivers have no Pennsylvanian rocks. The coal measures of Illinois extend into southwestern Indiana and western Kentucky as a single continuous coal field known as the Illinois Basin or Eastern Interior Coal Field (Fig. 1).

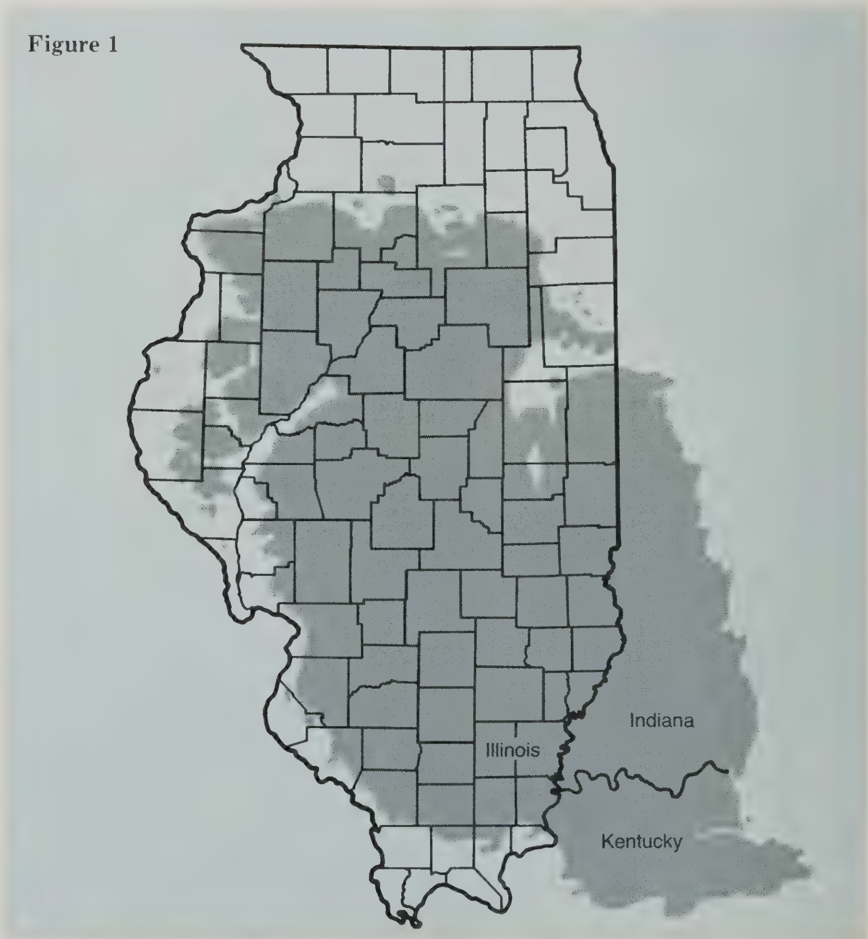
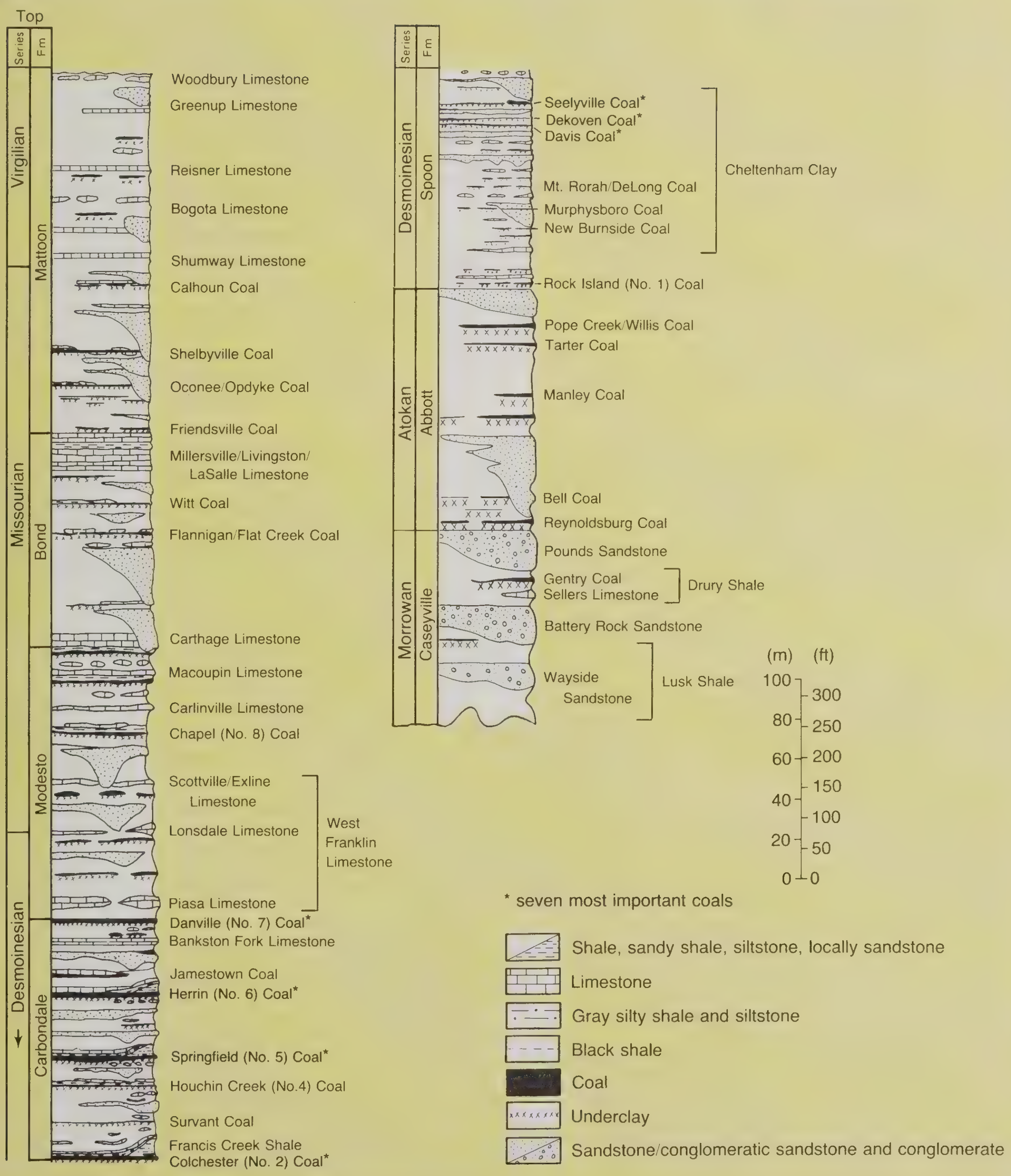


Figure 1. Illinois Basin or Eastern Interior Coal Field. Source: Illinois State Geological Survey, Coal Section.

Dozens of coal seams have been exploited commercially in Illinois, but only seven are important in terms of past and present production. Indicated by asterisks in Figure 2 and in order of geologic age, these seven are the Davis (oldest), Dekoven, Seelyville, Colchester (No. 2), Springfield (No. 5), Herrin (No. 6), and Danville (No. 7). The numbers derive from Amos Worthen's geological survey of Illinois in 1868. Worthen numbered the major minable seams, beginning with the geologically oldest or lowest coal as No. 1. The character and distribution of the principal coal seams in Illinois are discussed below in order of importance.

Figure 2. Rock sequence of coal-bearing strata of Illinois. This composite, generalized stratigraphic column of the Pennsylvanian System in Illinois shows the commonly thickest sections for each formation. Not all known units are shown, however, and not all units shown necessarily occur in the same section. Source: Illinois State Geological Survey, Coal Section.

Figure 2



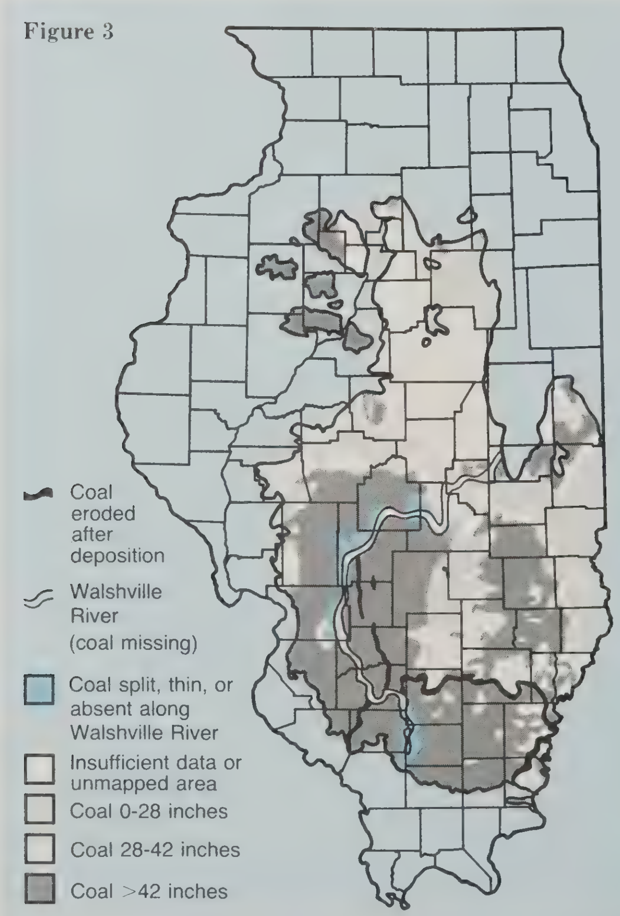
The Herrin (No. 6) Coal leads all seams in the State in resources and in total production. In recent years, this seam has accounted for approximately 80 percent of the coal mined in Illinois. Of the 74 billion tons of coal resources identified in this seam, 35 billion tons are judged to have a high potential for development.

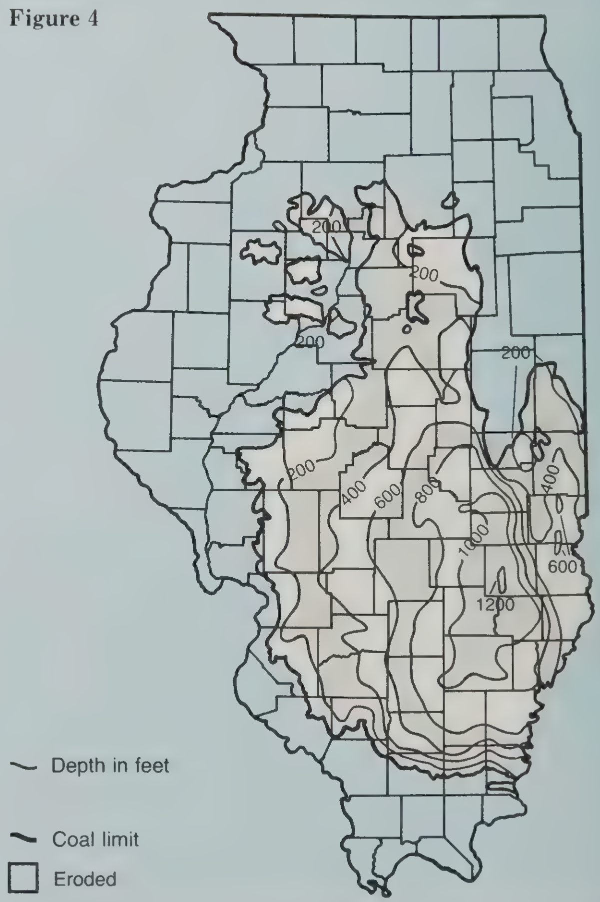
The most extensive resources of the Herrin seam underlie a large region of southern and west-central Illinois (Fig. 3). The coal is 6 or more feet thick over broad areas and locally may reach 15 feet. It is mined at the surface near the outcrops and underground at depths of 100 to 700 feet. The thickness and continuity of the seam allow many mines to sustain annual outputs of more than 1 million tons.

Large areas of thick coal in the Herrin seam have been mapped by geologists of the Illinois State Geological Survey from drill-hole data obtained in the deeper part of the Illinois Basin in southeastern and east-central Illinois (Fig. 3). The depth of this coal (700 to 1,200 feet) has thus far discouraged mining (Fig. 4). In much of Douglas and Vermilion counties in east-central Illinois, the Herrin seam is thicker than 6 feet and relatively shallow. Variations in thickness, quality, and roof stability have deterred mining in Vermilion County, but two large mines are active in Douglas County. Some of the coal is fairly low in sulfur, and about 220 million tons are strippable. Several large surface mines are operating in the Herrin seam in counties northwest of the Illinois River. The coal there is 3 to 6 feet thick and lies at a shallow depth. The presence of clay dikes and "white top" (clay mixed into coal) tends to raise the content of ash, which must be removed through cleaning. The heating value is the lowest among coals produced in Illinois, and the sulfur content high (3 to 4 percent). Proximity to market and easy mining conditions help to compensate for these disadvantages.

Figure 3. Generalized thickness of the Herrin (No. 6) Coal. Source: Illinois State Geological Survey, Coal Section.

Figure 4. Generalized depth of the Herrin (No. 6) Coal. The Springfield (No. 5) Coal lies 20 to 120 feet deeper; depth contours are very similar. Source: Illinois State Geological Survey, Coal Section.





The Springfield (No. 5) Coal, the second largest seam in Illinois, is also the second largest producer of coal. About 59 billion tons of coal resources are known to remain in the ground, of which almost 10 billion tons have a high potential for development. In neighboring Indiana and western Kentucky (Fig. 1) this seam is even more important and is mined extensively.

Major reserves that are currently minable remain in the Springfield seam (Fig. 5). Most of the active mines operate in the southeastern part of the State, where the coal seam was formerly referred to as Harrisburg (No. 5) Coal. The thickness of coal there averages about 4.5 feet but locally may exceed 8 feet. Another major area of relatively thick Springfield (No. 5) Coal occurs around the city of Springfield (Fig. 5), where considerable underground mining took place during the first half of the century. Coal deposits there range in thickness from 4.5 to 6 feet. The area has long been inactive until the recent opening of a new mine. Additional coal resources of the Springfield seam lie in Randolph and Perry counties in southwestern Illinois and in Peoria and Fulton counties in northwestern Illinois. In the southwest, the interval of rock between the Springfield and the Herrin is thin enough so that both seams can be taken together in surface mines. In northwestern Illinois, the coal occurs near the surface in large tracts suitable for major stripping operations. In recent years, areas previously mined for the shallower Herrin Coal have again become the target of mining, this time to extract the deeper Springfield Coal. Such renewed mining often leads to the reclamation of lands that in the past had received only limited reclamation. Large, untapped resources of the Springfield seam occur in south-central and east-central Illinois, north and west of the belt of low-sulfur coal where mining is concentrated. This coal is 2 to 6 or more feet thick (locally) and less than 200 to more than 1,000 feet deep (Fig. 4).

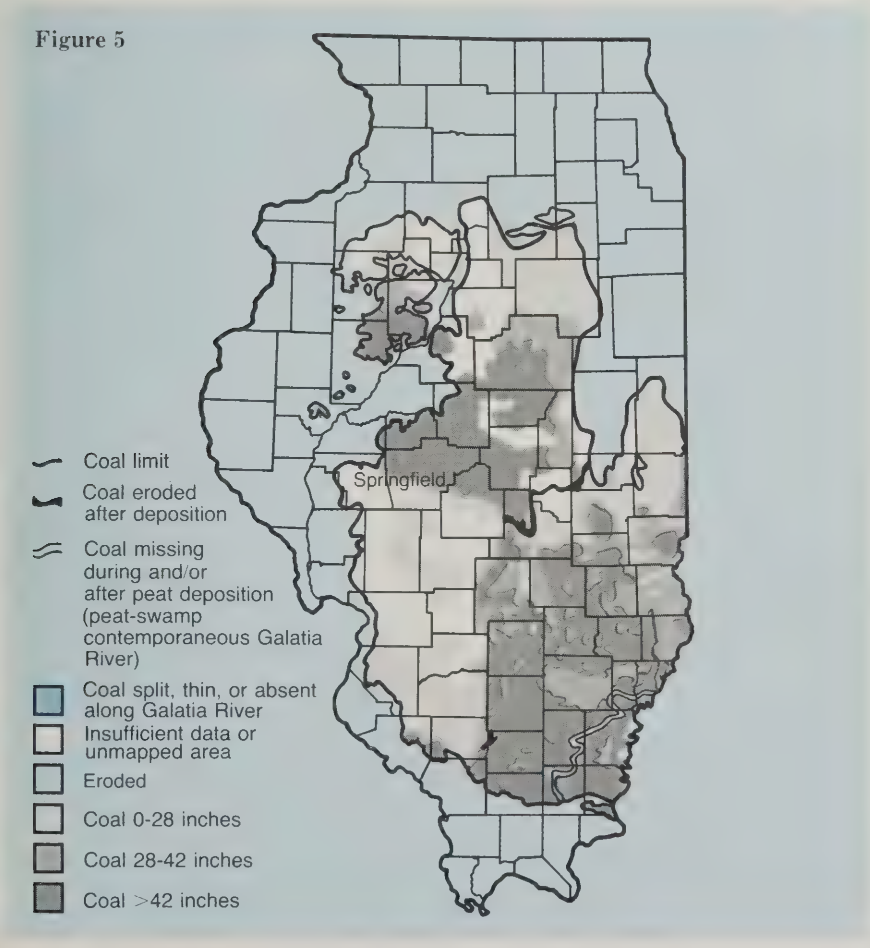


Figure 5. Generalized thickness of the Springfield (No. 5) Coal. Source: Illinois State Geological Survey, Coal Section.

While the Herrin and Springfield coals are by far the most important in terms of resources and current and past production, over 30 seams of at least local importance have been identified by geologists. Their occurrence and distribution were recently documented in a set of five statewide maps by the Illinois State Geological Survey (J. Treworgy and Bargh 1984). These seams are not evenly distributed over the approximately 3,000-foot thick sequence of coal-bearing rocks in Illinois, and most occur in the middle portion (Fig. 2). The Colchester (No. 2) Coal is extremely widespread, extending even beyond Illinois and the Illinois Basin, but it is generally too thin to warrant mining under current economic conditions. Only two medium-sized strip mines are presently exploiting this seam. The Davis and Dekoven coals occur close together, and their cumulative coal thickness is 6 to 7 feet. They have been extensively surface-mined in southeastern Illinois, and one mine has been active for many years in southern Illinois, straddling the boundary between Williamson and Saline counties. These two coals have recently been shown to be equivalent to the Seelyville Coal of east-central Illinois, a seam that has substantial remaining resources (C. Treworgy 1981). The Danville (No. 7) Coal was formerly the target of both surface and underground mining around Danville in eastern Illinois and locally in LaSalle, Livingston, McLean, and Marshall counties southwest of Chicago. In southern Illinois, the Danville Coal is too thin to be minable on its own, but it is sometimes recovered in surface mines together with the Herrin (No. 6) Coal. The Rock Island (No. 1) Coal of northwestern Illinois for many years provided the basis for a locally important industry in Rock Island and several adjacent counties. This seam does not persist in minable thickness over large areas, a prerequisite for modern large-scale mining. Coals such as the Reynoldsburg, Bell, and Murphysboro of southern Illinois and the Houchin Creek, formerly Summum (No. 4), Coal of northern Illinois have sustained locally important coal mines. Other coals identified in Figure 2 have at times been mined locally or have the potential to support mining in the future. *14, 66, 93, 140, 141, 187, 208, 241, 327, 393, 398, 447*

Sulfur Content

Most coal in Illinois has sulfur contents of 3 to 5 percent, a percentage that is considered high. Nationally, coal with sulfur contents below about 1 percent is generally referred to as low-sulfur coal. Such coal has been found only in very restricted areas of Illinois; however, coal with sulfur contents below about 2.5 percent and averaging 1.5 to 2.0 percent has been found over more extensive areas of the State and has been preferentially exploited for many years. Such coal is "low-sulfur coal" relative to most coal in Illinois; on a national basis, however, it would more appropriately be referred to as medium-sulfur coal.

Of particular importance is the Quality Circle of southern Illinois, a coal-bearing region that extends over parts of Williamson, Franklin, and Jefferson counties (Fig. 6). The Herrin (No. 6) Coal of the Quality Circle is consistently thick (over 6 feet, reaching 15 feet locally) and has sulfur contents as low as 0.5 to 0.7 percent. Although much of this premium coal has been mined, about 400 million tons remain in the ground. Most of these coal resources are already spoken for by currently active mines of the Quality Circle.

Until fairly recently, geologists did not fully understand why low-sulfur coal occurred in areas of such limited extent, seemingly randomly distributed. Geologists had recognized that low-sulfur coal is always overlain by gray shales, siltstones, and sandstone rather than by the black shales and limestones that usually overlie high-sulfur coal (e.g., Cady et al. 1952, p. 35). Work by Hopkins (1968) on the Springfield (No. 5) Coal of southeastern Illinois and particularly by Johnson (1972) on the Herrin (No. 6) Coal of southwestern Illinois demonstrated a close relationship between major ancient rivers and the low-sulfur coal areas. These rivers once flowed through the extensive Springfield and Herrin peat swamps that gave birth to these coals through the accumulation of peat over many 10,000s of years. Near the end of peat-forming times, these ancient rivers breached their natural levees in a number of places and dumped thick layers of mud, silt, and sand on the peat, often in the shape of small deltas. These muds provided protection against the sulfur-bearing seawater that later invaded the vast peat swamps. Without that protective layer of mud, sulfur is picked up by peat and incorporated into its organic structure; sulfur is also used by sulfur bacteria, which form colonies in peat and transform the sulfate of seawater to sulfide. Through a number of transitions, the bacterially reduced sulfur ultimately ends up as tiny sphere-shaped "framboids" made up of numerous small pyrite crystals (iron sulfide). Only a few tens to hundreds of microns in diameter, these tiny pyrite framboids are finely disseminated throughout the coal and are extremely difficult to separate in coal preparation plants. This pickup of sulfur from seawater does not occur, however, when a protective cover of at least 20 feet of river-derived gray shales is present.

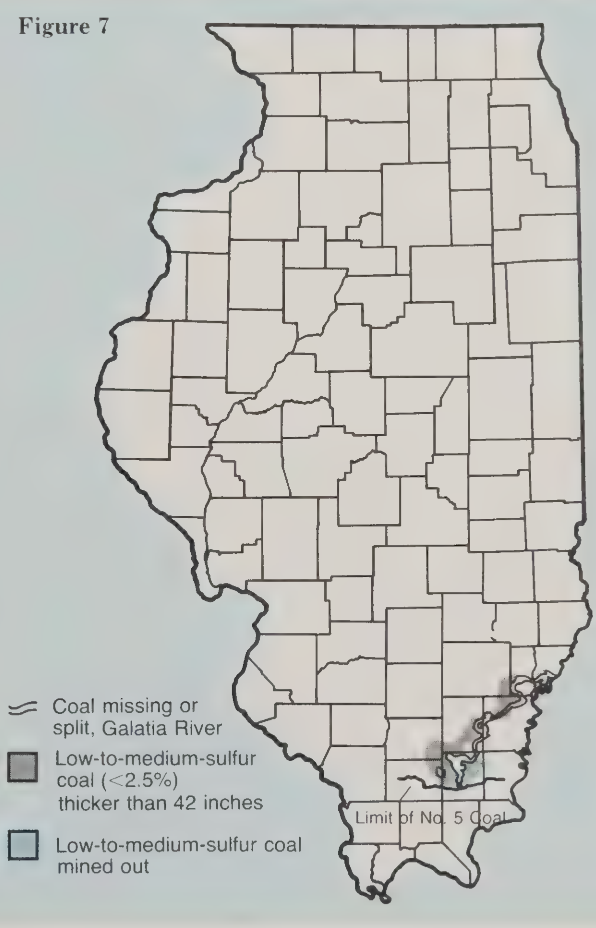
This new insight into sulfur deposition has enabled geologists to look with greater precision for areas with low-to-medium-sulfur coal. The course of the Walshville River in the Herrin Coal has now been mapped from Indiana, where the coal crops out of the surface, through east-central and western Illinois to the cropline of the Herrin Coal in southern Illinois (Fig. 6). Several areas with river-derived sediments of gray shale, siltstone, and sandstone have been identified along the river and are collectively referred to as Energy Shale. They tend to occur on the outside of major turns of the river, as one might expect. The Galatia River in the Springfield Coal of southeastern Illinois (Fig. 7) meanders more than the Walshville River and is accompanied by a broad band of river-derived gray shales, siltstone, and sandstones collectively called Dykesburg Shale. Since the Illinois State Geological Survey published its report on this low-sulfur coal (Hopkins 1968), three major mines have been constructed in the area. Their combined

Figure 6. Occurrence of low-to-medium-sulfur coal in the Herrin (No. 6) Coal. Source: Illinois State Geological Survey, Coal Section.

Figure 7. Occurrence of low-to-medium-sulfur coal in the Springfield (No. 5) Coal. Source: Illinois State Geological Survey, Coal Section.

Figure 6

Figure 7



annual capacity is 6.6 million tons of coal. Rivers that coexisted with peat swamps are known or suspected to have existed in several other important coal seams–the Murphysboro Coal of southwestern Illinois (Jacobson 1983), the Danville (No. 7) Coal of east-central Illinois and adjacent Indiana, and the Colchester (No. 2) Coal southwest of Chicago (C. Treworgy and Jacobson 1985).

To date, geologists at the Illinois State Geological Survey have identified almost 10 billion tons of coal resources that should prove to have low-to-moderate-sulfur contents. About 3.7 billion tons are considered to have a high potential for development under current economic conditions (C. Treworgy and Bargh 1982). About 3 billion tons occur in the Herrin Coal alone. As in the past, these resources can be expected to be mined preferentially in the future. *67, 142, 187, 230, 232, 394, 396*

Coal Resources and Their Potential for Development

Approximately 181 billion tons of coal resources have been identified in Illinois by the State Geological Survey. The majority is classified as deep-minable (underground) coal; that is, coal more than 28 inches thick and deeper than 150 feet. About 20 billion tons are surface-minable (strippable); such coal is more than 18 inches thick and no deeper than 150 feet. These coal resources are listed by county and major seam in Table 1.

Table 1. Identified remaining coal resources of Illinois in millions of tons by county and coal seam, January 1976.

								Resources		Reserves[a]	
County	Danville (No. 7)	Herrin (No. 6)	Springfield (No. 5)	Colchester (No. 2)	Dekoven	Davis	Misc.	Total	Surface Minable	Total	Surface Minable
Adams				619				619	619	76	76
Bond		2,365		2			2	2,369	0	1,551	
Brown				386				386	386	0	0
Bureau	370	628		599				1,597	450	260	150
Calhoun				15				15	15	0	0
Cass			105	189				294	294	2	2
Champaign	108	197						305	0	221	
Christian	55	3,362	1,236				41	4,693	0	3,481	
Clark	1,008	51	1,266				1,596	3,921	0	292	
Clay		2,046	1,980				37	4,063	0	17	
Clinton		3,132						3,132	0	2,150	
Coles	320	635	644				736	2,335	0	0	
Crawford	1,217	983	1,303				3,553	7,055	43	682	21
Cumberland		1,719	1,160				1,322	4,200	2	125	2
DeWitt			1,511					1,511	0	0	
Douglas		1,009	120					1,129	0	543	
Edgar	1,223	811	556				893	3,484	154	908	64
Edwards		903	1,084					1,987	0	309	
Effingham		1,191	1,981				385	3,556	1	92	0
Fayette	292	3,400	2,261				2	5,955	2	1,992	0
Franklin		1,534	2,050		345	503	67	4,499	3	1,339	0
Fulton	59	241	669	1,305			5	2,278	1,986	672	672
Gallatin		862	1,270		615	830	2	3,579	232	517	52
Greene		97		584				681	598	226	226
Grundy				691			37	727	348	25	25
Hamilton		2,559	2,386		4	5		4,953	0	1,428	
Hancock				30				30	30	29	29
Henderson				53				53	53	0	0
Henry	59	255		253			64	632	622	201	201
Jackson		122	243				141	506	362	244	183

Table 1. Continued.

County	Danville (No. 7)	Herrin (No. 6)	Springfield (No. 5)	Colchester (No. 2)	Dekoven	Davis	Misc.	Resources Total	Resources Surface Minable	Reserves[a] Total	Reserves[a] Surface Minable
Jasper		2,576	1,995				2,151	6,722	0	124	
Jefferson		2,686	2,844				25	5,554	25	1,281	23
Jersey		57		274				331	220	84	84
Kankakee				51			15	67	25	0	0
Knox	3	225	623	803			56	1,710	1,548	520	520
LaSalle	477	168		1,251				1,895	280	28	21
Lawrence	1,026	988	1,473				1,874	5,361	0	88	
Livingston	1,300	29		1,502			10	2,841	49	416	20
Logan		272	2,521					2,793	0	1,977	
McDonough				584				584	584	78	78
McLean	583		3,959	287				4,829	0	189	
Macon		366	1,574					1,941	0	415	
Macoupin	13	3,616		1,485		125	737	5,975	276	3,048	82
Madison		2,115		228		6	9	2,357	615	1,430	252
Marion		1,830	2,456					4,286	0	190	
Marshall	357	7		432				796	116	0	0
Menard			1,412					1,412	541	872	43
Mercer				15			54	69	69	0	0
Monroe		7						7	7	0	0
Montgomery	48	3,673		592		121	738	5,171	0	3,466	
Morgan		711		1,068				1,780	828	113	62
Moultrie		447						447	0	17	
Peoria	283	1,038	943	431				2,695	2,146	642	642
Perry		1,971	379					2,349	904	1,868	650
Piatt			1,308					1,308	0	0	
Pike				144				144	144	16	16
Putnam	214	78		383				674	0	5	
Randolph		350	162					512	381	342	223
Richland	452	1,812	1,673				149	4,086	5	7	0
Rock Island							42	42	42	0	0
St. Clair		2,218						2,218	1,040	1,381	427
Saline	78	1,293	858		673	999	12	3,912	503	1,202	172
Sangamon		1,962	2,958				214	5,135	418	3,426	110
Schuyler			107	606				713	713	191	191
Scott		6		249				256	227	30	30
Shelby	123	2,661	1,919				297	4,999	85	1,611	27
Stark	58	458		26				541	515	268	268
Tazewell	4	277	425	186				892	150	173	0
Vermilion	1,857	1,791					21	3,668	604	2,144	146
Wabash		898	1,147				158	2,203	158	564	136
Warren			1	363			39	403	403	55	55
Washington		3,736						3,736	0	3,503	
Wayne		2,840	2,913					5,753	0	79	
White		2,119	2,311		12	12		4,454	0	296	
Will				13				13	13	0	0
Williamson	57	597	900		684	341	40	2,621	589	449	110
Woodford	39		139	503				680	0	0	
Total	11,680	73,978	58,825	16,202	2,333	2,940	15,525	181,484	20,426	49,941	6,092

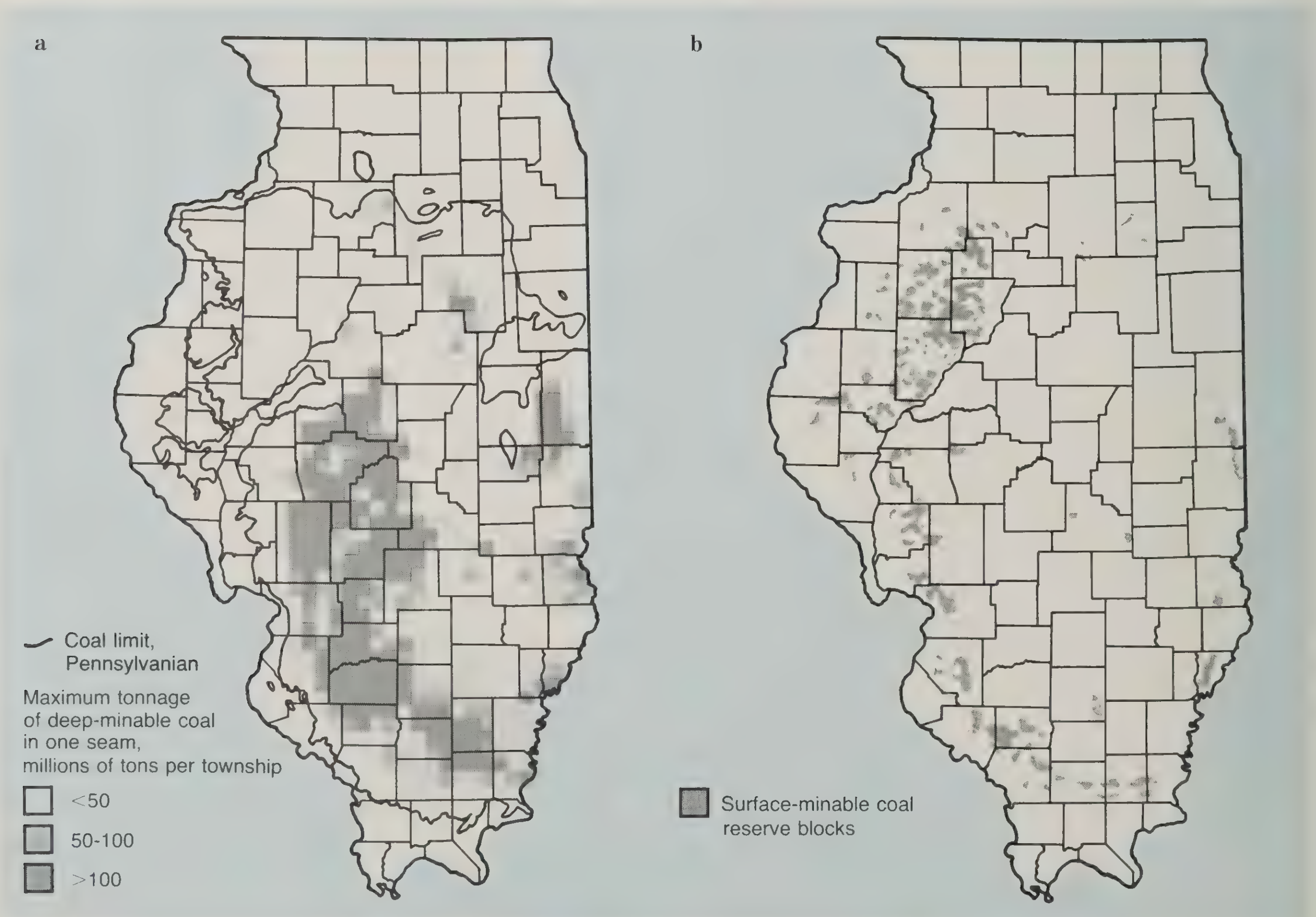
[a]Coal with high current potential for development.

Source: Illinois State Geological Survey, Coal Section; Keystone Coal Industry Manual 1985

The term *resources* refers to all coal in the ground and includes much that cannot be mined economically at the present time. For instance, no coal less than about 4 to 4.5 feet thick is currently deep-mined in Illinois; yet coal down to about 2.5 feet thick is included in the identified deep-minable resources. Recent studies by the Illinois State Geological Survey show that about 50 billion of the 181 billion tons of coal resources are comparable to seams currently mined in thickness, depth, size of reserve block, and ratio of overburden to seam thickness. Although such coal can be classified as having a high potential for development, much of it will remain undeveloped for many decades to come. Much less than 1 percent of coal with high development potential is currently mined each year or rendered unminable as a result of current mining practices. Table 1 and Figure 8 provide more information on the distribution of coal resources over counties and seams.

Deep-minable coal resources underlie 67 Illinois counties (Table 1) and vary from 10 million tons in Henry County to over 6 billion tons in Jasper County. While total deep-minable resources are distributed relatively evenly over a large area, the distribution changes significantly when only resources with high potential for development are shown (Fig. 8a). A township with more than 100 million tons of such coal could probably support a large underground mine (2 million tons per year for 25 years). A township with less than 50 million tons probably could not, by itself, support a modern underground mine; however, if the coal were contiguous with coal of similar quality in an adjacent township, sufficient tonnage might be present to support a mine. Resources with high development potential in reserve blocks large enough to support large underground mines are concentrated in the west-central, southwestern, and southern parts of the State. These have been and are now the major areas of underground mining in Illinois. More than 80 percent of current production is from these underground mines, and no significant change is expected.

Figure 8. Areas with coal resources of high potential for development: a. deep-minable coal and b. surface-minable coal. Source: Treworgy et al. 1978; Treworgy and Bargh 1982.



The Illinois State Geological Survey has identified more than 20 billion tons of surface-minable coal resources (thicker than 18 inches, no deeper than 150 feet) (C. Treworgy et al. 1978). These deposits are distributed throughout 52 counties but are primarily found in the southern and western areas of the State (Fig. 8b, Table 1). Approximately 6 billion tons (30 percent) of these deposits have characteristics similar to deposits currently mined and, therefore, are considered to have high potential for development.

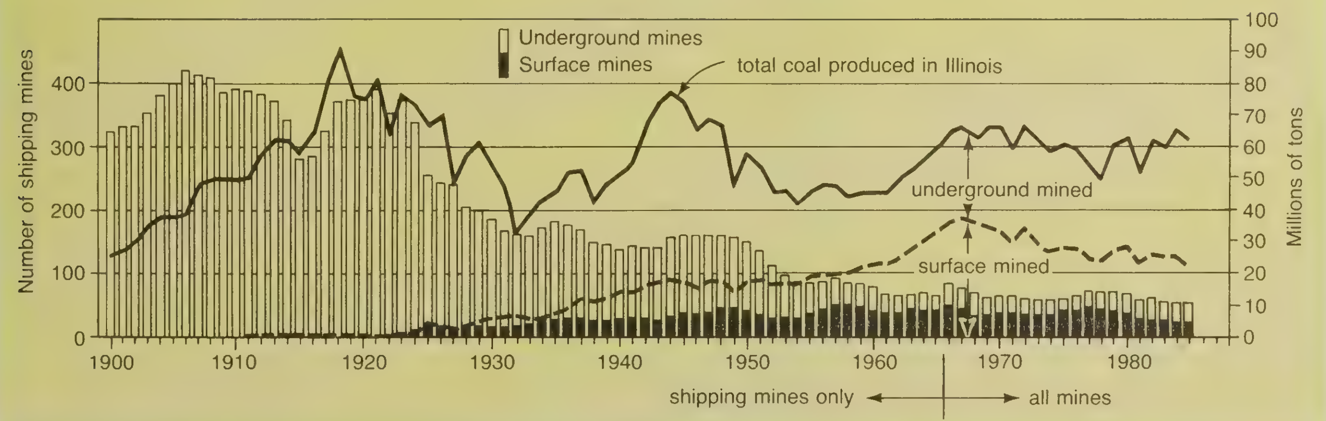
Surface-minable coal resources with a high potential for development are found in 38 counties. Fulton, Perry, Peoria, Knox, and St. Clair counties have the largest resources, although large quantities are also found in Stark, Madison, Greene, and Randolph counties. In 1984, only 11 of these 38 counties had active surface mines; 20 have never had large surface mines. In those counties that do not now have active surface mines, deposits of coal with high potential for development are generally thinner than the average thickness of deposits currently being mined. About 75 percent of the State's production from surface mines currently comes from southwestern and southern Illinois; the other 25 percent comes from Fulton, Peoria, and McDonough counties in western Illinois. In general, southwestern and southern Illinois are more suitable for surface mining than other areas of the State because land values are lower, the heating value of the coal is higher, and the number of tons recoverable per acre is greater. These southern coal resources of high development potential will probably continue to be the major source for surface-mined coal in the State. *34, 35, 67, 101, 140, 187, 208, 283, 284, 302, 316, 327, 373, 394, 395, 411*

Trends in Production

With the beginning of industrialization in the mid-1800s, the significant development of Illinois coal resources became possible. Construction of the railroads during the middle and late nineteenth century allowed the establishment of large shipping mines as opposed to local mines that produced for local consumption. Railroads not only hauled vast amounts of coal to industrial customers but also bought large quantities to fuel their locomotives. The total production of all mines in Illinois rose dramatically, from less than 10 million tons in 1886 to an all-time high of 90 million tons in 1918, the final year of World War I (Fig. 9). Output declined to less than half of that high during the economic depression of the 1930s. During World War II, demand for coal surged and production increased to more than 70 million tons. Illinois shared in the nationwide slump of the coal market during the 1950s. Major factors in this decline included the conversion of railway locomotives from steam to diesel power and the change from coal to oil and natural gas for home heating and industrial use. The resurgence of coal mining in the 1960s and 1970s reflected a major increase in the use of coal for generating electricity. Today, with the exception of approximately

Figure 9. Trends in coal production in Illinois, 1900-1985. Source: Illinois Department of Mines and Minerals, Annual Coal, Oil and Gas Reports; Illinois State Geological Survey, Mineral Economics Section.

Figure 9



2.5 to 3 million tons of coking coal, a few million tons of coal used by industry, and an insignificant tonnage sold for domestic use (mainly to miners and their families), nearly all of the coal mined in Illinois is burned in large generating stations.

Figure 9 also indicates that surface mining is a relatively recent development in the history of Illinois coal. Although the first recorded surface mine in the United States opened in 1866 near Danville in Vermilion County, only with the introduction of steam shovels to remove the overburden did surface mining begin to realize its potential. From 0.6 percent of total production around 1920, surface mining increased until it accounted for nearly half the output of coal in the mid-sixties. Since then, surface mining has slowly declined, although it continues to contribute over 40 percent of production. Table 2 indicates the Illinois acreage affected by surface mining

Table 2. Acreage affected by surface mining of coal in Illinois through June 30, 1984.

County	Acreage affected	Percent of county affected
Adams	228.00	0.04
Brown	54.10	0.03
Bureau	3,135.00	0.56
Clark	3.00	0.0009
Crawford	20.70	0.007
Edgar	51.00	0.01
Franklin	85.00	0.03
Fulton	52,535.47	9.39
Gallatin	2,786.66	1.32
Greene	56.00	0.016
Grundy	7,289.72	2.66
Hancock	101.00	0.02
Henry	2,676.00	0.51
Jackson	7,722.50	2.00
Jefferson	2,809.24	0.75
Jersey	1.00	0.0004
Johnson	82.05	0.037
Kankakee	2,160.00	0.49
Knox	21,665.69	4.70
LaSalle	1,213.00	0.16
Livingston	46.00	0.007
Madison	7.00	0.001
Marshall	1.00	0.0004
McDonough	507.00	0.14
Menard	6.00	0.003
Mercer	25.00	0.007
Morgan	4.00	0.001
Peoria	9,658.78	2.39
Perry	42,916.00	15.14
Pike	1.00	0.0002
Pope	53.24	0.02
Randolph	14,114.35	3.65
Saline	13,471.74	5.44
Schuyler	2,363.00	0.85
Scott	1.00	0.0006
Stark	2,686.39	1.45
St. Clair	14,799.60	3.36
Vermilion	5,359.70	0.93
Wabash	10.00	0.007
Will	6,322.36	1.17
Williamson	18,561.45	5.56
Illinois	235,589.74	0.65

Source: Illinois Department of Mines and Minerals Annual Coal, Oil and Gas Report, 1984 for coal as recently as 1984. After more than 100 years of surface mining, a total of 236,000 acres, less than 1 percent of the surface of the State, has been disturbed.

Surface mining has many advantages over underground mining. Less coal is wasted; recovery runs from 85 to 95 percent compared to 45 to 85 percent in underground mines. Productivity, measured in tons of coal mined per worker per day, is much higher in surface than in underground mines. Surface mines are also safer places in which to work. Accident rates are typically half those in underground mines, fires and explosions of gas and coal dust do not occur, and miners do not risk contracting black lung.

The most significant recent changes in surface mining have resulted from the enactment of laws requiring reclamation of mined land. The first such laws appeared in Illinois in the early 1960s. Today mining is governed by a complex and detailed body of federal, state, and sometimes county regulations; their overall intent is to ensure that land is returned to its premining use and productivity. As a result, restoration of the land is no longer an afterthought but must be treated as an integral part of the mining process.

Seventy-three of the 102 counties in Illinois have produced coal at one time or another (Fig. 10), and production figures as far back as 1882 are available for most of these counties from the Illinois Department of Mines and Minerals. From year to year, the number of producing counties and producing mines fluctuates as certain areas are mined out and others are developed. In 1984, 22 counties reported coal production (Table 3, Fig. 11). Five counties (Perry, Franklin, Saline, Randolph, and Williamson) ac-

Table 3. Illinois coal production in tons by county, 1984.

County	No. of mines	Underground	Surface	Total	Value[a]
Christian	1[b]	3,009,648	—	3,009,648	89,958,379
Clinton	1	3,275,349	—	3,275,349	97,900,182
Douglas	2	1,518,639	—	1,518,639	45,392,120
Franklin	4	7,788,141	—	7,788,141	232,787,534
Fulton	2	—	1,066,545	1,066,545	31,879,030
Gallatin	4	1,315,716	124,493	1,440,209	43,047,847
Hamilton	1	971,743	—	971,743	29,045,398
Jackson	1	—	2,276,639	2,276,639	68,048,740
Jefferson	2	3,767,447	—	3,767,447	112,608,991
Logan	1	828,897	—	828,897	24,775,731
Macoupin	2	3,395,459	—	3,395,459	101,490,269
McDonough	1	—	487,367	487,367	14,567,400
Peoria	1	—	393,492	393,492	11,761,476
Perry	6	4,077	14,991,560	14,995,637	448,219,590
Randolph	3	3,359,127	877,300	4,236,427	126,626,803
St. Clair	2	1,605,856	640,865	2,246,721	67,154,491
Saline	9	3,609,225	1,582,086	5,191,311	155,168,286
Vermilion	1	156,779	—	156,779	4,686,124
Wabash	1	2,544,916	—	2,544,916	76,067,539
Washington	1	1,475,100	—	1,475,100	44,090,739
White	1	231,452	—	231,452	6,918,100
Williamson	5[c]	1,087,916	2,903,357	3,991,273	119,299,150
Illinois	52	39,945,487	25,343,704	65,289,191	1,951,493,919

[a] Value calculated at an average of $29.89 per ton.
[b] One mine operated at junction of Christian, Montgomery, and Sangamon counties; all production placed in the county where tipple is located.
[c] One mine operated at junction of Williamson and Saline counties; all production placed in the county where tipple is located.

Source: Illinois State Geological Survey, Illinois Mineral Notes, and Illinois State Department of Mines and Minerals Annual Coal, Oil and Gas Report, 1984 counted for 55 percent of that production. Perry, the leading coal-producing county, was responsible for 59 percent of the surface-mined coal in Illinois. Underground mining is similarly concentrated. Franklin County leads all others with 7.8 million tons produced in 1984, about 20 percent of total deep-mined coal. *31, 34, 35, 60, 94, 208, 283, 302, 327, 373*

Heinz H. Damberger, Illinois State Geological Survey

Figure 10

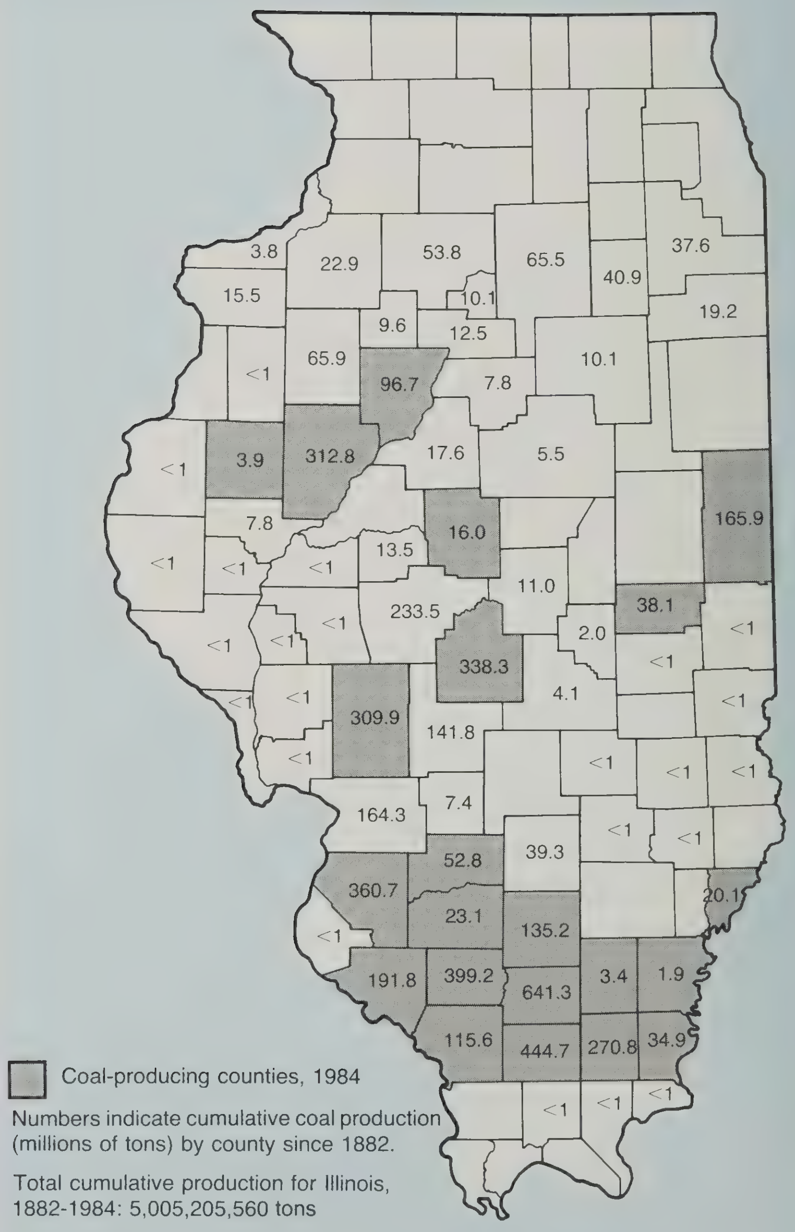


Figure 10. Cumulative coal production by county, 1882-1984. Source: Illinois Department of Mines and Minerals, Annual Coal, Oil and Gas Reports.

Figure 11

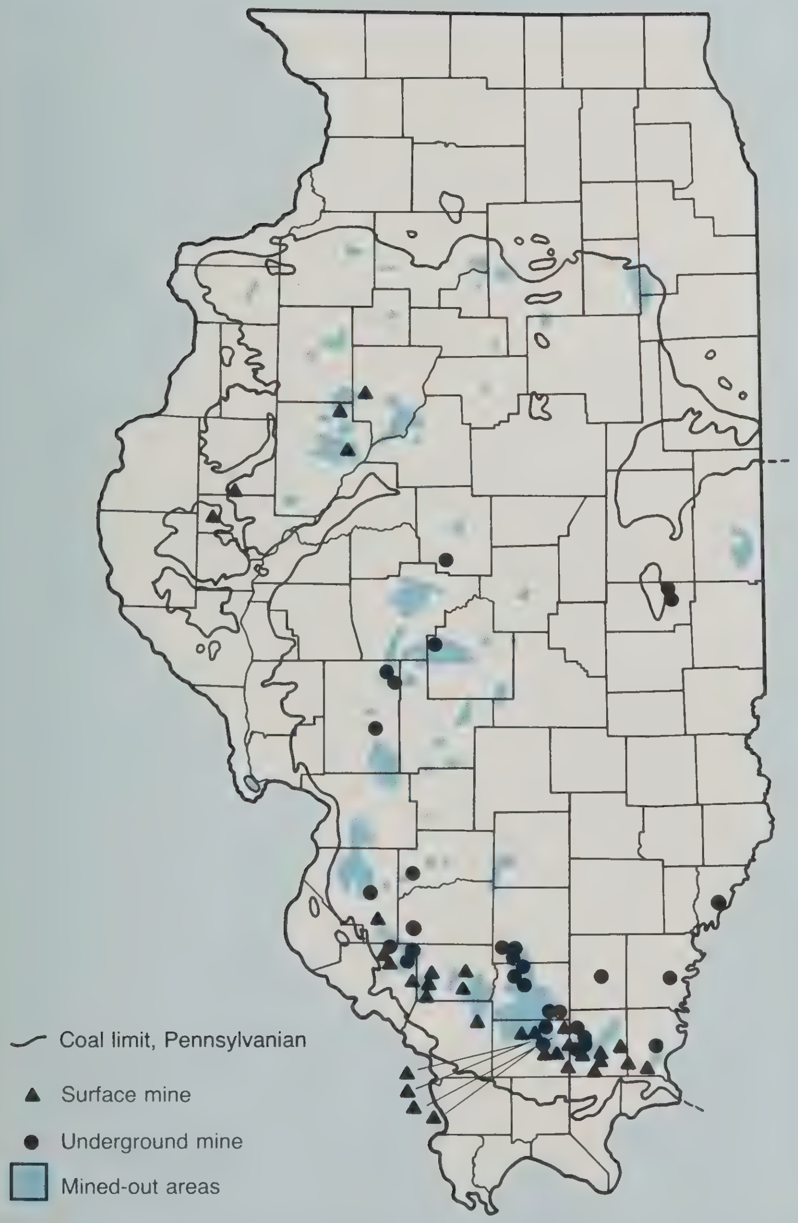


Figure 11. Active coal mines, 1984. Source: Illinois State Geological Survey, Coal Section.

Petroleum

Petroleum is unevenly distributed in sedimentary rocks throughout the world. It exists in the earth in gaseous, liquid, semisolid, and solid form. Petroleum gas as it is found in the earth is generally referred to as natural gas to distinguish it from manufactured gas; similarly, liquid petroleum is called crude oil to distinguish it from refined oil. Asphalt, tar, and pitch are examples of semisolid and solid forms of petroleum.

Several theories have been offered to explain the origin of petroleum. The most widely accepted is that billions of plants and animals lived, died, and were buried in the bottom sediments of widespread seas or lakes; as this material decomposed, fluid, fatty particles were released. As more sediments accumulated and the burial depth of these particles increased, they were distilled into hydrocarbons such as oil and gas. Eventually the sediments hardened under pressure and heat into sedimentary rocks. In the process, hydrocarbons displaced water (oil floats on water) in pores in the rocks. Later, as the layers of sedimentary rock were folded or broken, the oil and gas droplets and the salt water moved upward through interconnected pores. Some droplets eventually escaped to the surface as seepage, but many were trapped when they came to an impenetrable barrier of nonporous rock. Gas, which is lighter than either oil or water was trapped at the top; oil was caught beneath the gas and salt water beneath both. An accumulation of this kind is called an oil pool. Its essential elements are a porous and permeable body of rock (the reservoir rock) overlain by a roof of impervious rock, which can form a domelike configuration that traps and confines a pool of oil or gas or both.

The size of a petroleum deposit can only be determined by drilling test wells, which when drilled in previously unproven areas are called wildcat wells. If a test well taps a deposit of petroleum, it is called a discovery oil well or a discovery gas well, depending upon which is found. Later wells drilled into that same deposit are called development wells. If the test well yields neither gas nor oil, it is called a dry hole.

Since gas and oil are destroyed as they are consumed, new supplies can come only from the discovery of new deposits. Although petroleum continues to be formed from organic matter buried with deposits of sediments, the process is so slow that the oil and gas now being created will never serve the needs of our civilization. The oil and gas pools that have been identified and can be recovered using current methods of extraction are referred to as petroleum reserves. Petroleum resources, on the other hand, include those reserves as well as oil and gas pools that might be tapped in the future using present or improved technology. Thus, resources include known and recoverable gas and oil deposits, those not recoverable at present, and those as yet undiscovered. *221, 223, 275*

Crude Oil

Petroleum has been commercially produced in Illinois since 1885 when successful oil and gas wells were drilled near Litchfield in Montgomery County. In 1908, when Crawford and Lawrence counties were first heavily drilled, Illinois oil production peaked at about 34 million barrels. During this period, Illinois ranked third among oil-producing states. A second oil boom occurred in the late 1930s and early 1940s with the discovery of the Clay City, Louden, and Salem fields in southern Illinois. In 1940 Illinois

Figure 1

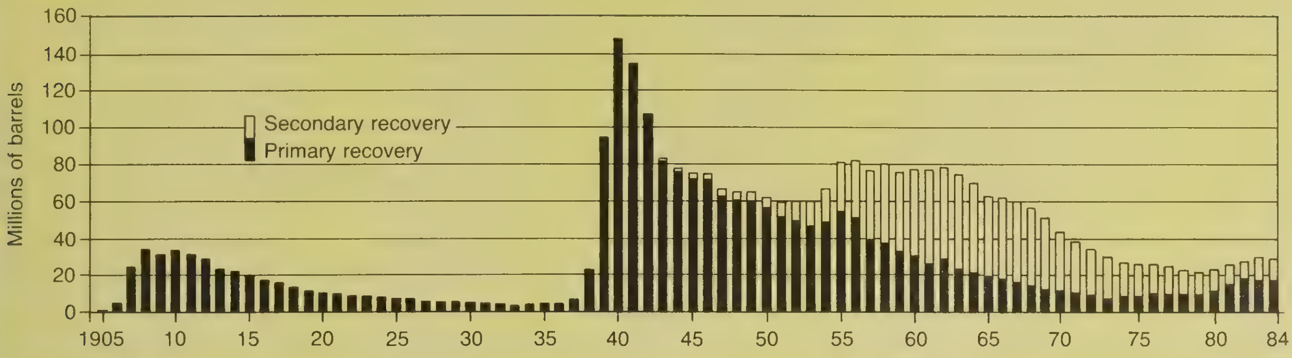


Figure 1. Annual production of crude oil in Illinois, 1905-1984. Source: Illinois State Geological Survey, Illinois Mineral Notes 93.

recorded its highest yield of oil–147,647,000 barrels, over five times the annual production of the 1980s. After the peak production years of the 1940s, no new large oil discoveries have been made and total oil reserves have been decreasing. Reserves in 1956 were approximately 700 million barrels; by 1983 the estimate was 135 million barrels. In 1963 Illinois ranked eighth among oil-producing states; twenty years later, Illinois ranked fourteenth. The history of oil production in Illinois is shown in Figure 1.

Total crude oil production in 1984 was valued at approximately $830 million and amounted to 28.9 million barrels (Table 1). Although a 32 percent increase in production has been achieved over the past five years, production in the current decade has been only about a third of what it was twenty years ago. The average number of barrels produced per well in 1984 was 961, far below the per-well average of over 2,000 barrels during the 1960s.

Because pumping, the primary extraction method, does not extract all the oil, secondary techniques are used to remove a portion of the remaining

Table 1. Annual crude oil production, in Illinois, 1960–1984.

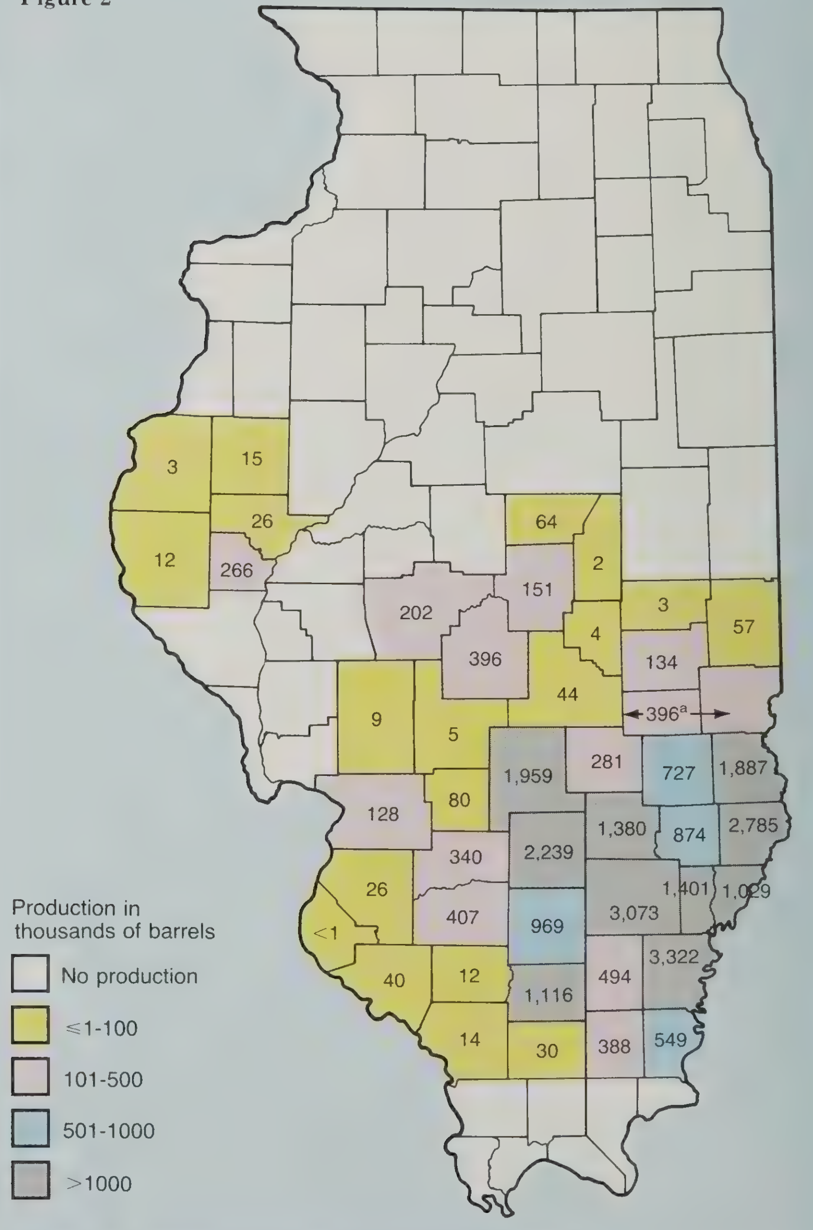
Year	Barrels (× 1,000)	Number of wells[a]	Average barrels per producing well
1960	77,341	32,160	2,405
1961	77,478	30,398	2,549
1962	78,800	30,496	2,584
1963	74,796	30,149	2,481
1964	70,168	29,511	2,378
1965	63,708	29,035	2,194
1966	61,982	28,591	2,168
1967	60,115	27,893	2,155
1968	56,391	27,235	2,070
1969	50,724	26,715	1,899
1970	43,747	26,169	1,672
1971	39,084	25,361	1,541
1972	34,874	24,716	1,411
1973	30,669	24,283	1,263
1974	27,553	23,630	1,166
1975	26,067	23,373	1,115
1976	26,272	23,621	1,112
1977	25,608	23,758	1,078
1978	23,362	23,914	977
1979	21,793	24,171	902
1980	22,702	24,869	913
1981	25,490	26,301	969
1982	27,709	27,735	999
1983	29,200	28,223	1,034
1984	28,873	30,047	961

[a]Number of wells producing at end of year.

Source: Illinois State Geological Survey, Illinois Mineral Notes 93 oil. Since the 1940s and especially during the 1960s, a large share of the oil in Illinois has been produced by waterflooding, a technique in which water is pumped down holes drilled into oil-bearing rock to push part of the remaining oil toward a production well where it can then be pumped to the surface. Figure 1 illustrates how important secondary recovery methods have become over the past thirty years. In 1984 waterflooding accounted for approximately 41 percent of the total oil produced in Illinois.

Forty-six of the 102 counties in Illinois produced crude oil in 1984 (Fig. 2). Wayne and White counties were the major producers, and each accounted for approximately 11 percent of the oil produced in Illinois in 1984. Close behind were Lawrence and Marion counties, accounting for approximately 10 and 8 percent, respectively, of the total. Cumulative crude oil production by county from 1888 to 1984 is shown in Figure 3. Of the 47 oil-producing counties, only Champaign was not producing in 1984. Sixteen counties, however, produced less than 50,000 barrels in 1984, and 5 of those produced less than 5,000 barrels that year. *7, 33, 60, 209, 333, 342, 419*

Figure 2



[a]Combined production of Cumberland and Clark counties.

Figure 2. Crude oil production by county, 1984. Source: Illinois State Geological Survey, Illinois Mineral Notes 93.

Natural Gas

A variable amount of natural gas is found in practically all oil pools, and the range is great–from minute quantities dissolved in the oil to 100 percent of the petroleum content of the reservoir. Natural gas has a low viscosity and a high buoyancy compared to the water and oil in the petroleum pool. As a result, its volume is much more responsive to changes in pressure and temperature than is the volume of oil or water. The expansion of natural gas in response to decreased pressure is an important factor in moving oil from the reservoir rock into the well bore in the production of oil pools.

Although gas was discovered early in Illinois–in Montgomery County in 1882, in Pike County in 1886, and in Randolph County in 1888–the State has never been an important producer of natural gas. Production amounted to 1,530 million cubic feet in 1984, a modest increase over the previous three years (Fig. 4). About half the decline from 1981 to 1983 can be attributed to falling production in the Mattoon field in Coles County.

Figure 3

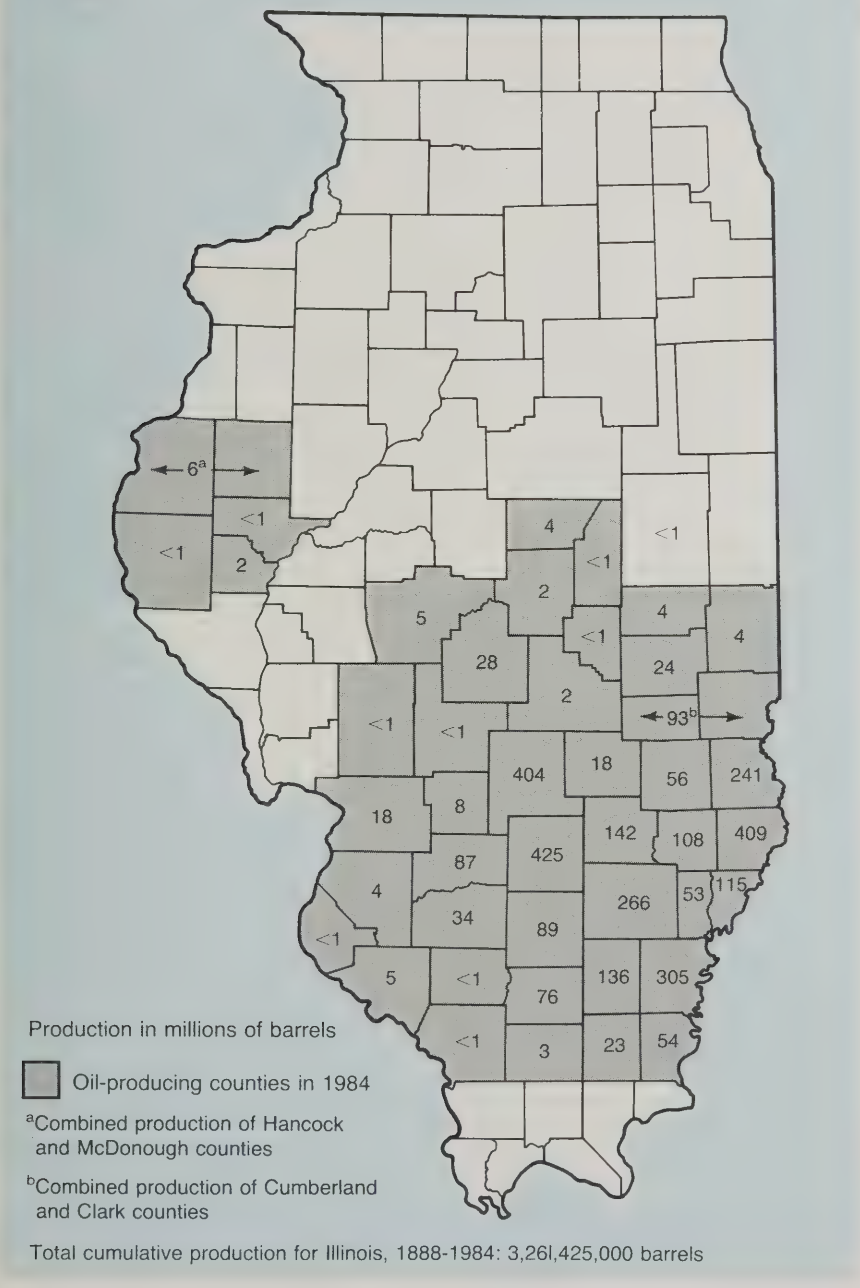


Figure 3. Cumulative production of crude oil by county, 1888-1984. Source: Illinois State Geological Survey, Illinois Mineral Notes 93.

Figure 4

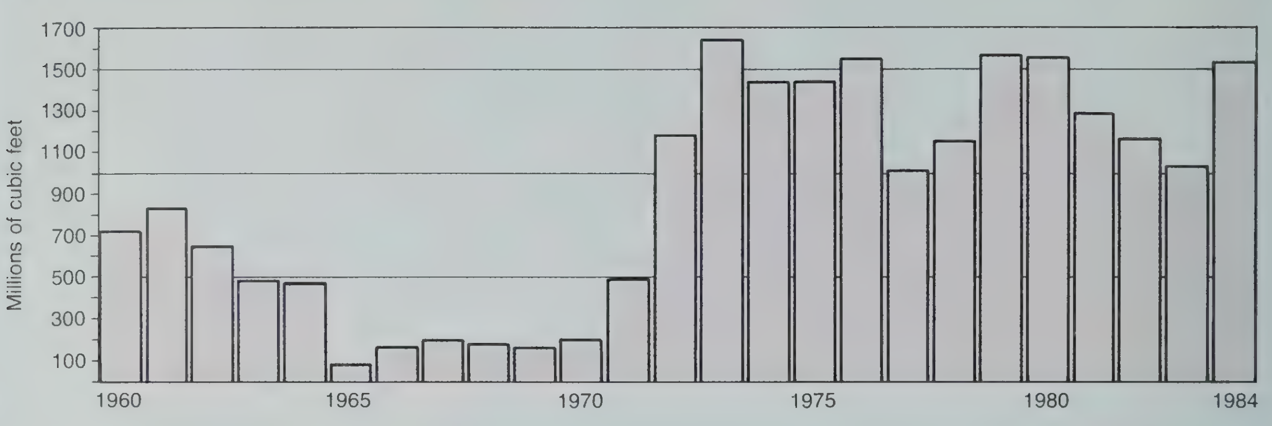


Figure 4. Production of natural gas sold in Illinois, 1960-1984. Source: Illinois State Geological Survey, Illinois Petroleum Series.

Thirteen Illinois counties produced natural gas in 1984, and all are located in the southern half of the State (Fig. 5). In spite of decreased production in the Mattoon field, Coles remained one of the top three gas-producing counties in the State, with approximately 432 million cubic feet. Pike and Saline were the only other counties in Illinois that produced in excess of 100 million cubic feet of natural gas, with approximately 470 and 260 million cubic feet respectively. Taken together, these three counties were responsible for slightly more than three-fourths of the gas production in Illinois in 1984. *209, 275, 342, 419*

Donald F. Oltz, Illinois State Geological Survey

Figure 5

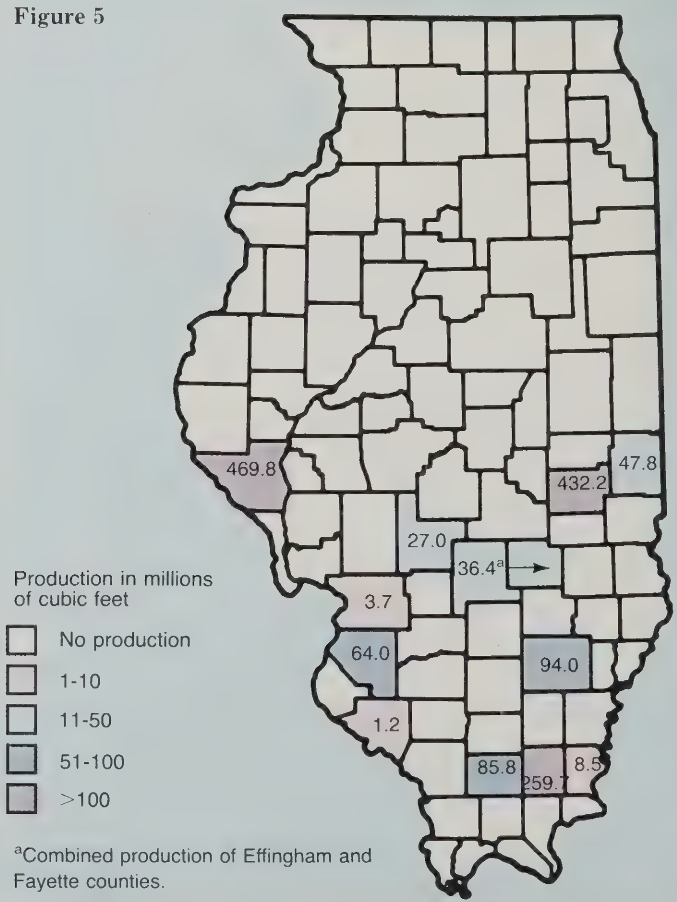


Figure 5. Production of natural gas by county, 1984. Source: Illinois State Geological Survey, Illinois Mineral Notes 93.

Industrial Minerals and Metals

The terms *mineral* and *rock* are often used together and the materials they describe are closely related. In general, minerals are considered to be naturally occurring chemical elements or compounds that were formed by inorganic processes. Rocks, on the other hand, are mixtures of particles or grains of several minerals. The term *industrial minerals*, however, usually includes materials that are considered rocks–limestone and dolomite, for example, as well as silica sand, which is composed almost entirely of sand-size particles of a single mineral, quartz. Nonmetallic minerals that are not fuels are typically grouped under this heading. In Illinois, therefore, industrial minerals that are produced commercially include limestone, dolomite, sand and gravel, peat, clay and shale, silica sand, fluorspar (fluorite), and tripoli. Metallic minerals such as sphalerite (zinc ore) and galena (lead ore) are recovered only as by-products of fluorspar mining in Illinois. Those materials are discussed in the sections that follow. In some instances, tripoli for example, production tables are not included because the small number of producers renders the data confidential.

Due to the relatively low unit cost of many industrial minerals, especially construction aggregates (limestone, dolomite, and sand and gravel), the utilization of a given deposit depends on many factors, including its quality, thickness, and areal extent; its accessibility to railroads, waterways, and heavy-duty roads; the thickness and characteristics of the overburden; its distance from the point of use; and the availability of other suitable deposits in the market area. *60, 221, 223, 260, 261, 276, 342, 412, 447, 448, 449, 450*

Stone

Limestone and dolomite are the most widely quarried rocks in Illinois (Goodwin 1983). Limestone is a sedimentary rock that consists mainly of the mineral calcite, which is composed of calcium, carbon, and oxygen. Dolomite, another common carbonate rock much like limestone, consists primarily of the mineral dolomite, which is composed of calcium, magnesium, carbon, and oxygen. These carbonate rocks were deposited as lime muds on the floors of ancient seas that repeatedly covered most parts of Illinois 320 to 500 million years ago (Mississippian to Ordovician periods). Shelled creatures, corals, and coral reefs helped build up these thick deposits. Major quarries are located in the northern quarter of the State, where some are among the largest in the world; along the western margin of the State; and near its southern tip. Although thick limestone and dolomite deposits were originally continuous at the surface across the width of Illinois, in later geologic time they slowly subsided in central and eastern Illinois and now lie buried beneath coal-bearing strata in the Illinois Basin at levels too deep for quarrying. Underground mining of some of these deposits, however, may prove economically feasible in the future (Baxter 1980).

In 1984 Illinois ranked fourth in the nation in the production of stone; only Texas, Florida, and Pennsylvania produced more. The total value of Illinois stone production that year was approximately $172 million. Production by county for 1983 is shown in Figure 1.

Crushed and broken stone is the most important rock product of the State, and its annual production since 1941 is shown in Figure 2. About 45 million tons were produced in 1984. Various types of construction aggregate utilize about three-fourths of the production with road-base stone the single largest use. Other important markets for crushed stone include the making of portland cement and use as agricultural limestone or agstone, which is applied to farmlands to neutralize soil acidity, to improve soil structure, to add calcium and magnesium, and to make soil nutrients more readily available to plants.

In addition to crushed and broken stone, 1,836 tons of dimension stone were quarried in Kane County in 1983. Dimension stone includes large pieces of irregular broken stone or rubble used primarily as rip-rap along shorelines, cut stone or veneer used primarily for exterior surfaces of buildings, and naturally flat slabs used primarily in walkways or retaining walls.

Because stone is such a bulky commodity, shipments are generally confined to areas near the quarries. About 90 percent of Illinois stone is shipped by trucks for relatively short distances, but Illinois waterways and railroads are used by some producers for longer shipping distances. Almost a third of the Will County production, for example, was shipped by water in 1983. *20, 143, 221, 342*

Sand and Gravel

Sand and gravel are mineral resources that are widely scattered throughout the State. They are abundant in many areas of northeastern Illinois but are generally less abundant and of lower quality elsewhere (Masters 1983). Preglacial gravels composed predominately of chert particles are located in southernmost Illinois and in small areas of western Illinois. Glacial-fluvial deposits, however, which were laid down during the Pleistocene or Ice Age from 12,000 to several hundred thousand years ago, are the principal sources of sand and gravel in Illinois. The huge lobes of the continental ice sheets that moved into Illinois from Canada carried

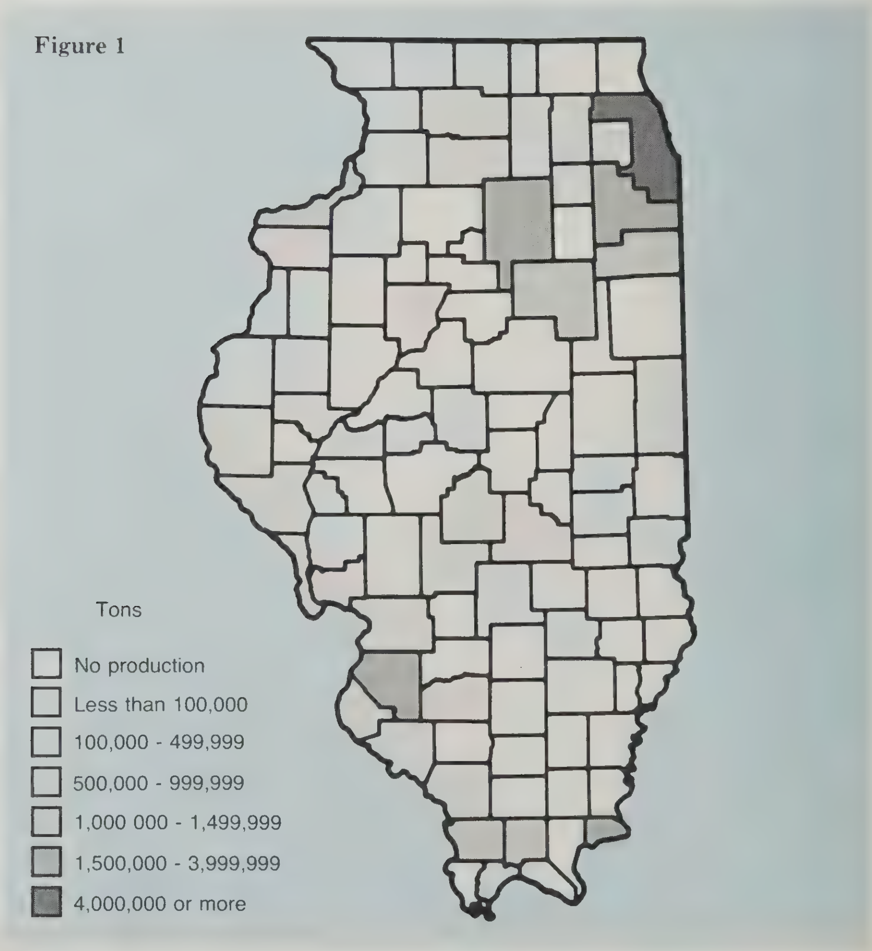


Figure 1. Production of stone by county, 1983. Source: Illinois State Geological Survey, Illinois Mineral Notes 93.

Figure 2

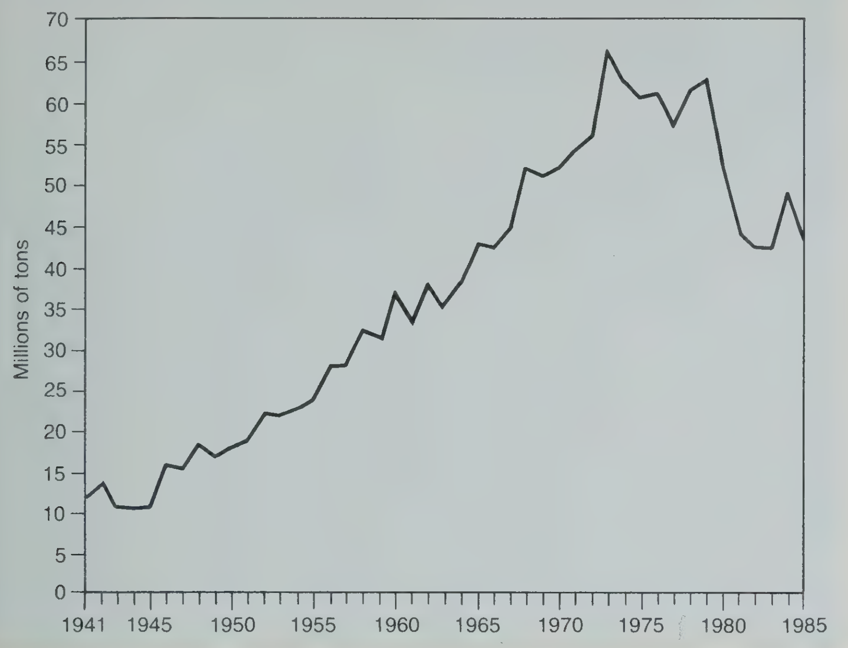


Figure 2. Production of crushed and broken stone, 1941-1985. Source: data through 1970, Busch 1973; data from 1971, Illinois Mineral Notes.

enormous amounts of rock debris, much of which was washed and sorted by meltwaters into various sand and gravel deposits, including outwash plains, valley trains, kames, and eskers. Sand of more recent origin is found redeposited in larger streams and rivers and is recovered by dredging.

The commercial story of sand and gravel began in the early 1800s when small amounts of these materials were used to make the dirt roads of Illinois more passable in rainy weather. With the coming of the railroads, gravel was sold as railroad ballast. Only after the turn of the century, however, when the use of concrete in construction became common, did the production of sand and gravel in Illinois increase significantly.

In 1984, Illinois ranked eighth in the nation in the production of sand and gravel for construction purposes. Total production was about 26 million tons (Fig. 3) with a value of approximately $72.5 million. Fifty-eight of the 102 counties in the State produced sand and gravel in 1982 (Fig. 4).

Figure 3

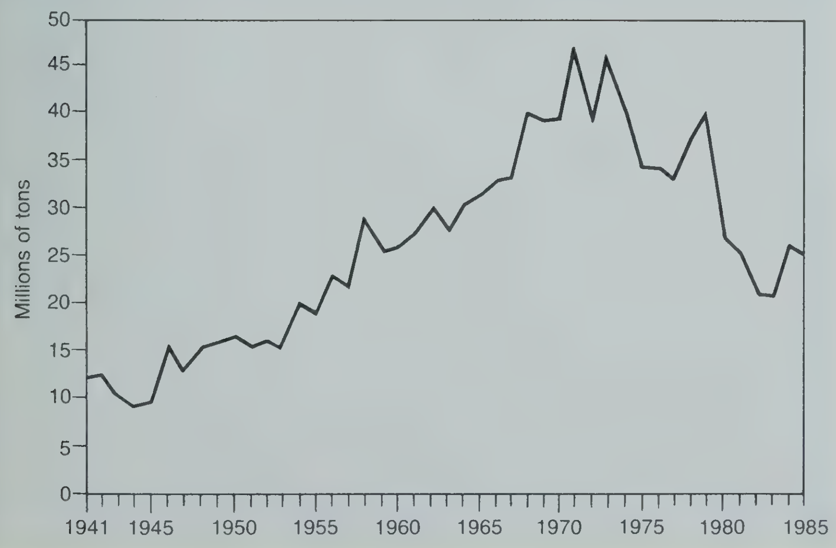


Figure 3. Production of sand and gravel, 1941-1985. Source: data through 1970, Busch 1973; data from 1971, Illinois Mineral Notes.

Illinois sand and gravel are used primarily as construction aggregate. The recession of recent years and the consequent slowdown in construction has had a significant effect on the industry. Between 1980 and 1982, the use of sand and gravel in construction declined 23 percent; similar declines were reported in their use in paving (down 18 percent) and as fill (down 27 percent).

Although natural sands are usually mixtures of many kinds of small rock and mineral fragments, silica or industrial sand consists almost entirely of small grains of a single mineral–quartz. Illinois ranks first in the nation in the production of silica sand with a production in 1984 of about 4.1 million tons valued at approximately $52.2 million. Two northern counties, LaSalle and Ogle, were responsible for this production from quarries in the St. Peter Sandstone (Lamar 1927), which was deposited near the shoreline of an ancient sea of the Ordovician Period about 480 million years ago.

Unground silica sand is used primarily in the manufacture of glass, in sandblasting, and for grinding and polishing. Coarse-grain sand is used as a propping agent during the hydrofracturing of reservoir rocks in the completion of certain oil and gas wells. Because it can withstand high temperatures, it is also used as molding sand in the casting of steel and other metals. Silica sand ground to a powder is used as an abrasive for polishing plate glass, as a filler in paints, and in the manufacture of pottery, porcelain, and tile. *221, 258, 266, 286, 333, 342*

Peat

After the retreat of the last great ice sheet from Illinois about 12,000 years ago, many ponds and lakes were left in the northern part of the State, particularly in the northeast. Reeds, sedges, and mosses grew along their shores, and as these plants died, their partially decomposed remains were

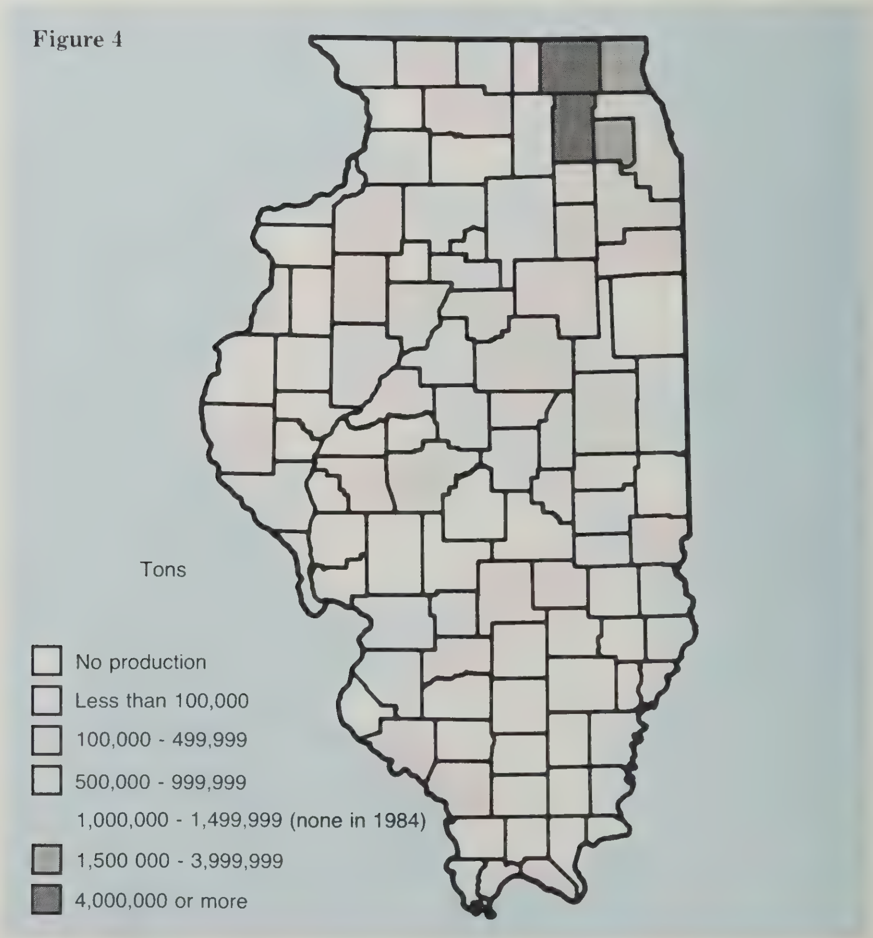


Figure 4. Production of sand and gravel by county, 1984. Source: Illinois State Geological Survey, Illinois Mineral Notes 93.

preserved beneath the water. Compaction and disintegration of the plant remains increased as the deposits grew deeper, and gradually these ponds and lakes were transformed to peat bogs.

Although peat is classified as a fuel by the U.S. Bureau of Mines, it is sold in the United States for agricultural and horticultural purposes, primarily as a soil conditioner because of its water-holding capacity. Three kinds of peat–reed-sedge, moss, and peat humus–were produced in three Illinois counties–Cook, Lake, and Whiteside–in 1984. Commercial sales of Illinois peat averaged about $1.5 annually between 1977 and 1984. Among the 22 peat-producing states, Illinois ranked third after Michigan and Florida in 1983. *178, 260, 342*

Clay and Shale

Clays are unindurated sedimentary deposits composed of several very fine-grained minerals. Indurated clays are called shales. The mineral particles found in clays and shales originated from the chemical and mechanical weathering of various kinds of rock. These particles were later eroded and deposited in many sedimentary environments. Clays are generally near-surface or surficial materials that were deposited during the glacial age by ice, water, and wind. Shales are part of the bedrock, about 290 to 500 million years old, and are interbedded with sandstones, limestones, and coals. Exceptions to this categorization are the absorbent clays of southernmost Illinois and the refractory clays that occur beneath coal seams (Lamar 1965).

Both the Indians and the early settlers in Illinois used clay to make pottery. As settlements increased and the need for construction materials grew, clay and shale were used to make bricks, especially in areas where building stone and timber were in short supply. Bricks were made in the Alton area around 1818, and brickyards were established at Quincy in 1828 and in Chicago and Jacksonville in the 1830s (Risser and Major 1968). The first brick pavement in Illinois was laid in Bloomington in 1875, an event that marked the beginning of a clay industry that was to be important in the State for many years. Drainage tile soon joined the list of clay products as extensive areas of the State were drained to improve agricultural land.

Common clay, refractory or fire clay, and absorbent clay (fuller's earth) resources are all present in Illinois; however, production is primarily common and absorbent clay. Figure 5 illustrates trends in clay production in Illinois since 1955. The general decline since the late 1960s has been due

Figure 5

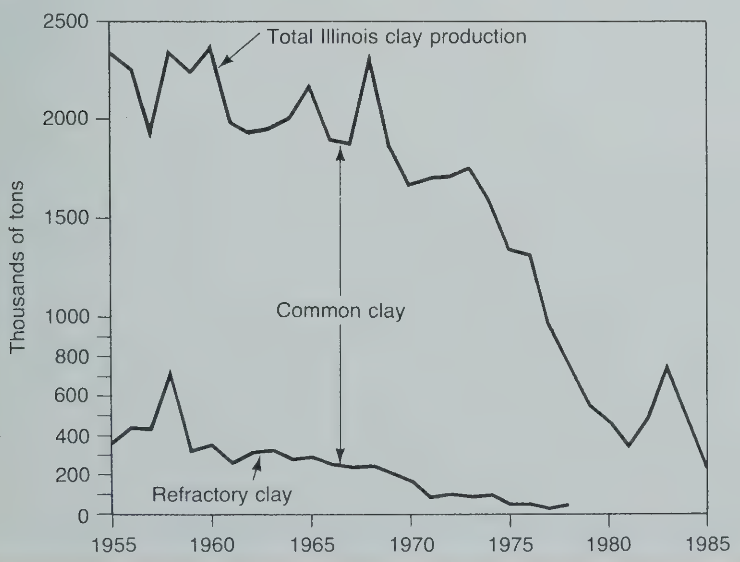


Figure 5. Production of clay, 1955-1985. Since 1979 no data on refractory clay have been available; in 1985 none was produced in Illinois. Source: Illinois State Geological Survey, Illinois Mineral Notes 93.

primarily to keen competition from low-cost out-of-state producers. The production of absorbent clay, however, has been growing in recent years. Illinois ranked fourteenth among the 44 clay-producing states in 1984; total clay production that year was 253,000 tons valued at nearly $940,000.

A relatively few counties are responsible for clay production in Illinois. Of the six clay-producing counties in 1984, LaSalle and Livingston were by far the most important producers and accounted for 73 percent of the total production. Absorbent clay, sold primarily to manufacturers of animal litter and oil and grease absorbents, was produced only in Pulaski County. The production of refractory clay, limited to Grundy County, declined by over 50 percent from 1981 to 1982. No production was reported in 1983 and 1984.

The principal market today for common clay in Illinois is the brick industry, which used about 42 percent of the 1984 production. About 38 percent was used in the manufacture of portland cement, structural concrete, concrete blocks, and highway surfacing. The manufacture of sewer pipe and drainage tiles accounted for smaller amounts, about 17 percent. *260, 333, 342*

Fluorspar and Associated Minerals

Fluorspar, or fluorite, is a mineral composed of calcium and fluorine. Crystals are vitreous, transparent to translucent, and commonly white to gray in color. Various shades of purple, blue, yellow, green, pink, or tan are also found, and some crystals are colorless. Fluorspar usually glows under ultraviolet light, hence the word *fluorescence*. Fluorite crystals are sometimes considered gemstones because of the light they reflect from their cleavage faces and because of the polish that can be given to these faces; however, their brittleness and relative softness make them unsuited for most jewelry. Massive fluorspar may also be cut and polished into various forms such as goblets and figurines (Bradbury et al. 1968).

Much of the fluorspar produced in the United States comes from a small area in extreme southeastern Illinois (Pope and Hardin counties) and an adjacent area in Kentucky. It has been extracted from surface mines and underground mines, some of which extend to depths of almost 900 feet. Fluorspar is found in limestone and sandstone strata deposited during the Mississippian Period (about 330 million years ago). Complex faulting of this region about 60 million years later produced open fractures through which mineralizing solutions could flow. Although the time and origin of the mineralizing solutions that formed fluorspar deposits are not precisely known, geologists theorize that the ores were deposited by hot, fluorine-bearing, aqueous solutions rising from deep within the earth's crust. Vein deposits (Fig. 6a) occur as fillings of openings in portions of nearly vertical fault planes. Bedded-replacement deposits (Fig. 6b) are irregular bodies of ore that occur parallel to bedding in the host limestone. Mineralizing solutions probably spread laterally through permeable zones from joints and minor faults, and the chemical replacement of limestone by fluorite resulted.

Fluorspar has been mined in Illinois since 1842, but early operations sought galena, which was sometimes found in association with fluorspar; the fluorspar itself was generally discarded. Even today, especially because of competition from foreign fluorspar producers, a major portion of profits may come from the recovery of such by-product minerals as sphalerite (zinc ore with small amounts of cadmium and germanium), galena (lead ore with small amounts of silver), and barite. The Upper Mississippi Valley Zinc-Lead District, which includes northwestern Illinois and adjacent areas in Wisconsin and Iowa, was the leading lead-producing district in the United States during the mid-1800s, with most of the lead shipped down the Galena and Mississippi rivers (Trowbridge and Shaw 1916; Schockel 1916).

Fluorspar is widely used as a flux in the manufacture of steel, in the fluoridation of water, and in the manufacture of glass. Currently, the chemical industry is the largest user of fluorspar, primarily for the manufacture

Figure 6

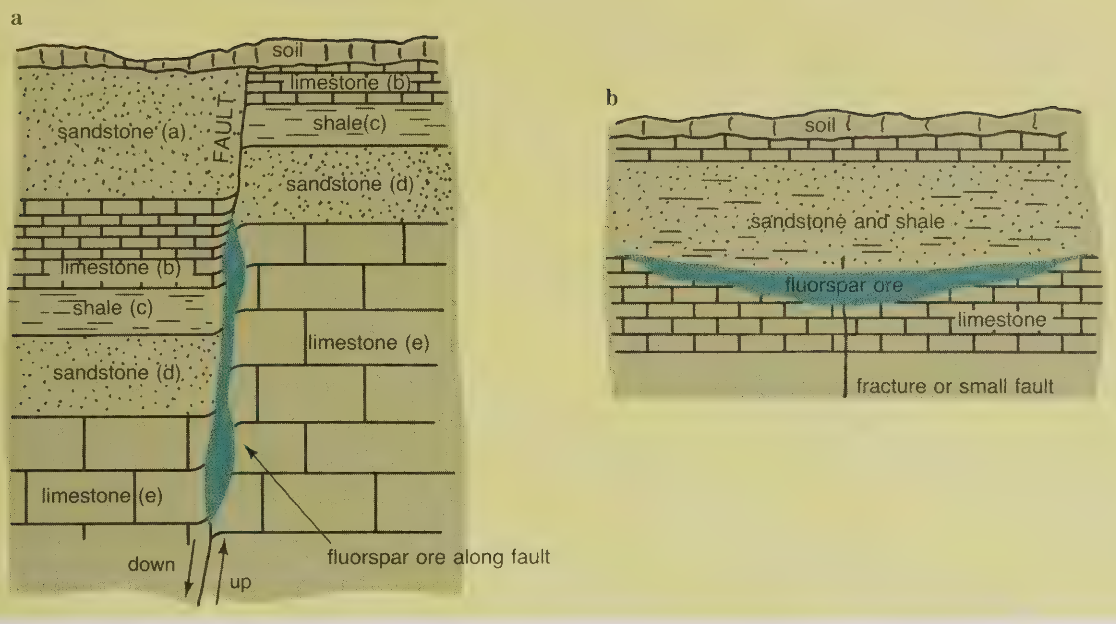


Figure 6. Cross sections showing the occurrence of fluorspar: a. vein deposit of fluorspar ore along a vertical fault and b. horizontal bedded-replacement of fluorspar ore. Source: Lamar 1965; Bradbury et al. 1968.

of hydrofluoric acid, which is used in the production of aluminum, gasoline, nuclear power, rocket fuels, uranium, and organic and inorganic fluorides. Inorganic fluorides, in turn, are used in toothpaste, in optical-glass lenses, and in hardening agents for concrete. Organic fluorides are used in the manufacture of plastics, refrigerants, nonstick coatings, herbicides, stain repellents, anesthetics, foaming agents for fire extinguishers, astronautical equipment, and space guidance systems (Reinertsen 1984).

Although many other industrial minerals mined in Illinois have higher annual production values, fluorspar was named the official mineral of the State because of its attractiveness and because it occurs rarely in the United States in minable amounts. Illinois has been the leading producer of fluorspar in the nation since 1942 and has for many years accounted for more than 50 percent of the total U.S. production. In 1984, fluorspar production in Illinois accounted for more than 90 percent of the total U.S. production. Shipments of finished fluorspar from domestic operations, however, have recently been at their lowest level in 50 years. This decline is due in part to the recession in the U.S. steel industry and in part to low-priced fluorspar imports, especially those from Mexico. In 1984, only 9.7 percent of the fluorspar used in the United States was domestically produced. *52, 260, 328, 342, 351, 399*

Tripoli

Amorphous silica, also known as tripoli, is a high purity material that consists of microcrystalline particles of the mineral quartz (Leamnson et al. 1969). It has been produced for many years in extreme southern Illinois (Alexander County) from highly siliceous sedimentary deposits about 400 million years old (Devonian Period). Traditionally, it has been mined from audits dug into steep hillsides (Lamar 1953). The silica is disaggregated by grinding it to a fine powder. Tripoli is used in polishing optical glass lenses, as an abrasive in soaps, in the manufacture of glass, and as a filler in paint. Recently, open-pit mining has begun producing lower-quality, iron-stained tripoli for use in the manufacture of portland cement.

Illinois has been the nation's principal producer of this material for many years and accounted for more than half the total U.S. production in 1981, 1982, and 1983. *259, 266, 342*

John M. Masters, Illinois State Geological Survey

Suggested Readings

This bibliography suggests reading related to topics introduced in *The Natural Resources of Illinois* and provides a starting point for in-depth research. A series bibliography precedes the citations bibliography, and the nature of each is explained below.

Series Bibliography

Included here are serial publications that can be consulted on a regular basis for information on the natural resources of Illinois. Since some of these began publication in the nineteenth century, they offer an historical perspective as well as a current outlook. Some are published regularly; others appear irregularly. A few are no longer published, and their active dates are given. Many of the series listed below provided data used in *The Natural Resources of Illinois*.

American Geological Institute, Geological Reference Information System

Bibliography and Index of Illinois Geology: Annual State Bibliography

American Petroleum Institute

Quarterly Review of Drilling Statistics

Center for the Great Lakes

The Great Lakes Directory of Natural Resource Agencies and Organizations (previously issued by the Great Lakes Basin Commission; issued irregularly)

Illinois Cooperative Crop Reporting Service in cooperation with the Illinois Department of Agriculture, Bureau of Agricultural Statistics, and the U.S. Department of Agriculture, Statistical Reporting Service

Illinois Agricultural Statistics: Annual Summary

Illinois Department of Conservation

Illinois Commercial Catch Report, Exclusive of Lake Michigan

Illinois Fishing Guides (available for several Illinois lakes)

Outdoor Highlights

Special Fisheries Report

Surface Water Resources of the Counties of Illinois

Illinois Department of Energy and Natural Resources

Alternative Energy Research and Development in Illinois

ENR Document (covers a range of topics on energy and natural resources)

IIEQ Document (merged into ENR Document)

IINR Document (merged into ENR Document)

Solar Energy Directory

Illinois Department of Mines and Minerals

Annual Coal, Oil and Gas Report

Annual Report

Annual Surface-mined Land Reclamation Report

Illinois Natural History Survey

Biological Notes

Bulletin

Circular

Illinois Scientific Surveys Joint Report (in cooperation with the Illinois State Geological Survey and the Illinois State Water Survey)

Illinois State Entomologist's Report (1867-1917)

Manual (four issued, 1936-1957)

Natural History Survey of Illinois (volumes on ornithology and ichthyology completed, 1889-1908)

Publications of the Illinois Natural History Survey (list of available publications)
Special Publication

Illinois Nature Preserves Commission
Illinois Nature Preserves System Report

Illinois State Academy of Science
Transactions

Illinois State Geological Survey
Bulletin
Circular
Contract/Grant Report
Cooperative Ground-water Report (in cooperation with the Illinois State Water Survey; title varies)
Educational Extension Publications
Educational Series
Environmental Geology Notes
Guidebook
Illinois Coal Mining Investigations Bulletin (in cooperation with the U.S. Bureau of Mines, the University of Illinois Engineering Experiment Station and Department of Mining Engineering, and the U.S. Geological Survey, 1913-1930; title varies)
Illinois Mineral Notes
Illinois Petroleum (published as Press Bulletin from 1919-1924)
Illinois Scientific Surveys Joint Report (in cooperation with the Illinois Natural History Survey and the Illinois State Water Survey)
Industrial Mineral Notes (continued as Illinois Mineral Notes with number 48)
Maps
Mineral Economics Brief (combined with Industrial Mineral Notes to form Illinois Mineral Notes)
Monthly Oil and Gas Drilling Report
Publications of the Illinois State Geological Survey (list of available publications)
Report of Investigations (1924-1968)
Reprint Series
Worthen Reports (publications of the original Geological Survey of Illinois, 1866-1882)

Illinois State Museum
Guidebooklet
Handbook of Collections
Inventory of Collections
Miscellaneous Publications and Reprints
Popular Science Series
Reports of Investigations
Research Series
Scientific Papers
Story of Illinois

Illinois State Water Survey
Bulletin
Circular
Contract Report
Cooperative Ground-water Report (in cooperation with the Illinois State Geological Survey; title varies)
Hazardous Wastes Research and Information Center Research Report (HWRIC RR)
Illinois Scientific Surveys Joint Report (in cooperation with the Illinois Natural History Survey and the Illinois State Geological Survey)
Miscellaneous Publication (numbered series)
Public Information Brochure
Publications of the Illinois State Water Survey (list of available publications)
Report of Investigation

Mining Information Services, McGraw-Hill
Keystone Coal Industry Manual (annual)

Mohlenbrock, R. H.
The Illustrated Flora of Illinois (10 volumes complete, others to come)

National Wildlife Federation
National Wildlife Federation Conservation Directory (annual)

U.S. Department of Energy
Coal Production
Natural Gas Production and Consumption Annual
Power Production, Consumption, and Capacity: Annual Report

U.S. Fish and Wildlife Service
Circular
Division of Biological Services Program Series (FWS/OBS)
Fishery Statistics of the United States
North American Fauna
Research Report
Resource Publication
Special Scientific Report: Fisheries
Special Scientific Report: Wildlife
Technical Papers

U.S. Geological Survey
Bulletin
Circular
Professional Paper
Water-resources Data for Illinois
Water-resources Investigations Report
Water-supply Paper

University of Illinois Press
Illinois Biological Monographs

Citation Bibliography

Each item in this bibliography is keyed by number to one or more entries in the book. Reference 12, for example, can be accessed from the entry on forests because Anderson discusses and maps forestland present in Illinois at the time of European settlement. Its number is also given at the end of the prairie-chicken entry, however, because Anderson describes the habitat of this native bird. Because of the importance of prairie in the historical landscape of Illinois and because of the interest in preserving the remaining prairie remnants, reference 12 is also listed under the entries for natural divisions, natural communities, and nature preserves. The parenthetical references (author and date) that appear in the text are also included in the citation bibliography and can be accessed alphabetically.

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Appendix A
Selected Resources: Illinois's Rank

Resource	Rank	Quantity	Year
Land area	24	55,645 square miles	1985
Population	5	11,426,518	1980
Population density	9	205.3 persons per square mile	1980
Number of farms	5	98,483	1982
Cropland planted	2	23,929,000 acres	1984
Forestland	38	3,757,000 acres	1978
Irrigated land	26	166,000 acres	1982
Soybeans	1	9,020,000 acres	1984
	5	32.0 bushels per acre	1984
	1	288,640,000 bushels	1984
Corn	2	10,940,000 acres	1984
	15	114.0 bushels per acre	1984
	2	1,247,160,000 bushels	1984
Oats	12	165,000 acres	1984
	7	65.0 bushels per acre	1984
	10	10,725,000 bushels	1984
Wheat	12	1,600,000 acres	1984
	13	44.0 bushels per acre	1984
	13	70,400,000 bushels	1984
Rye	16	11,000 acres	1984
	13	28.0 bushels	1984
	15	308,000 bushels	1984
Hay	21	1,220,000 acres	1984
	9	3.18 tons per acre	1984
	14	3,880,000 tons	1984
Sorghum harvested for grain	10	285,000 acres	1984
	6	69.0 bushels per acre	1984
	8	19,665,000 bushels	1984
Cattle on farms	15	2,500,000	1984
Fed cattle marketed	7	850,000	1984
Pigs sold	2	9,374,000	1984
Sheep on farms	18	136,000	1984
Export of agricultural products	2	$3,279,000,000	1984

Resource	Rank	Quantity	Year
Export of feed grains and products	1	$1,751,000,000	1984
Export of soybeans and products	2	$1,232,000,000	1984
Export of live animals and meats	8	$43,000,000	1984
All vegetables	10	62,400 acres	1985
Sweet corn	7	40,100 acres	1985
Horseradish	1	1,200 acres	1983
Apples	12	106,000,000 pounds	1985
Peaches	14	16,000,000 pounds	1984
		no crop due to frost	1985
Milk production	12	2,629,000,000 pounds	1984
Cheese production	10	100,701,000 pounds	1984
Creamed cottage cheese	3	47,661,000 pounds	1984
Ice cream	9	32,860,000 gallons	1984
Eggs	23	876,000,000 eggs	1984
Coal production	5	60,477,256 tons	1985
Coal resources	3	181 billion tons	1985
Bituminous resources	1	181 billion tons	1985
Crude oil production	14	30,226,487 barrels	1985
Natural gas production	27	1,324 million cubic feet	1985
Fluorspar	1	data withheld	1985
Common and refractory clay	14	253,000 tons	1984
Absorbent clay	4	data withheld	1983
Sand and gravel	8	25,969,000 tons	1984
Industrial sand	1	4,100,000 tons	1984
Stone	4	48,500,000 tons	1984
Tripoli	1	data withheld	1985
Lime	7	data withheld	1985
Slag (iron and steel)	8	data withheld	1984
Cement	10	1,876,231 tons	1984
Expanded perlite	3	data withheld	1984
Peat	4	data withheld	1984

Appendix B
State and Federal Agencies

For telephone numbers and addresses of state offices in your immediate area, look in your local phone book under *Illinois, State of.* Telephone numbers and addresses of state offices not listed below may be obtained from the Government Offices Operator at (217) 782-2000. For telephone numbers and addresses of federal offices in your area, look in your local phone book under *United States Government.* Toll-free numbers are indicated by (800).

State of Illinois

Attorney General

Agricultural Division
500 South Second Street
Springfield 62701
(217) 782-1090

Consumer Protection Hotline: (800) 252-8666

Environmental Control Division
500 South Second Street
Springfield 62701
(217) 782-1090

Department of Agriculture

Public Information
State Fairgrounds, P.O. Box 4906
Springfield 62708
(217) 782-4884

Bureau of Agricultural Statistics
State Fairgrounds, P.O. Box 4906
Springfield 62708
(217) 492-4295

Bureau of Plant and Apiary Protection
State Fairgrounds, P.O. Box 4906
Springfield 62708
(217) 785-2427
(This bureau provides pesticide information.)

Division of Meat, Poultry, and Livestock Inspection
State Fairgrounds, P.O. Box 4906
Springfield 62708
(217) 782-4944

Division of Natural Resources
State Fairgrounds, P.O. Box 4906
Springfield 62708
(217) 782-6297
(This address and number may also be used for the Bureau of Farmland Protection and the Bureau of Soil Conservation.)

Department of Commerce and Community Affairs

Business Hotline: (800) 252-2923

Energy Hotline: (800) 252-8643

Tourism In-state Hotline: (800) 252-8987

Tourism Out-of-state Hotline: (800) 637-8560

Department of Conservation

Information and Reservations for State Parks:
(800) 252-8456

Information and Education
Lincoln Towers, Suite 100
524 South Second Street
Springfield 62706
(217) 782-7454

Division of Fisheries
600 North Grand Avenue West
Springfield 62706
(217) 782-6424

Division of Forest Resources
600 North Grand Avenue West
Springfield 62706
(217) 782-2361

Division of Law Enforcement
600 North Grand Avenue West
Springfield 62706
(217) 782-6431

Divison of Natural Heritage
600 North Grand Avenue West
Springfield 62706
(217) 785-8774

Division of Wildlife Resources
600 North Grand Avenue West
Springfield 62706
(217) 782-6384

Endangered Species Program
600 North Grand Avenue West
Springfield 62706
(217) 785-8774

Illinois Nature Preserves Commission
600 North Grand Avenue West
Springfield 62706
(217) 785-8686

Regional Offices
Region I Sterling: (815) 625-2968
Region II Spring Grove: (815) 675-2385
Region III Champaign: (217) 333-5773
Region IV Alton: (618) 462-1181
Region V Benton: (618) 435-8138
Chicago: (312) 793-2071

Target Illinois Poacher Hotline: (800) 252-0163

Department of Energy and Natural Resources

Public Information Office
325 West Adams Street
Springfield 62704
(217) 785-2800

Energy Information: (800) 252-8955

Department of Mines and Minerals

General Office
704 Stratton Building
Springfield 62706
(217) 782-6791

Mine Rescue Division
609 Princeton Avenue
Springfield 62703
(217) 782-4831

Oil and Gas Division
704 Stratton Building
Springfield 62706
(217) 782-7756

Department of Public Health

Division of Engineering and Sanitation
535 West Jefferson Street
Springfield 62761
(217) 782-4674
(call with bird problems)

Department of Transportation

General Information
2300 Dirksen Parkway
Springfield 62764
(217) 782-5597

Division of Water Resources
DOT Administration Building, Room 339
Springfield 62764
(217) 782-2152

Hazardous Waste Research and Information Center (HWRIC)
1808 Woodfield Drive
Savoy 61874
(217) 333-8956

Illinois Emergency Services and Disaster Agency (IESDA)
110 East Adams Street
Springfield 62706
(217) 782-7860
(24-hour response for any state disaster)

Illinois Environmental Protection Agency (IEPA)

Emergency Response Unit
2200 Churchill Road
Springfield 62708
(217) 782-3637
(for environmental emergencies)

Public Information
2200 Churchill Road
Springfield 62708
(217) 782-3397

Illinois Historic Preservation Agency
Old State Capitol, Level 2
Springfield 62701
(217) 782-4836

Illinois House of Representatives

Status of Bills and General Information:
(800) 252-6300

Illinois Natural History Survey
607 East Peabody Drive
Champaign 61820
(217) 333-6880

Illinois Pollution Control Board
309 West Washington Street
Chicago 60606
(312) 793-3620

Illinois State Geological Survey
615 East Peabody Drive
Champaign 61820
(217) 333-5100 or (217) 344-1481

Illinois State Library

Reference Desk
Centennial Building
Springfield 62756
(217) 782-7597

Illinois State Museum

General Information
State Museum Building
Springfield 62706
(217) 782-7386

Illinois State Water Survey
2204 Griffith Drive
Champaign 61820
(217) 333-2210

Lieutenant Governor: (800) 252-6584
(for assistance in solving bureaucratic problems dealing with the state and federal governments)

Secretary of State

Publications and Public Information
Centennial Building, Room 474
Springfield 62756
(217) 782-5763

United States Government

U.S. Army Corps of Engineers

Chicago District
219 South Dearborn Street
Chicago, IL 60604
(312) 353-6400

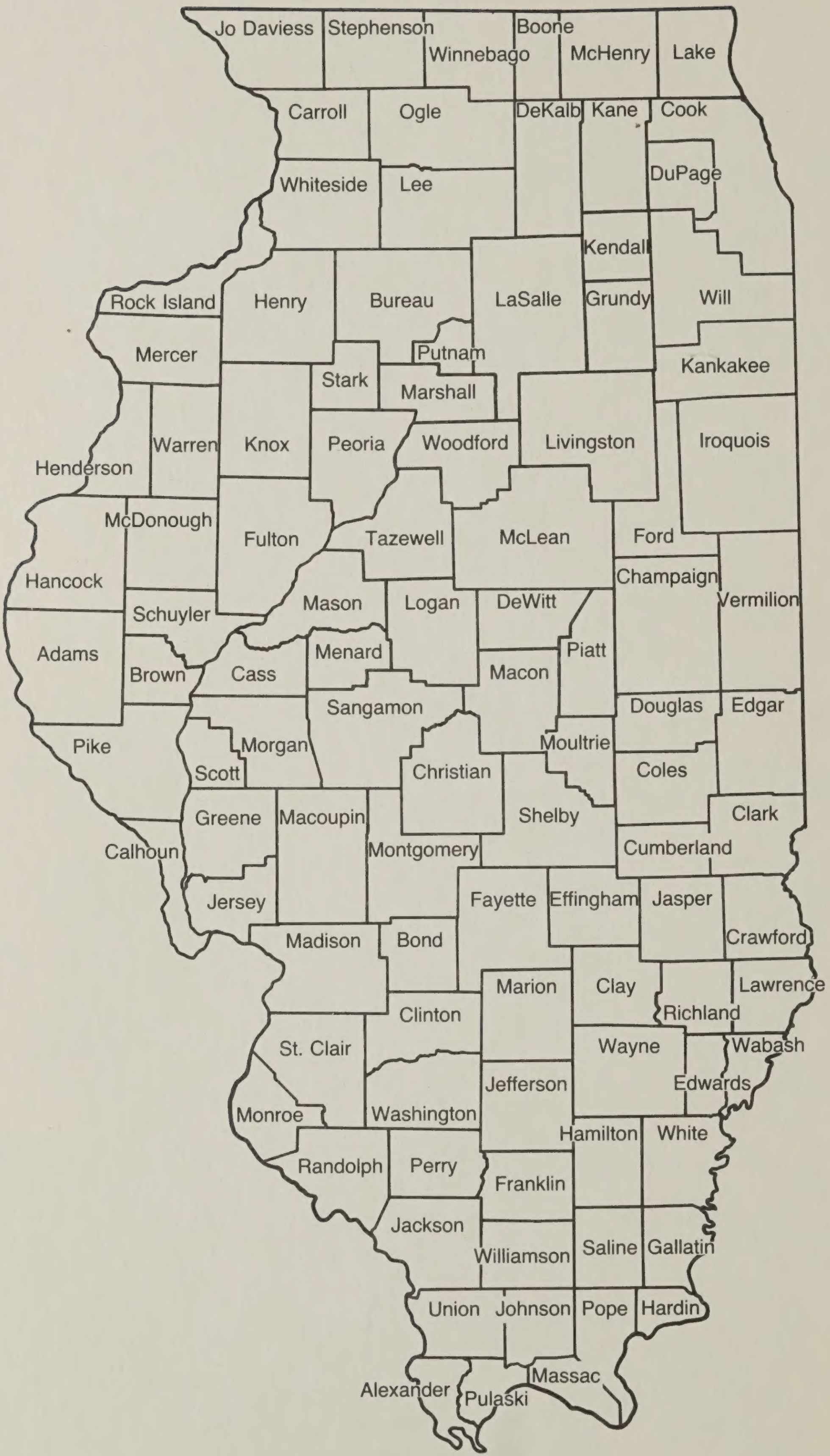
Louisville District
P.O. Box 59
Louisville, KY 40201
(502) 582-5601

Rock Island District
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204
(309) 788-6361

St. Louis District
210 Tucker Boulevard North
St. Louis, MO 63101
(314) 263-5656

U.S. Coast Guard

Marine Safety Office
610 South Canal Street
Chicago, IL 60607
(312) 353-1226



County Reference Map