CHAPTER 4

Vegetation Ecology and Change in Terrestrial Ecosystems

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OBJECTIVES

What are the major vegetation types that have occurred in Illinois and how have they changed since the last ice age and more specifically since European-Americans settled the region? Ecological factors influencing trends, composition, and diversity in prairie, savanna, open woodland, and forest communities are examined. Historical and contemporary changes will be explored with reference to the proportion and characteristics of habitats remaining in a relatively undegraded condition. While Illinois is a focus for this chapter, the processes and factors explaining vegetational variation have relevance to the entire Midwest and in many cases beyond.

INTRODUCTION

Vegetation change is a major focus of ecological monitoring and research and has both temporal and spatial aspects. Of course, all change is measured through time. Change can be evaluated on a time scale of thousands of years, such as following Pleistocene glaciation, or in the time frame of an annual species. An example of a spatial aspect of vegetation change is the emergence of forest where once prairie occurred (see Fig. 3.11). This was a common occurrence in the Midwest following a post-settlement decline in fire frequency. Other examples are the potential effects of climate warming on vegetation such as the projected migration of tree species to more northern locations (1), something that while occurring over an extended time period would have wide-ranging impacts on associate species of plants and animals including humans. Also, the pace of changes in established plant communities can differ depending on habitat conditions. For example, change can be relatively rapid where resources, such as moisture and nutrients, are not limiting but slower on dry, nutrient poor sites. These ecologically stressful habitats can provide key insights to historical vegetation assemblages because of a slower pace of change. Of course, some quite evident changes occurred in a very short period, such as the conversion of prairie to plowed field. Overall, the degree and magnitude of regional vegetation changes since the Pleistocene (about 14,000 years ago) and habitat destruction during the past 200 years have been extensive. Understanding these processes and their consequences is a key step in conserving biodiversity. The following chapter explores the dominant types of native terrestrial vegetation and changes as they have occurred in Illinois primarily since Pleistocene glaciation with a focus on the post-European settlement period.

IN THE FORMER TIME

The last glacial episode, known as Wisconsinan glaciation, covered the northeastern quarter of Illinois from about 30,000 to 14,000 years ago (see Fig. 2.3). Vegetational changes since that time throughout Illinois included a tundra phase followed by a period of domination by spruce and fir and then spruce/pine forests (2, 3, 4). Just how far south these northern species occurred in Illinois is unclear, but there is fossil pollen evidence of spruce woodland and tundra occurring in central Illinois during the late Pleistocene (4) and of tundra extending to Williamson County in southern Illinois (2). This boreal phase lasted a few thousand years, but by 9,000 years before present (B.P.) deciduous forest began to invade with the development of a warming cycle known as the hypsithermal interval (5, 6). By about 8,300 years B.P., forests were dominated by oak and hickory (7) and prairie species began to invade (4) forming a Prairie Peninsula (8) extending east to Ohio (Fig. 4.1). Although there is regional variation, the period from about 8,000 years B.P. to 5,000 years B.P. included the emergence of savannalike habitats (9, 10). Increased moisture in the southern portion of the Prairie Peninsula about 5,000 years B.P. resulted in an increase in forest (4). Fire, periodic droughts, and grazing animals helped maintain grassland during this period (11, 12). While oak and hickory species were dominant in upland forests, bottomland forests included species such as Silver Maple (*Acer saccharinum*), Cottonwood (*Populus deltoides*), Green Ash (*Fraxinus pennsylvanica* var. *subintegerrima*), Hackberry (*Celtis occidentalis*), Sycamore (*Platanus occidentalis*), as well as bottomland species of oak and hickory (e.g,. Bur Oak [*Quercus macrocarpa*], Swamp White Oak [*Q. bicolor*], Pin Oak [*Q. palustris*], Overcup Oak [*Q. lyrata*], Kingnut Hickory [*Carya laciniosa*], Pecan [*C. illinoensis*], and Bitternut Hickory [*C. cordiformis*]).

Vegetation history in North America can be divided conveniently into two periods: pre- and post-European colonization. In Illinois, this division between the two periods occurred from about 1800 to 1840. At that time, results from Government Land Office surveys indicate that about 97% of the state was prairie and forest (19,713,123 acres of prairie [54.7%] and 15,301,598 acres of forest and savanna [42.3%]); the remaining lands were in other, mostly wetland, cover types (Chapter 3). There are trees still standing that were mature at the time of this change in cultural domination. Bur Oak, for example, can live to about 340 years and White Oak to over 400 years. Senior trees bearing an open-grown crown structure, still found scattered throughout the state, stand as testimony to the open prairie and savanna conditions from where they grew. In places, this aspect remains but usually under highly modified circumstances (Fig. 4.2).

This distinction in time may seem arbitrary given that humans and human cultures were well-established throughout the western hemisphere prior to contact with European colonists (13). However, attitudes about land use were very different between native cultures and the colonizers and these differences influenced vegetation and wildlife in many complex ways. The impacts of these cultural influences are a matter of scale. Both cultures had agriculture and utilized natural resources. However, the Europeans came from a landscape that long ago largely had been tamed. The key differences are that prior to European colonization, human disturbances in North America involved local perturbations and regional effects (e.g., broadcast-scale fire) forming a dynamic mosaic within a wilderness context (14). Post-settlement changes can be characterized as an inverse image of the pre-settlement landscape with small, local remnants of native vegetation surrounded by a predominant landscape significantly altered by anthropogenic land-use practices. The following sections detail these changes in prairie, savanna/open woodland, and forest communities, using as a template remnants of native vegetation, our canaries in the contemporary environment.

Figure 4.1. The Prairie Peninsula of Transeau (8) showing the three prairie types found in the central plains and midwestern states and provinces in North America. Modified from Robertson (161).

Figure 4.2. Degraded "savanna" with Bur Oaks and Eurasian meadow understory, Livingston County, Illinois. Photo by J. Taft.

PRAIRIE

PART I — DISTRIBUTION AND GENERAL ECOLOGY OF THE CENTRAL PLAINS GRASSLANDS

The grasslands of central North America originated in the Miocene-Pliocene transition, about 7–5 million years B.P., when a drying period began. The Miocene uplift of the Rocky Mountains created a partial barrier between moist Pacific air masses and the interior portion of the continent. Also, the spread of the Arctic ice sheet, by tying up atmospheric moisture, contributed to increased aridity. Woody plants are generally less well adapted to drought than most grass species and the spread of the grasslands occurred at the expense of forests. As the grassland expanded, there was an increase in the number of grazing and browsing animals, indicating that the association of grasses and grazers has occurred over a long period of time (15, 16).

The prairies of Illinois were part of the Prairie Peninsula (8), as previously noted a large triangular wedge of grassland that extended from the foothills of the Rocky Mountains eastward into the Midwest with scattered outliers in southern Michigan, Ohio, and Kentucky (Fig. 4.1). Because the Rocky Mountains intercept moist air masses moving eastward from the Pacific Coast, the grassland lies in the partial rain shadow to the east. From west to east within the central grasslands, annual precipitation increases from 25–38 cm to 75–100 cm and becomes more reliable, potential evapotranspiration decreases, the number of days with rainfall increases, and periods of low humidity and periodic droughts in July and August decrease (17).

Ecologists traditionally have separated the central grassland into three major divisions (Fig. 4.1). The arid western shortgrass prairie is dominated by species such as Buffalo Grass (*Buchloe dactyloides*), Blue Grama Grass (*Bouteloua gracilis*) and Hairy Grama Grass (*B. hirsuta*) that reach only 30–45 cm in height. The mid- or mixed-grass prairie occupies the middle sector of the central grassland and is dominated by grasses that are 50–120 cm tall, including Little Bluestem (*Schizachyrium scoparium*), Needlegrasses (*Stipa spartea* and *S. comata*), and native rye/wheat grasses (e.g., *Elytrigia smithii* and *E. dasystachya*). The prairies of Illinois are in the eastern portion of the central grassland, the tallgrass prairie. While the region is subject to periodically severe droughts, typically this area receives supplemental moisture from the Gulf of Mexico, contributing to relatively high annual rainfall compared to the Great Plains grasslands. The dominant grasses on mesic sites include Big Bluestem (*Andropogon gerardi*), Indian Grass (*Sorghastrum nutans*), Little Bluestem, and Northern Dropseed (*Sporobolus heterolepis*), and the first two species can achieve heights greater than 2 m. Wet and wet-mesic prairies are found on poorly drained sites and dominant species include Cordgrass (*Spartina pectinata*) and Bluejoint Grass (*Calamagrostis canadensis*), while on dry sites Little Bluestem and Sideoats Grama (*Bouteloua curtipendula*) are important grasses (17, 18, 19). Prairies in very dry habitats in Illinois (e.g., with substrates of sand or gravel and/or steep exposures) include some of the species from the mixed-grass prairies of the Great Plains.

Because of increased rainfall and reduced evapotranspiration, the climate is increasingly favorable for tree growth from west to east in the central grasslands. In Illinois and the rest of the Prairie Peninsula, the average climate for approximately the past 5,000 years largely appears to have been more favorable for forest than grassland. However, to understand factors influencing the persistence of grasslands in this region it is necessary to consider climatic extremes rather than averages. Periodic droughts have occurred when forests retreated and grasslands advanced or were maintained. Furthermore, droughts most detrimental to woody species are those that result in inadequate winter recharge of deep soil moisture. Nevertheless, despite such periodic climatic extremes, other factors are needed to account for the persistence and predominance of prairie in the Midwest. Prairies in this region probably would have converted to forest during the past 5,000 years if it had not been for occasional prairie fires set by lightning and the nearly annual burning by North American native peoples (15, 20, 21). The role of Indians in maintaining the prairies and the reasons they burned these grasslands has been discussed and documented by various authors (e.g., 20, 22, 23, 24).

Although many woody species such as oaks (*Quercus* spp.) readily resprout after being top-killed by fire, prairie species generally are better adapted to burning than are most woody plants. The adaptation protecting grasses and forbs from fire is their annual growth habit that dies back to underground organs each year, exposing only dead material aboveground (25). Prairie fires become very hot above ground and on the surface of the soil (26, 27) but because fires move quickly and soil is a good insulator, there is little penetration of heat into soil (164). Consequently, growth zones below the soil surface are protected from the heat. The same adaptation protecting prairie plants from fire also protects them from desiccation during drought and periodic grazing (25, 28, 29).

Grasslands can produce more biomass annually than can be decomposed in a year; however, total grassland productivity can decline if this excess plant litter is not removed by fire or grazing (30, 31). Because productivity of prairie gradually can decline in the years following burning, in the absence of large mammal grazers, an approximate balance between biomass production and decomposition in Illinois prairies on mesic sites is reached in about two or three years after burning (32, 33). Grasslands evolved under conditions of periodic drought, fire, and grazing and are adapted to all three (29, 34, 35, 36).

Grazers in North American grasslands range in size from minute arthropods (see Chapter 7) to large grazers, such as Bison. Bison are considered to be a keystone species in some grasslands (37) and historically were the most important large mammalian herbivore in prairies. The extent of the role of Bison in presettlement Illinois is a subject of some debate as there is little evidence for the occurrence of Bison in Illinois prior to 1,000 A.D., although there is substantial evidence for their presence after that time. At the present time, with the elimination of Bison from Illinois prairies, the large herbivore having the greatest impact on tallgrass prairies is the White-tailed Deer. This herbivore may be having a negative impact on prairie diversity, composition, and structure under some conditions (see sidebar on Deer Browse).

In addition to biotic and abiotic interactions of prairie species with fire, climate, and grazers, most prairie plants form endomycorrhizal (myco = fungus and rhizo = root) associations with specialized fungi (42, 43). Exceptions include species occurring on very wet or highly disturbed sites. Endomycorrhizal fungi colonize the root system of the plant and produce threadlike hyphae that grow between and within (thus Endo) cortical cells in the outer part of the plant root. Fungal hyphae also extend outside of the root and act as a supplemental root system provisioning the plant with water and inorganic nutrients,

DEER BROWSE— While the Bison diet is about 90–95% grass, and they consume almost no forbs, White-tailed Deer selectively browse forbs and utilize little amounts of prairie grasses from May through August. Under conditions of high deer density (32–50 deer per km^2) at Goose Lake Prairie State Park in northeastern Illinois, diversity of the forbs declined. The decline in diversity occurred because evenness (a measure of equitable distribution of species) decreased, as species preferred by deer, such as Ashy Sunflower (*Helianthus mollis*), Culver's Root (*Veronicastrum virginicum*), and Sweet Black-Eyed Susan (*Rudbeckia subtomentosa*) decreased in abundance, whereas the abundance of unpreferred species including Old Field Goldenrod (*Solidago canadensis*), and species tolerant of browsing such as Rosinweed (*Silphium integrifolium*), increased in abundance (38, 39). However, in areas that received complete protection from browsing, diversity also declined. Under these conditions species that were sensitive to deer browsing increased in abundance, and species that had increased under conditions of high deer density declined in abundance, presumably, because they were out-competed by the browse-sensitive species. No species were eliminated by deer browsing so species richness was the same under conditions of low and high deer browsing pressure, although loss of species can occur if browsing intensity is high for an extended period of time. These results indicate that forb diversity will be maximized with intermediate levels of deer browsing (39). Thus, deer browsing can negatively or positively affect forb diversity depending upon the deer density and browsing intensity. Nevertheless, the quality of the forb community (sensu 40) will decline with deer browsing, because the browsing sensitive species tend to be more conservative species (typical of higher quality remnants) than browse-tolerant species (41).

especially relatively immobile nutrients such as phosphorus. The specialized fungi cannot grow without association to the plant root and are solely dependent upon plant photosynthesis for their energy source. This relationship can be mutualistic but under conditions of high availability of phosphorus it may be more parasitic or commensalistic (44), the latter term describing an apparent association where one species benefits from but does no particular harm or favor to another organism. Under conditions of high phosphorus availability the plant invests energy in the association but it does not gain the benefit of receiving increased amounts of a limiting soil nutrient. Under these conditions the fungus benefits from the association but the plant does not (45). Plants with fine fibrous root systems like cool-season (C3) grasses have less dependency on the mycorrhizal association than prairie forbs and coarse-rooted warm-season (C4) grasses such as Big Bluestem and Indian Grass (46, 47). Cool-season plants with the C3 photosynthetic pathway achieve most efficient growth during cool, moist conditions while plants with the C4 photosynthetic pathway achieve most efficient growth during warm, dry conditions. Nevertheless, plants may benefit from the mycorrhizal association even if they do not gain increased availability of inorganic nutrients, because the association can protect some plants from soil pathogens (48) or mitigate the effects of grazing (49).

PART II—PRAIRIE TRENDS IN THE PRAIRIE STATE

Prairies at the time of European settlement (circa 1820)

While it has been calculated that prairie comprised about 55% of the presettlement Illinois land cover (see Fig. 3.7), this is a point-in-time reference and the vegetation was primarily a shifting mosaic of prairie, savanna, and forest that was largely controlled by fire frequency under climatic conditions capable of supporting any of these vegetation types. Fire frequency largely was determined by topography and the occurrence of firebreaks such as waterways and dissected landscapes (50). Across landscapes that are level to gently rolling, fires carry readily, but in hilly and dissected landscapes the spread of fire across the landscape is more limited (51). Fires tend to carry well uphill, because rising convection currents encourage fire movement; but spread of fire down slopes tends to be slowed by the rising convection currents. The importance of waterways in determining the distributional patterns of forest and prairie in presettlement Illinois was demonstrated by the noted early ecologist/botanist Henry Allen Gleason through the use of the Government Land Office records for some Illinois counties (52). Gleason observed that prairies were more associated with the western sides of streams while forests, although often found on both sides of a stream, generally were more developed on leeward eastern sides. This pattern was attributed to the prevailing westerly winds that carried fires from west to east, so that west sides of waterways burned more frequently than east sides. While forests generally can be described as having affiliation with water courses (e.g., Fig. 3.7), prairies also occurred in the floodplains of the major rivers (53, 54, 55). Some areas of the Grand Prairie Natural Division were seasonally flooded. While fire would have been a factor during dry periods, saturated soils is another factor that limited woody encroachment in poorly drained regions.

PRAIRIE TRENDS SINCE EUROPEAN SETTLEMENT

The presettlement prairies of Illinois were drastically altered by the influx of Euro-American settlers. The earliest settlers entered the unglaciated southern portion of the state. This was a familiar landscape since these people mostly were hunters and trappers from forested regions of Tennessee, Kentucky, and West Virginia. As they migrated northward, they followed the finger-like traces of forest along the major waterways, and initially avoided the larger tracts of prairie. The larger tracts of prairie were avoided in favor of smaller tracts that were adjacent to waterways and timber for a variety of reasons. The settlers needed water for their livestock and to turn water wheels for a source of power. Timber was needed as a source of fuel and for building materials and the large tracts of prairie exposed the settlers to the force of the winter storms (11). Timber was considered to be such an important commodity on the prairie that counties were not allowed to form as governmental units until it could be demonstrated that they had access to an adequate amount of timber to support development (56).

It is of interest that cool-season grasses, such as the exotic Kentucky bluegrass (*Poa pratensis*) were favored by the European settlers as forage for their livestock over the native grass species. Bluegrass provided green forage a month earlier in the spring and a month later in the fall than the native species (56). Because the native grasses evolved under a system of intermittent grazing pressure, they could be eliminated by exposing them to continuous grazing. Within a couple of years of continuous grazing the native species would decline and Kentucky Bluegrass would invade and become dominant.

Many of the earliest settlers believed that prairie soils were infertile. They had been familiar with life in the forest and thought that soils that appeared incapable of supporting trees surely would not be productive for crops. However, rather than being infertile, a characteristic of these grasslands is that about two-thirds of the plant biomass is located beneath the surface of the soil in the form of roots and other underground organs. As belowground and aboveground portions die and decay, they greatly enrich the soil with organic matter. But turning over the thick prairie sod was an almost insurmountable obstacle to early prairie farmers until 1837 when John Deere, in Grand Detour, Illinois, invented the self-scouring moldboard steel plow. As counties were settled, one of the first industries to develop was clay tile manufacturing for draining the seasonally wet prairies common throughout much of the Grand Prairie region. The combination of drainage tiles and the moldboard steel plow set the stage for the conversion of prairie to cropland. However, even though settlers learned of the fertility of the prairie soil and could raise large crops, at first many of the larger tracts of prairie remained unsettled because of the lack of a transportation system that could get the crops to distant markets. With the coming of the railroads in the 1850–60s, there was a rapid conversion of the prairies to cropland (11). During this period, about 3.3% of the prairie was plowed each year (57) and by the late 1800s, most of the prairie was gone (58). Documented objections to this dramatic conversion (e.g., 59) apparently were few.

As the prairies were converted to an agricultural landscape, fires that had swept nearly annually across the landscape in presettlement times were actively stopped by the settlers who viewed them as a threat to their economic security. According to Gerhard (60), “The first efforts to convert prairies into forest land were usually made on the part of the prairie adjoining timber..., three furrows were plowed all around the settlement to stop the burning of the prairies..., whereupon the timber quickly grows up...”. The settlers also indirectly stopped the fires by increasing plowed fields and roads which acted as firebreaks. Cessation of these nearly annual conflagrations served to further the demise of the prairies, as many of them were converted to savanna and then forest by invading tree species that were no longer restricted by the periodic fires.

What remains in the contemporary landscape is an archipelago of small and isolated prairie patches lacking the full complement of natural processes such as grazing by large herbivores (e.g,. Elk and Bison) and landscape-scale fires that would promote a dynamic mosaic of burned and unburned prairie. Instead, prairies that are treated with prescribed fire are burned relatively infrequently (e.g., every three to five years) compared to background levels (e.g, 61), and the burns probably are less patchy. Typically, about 50% of a site is burned at one time to provide an unburned refuge for fire-sensitive arthropod species dependent on prairie plants. Further, the isolation of remnants limits the migration of species needed to compensate for natural population declines. Monitoring prairies over time is vital to determine whether these last remnants of our natural heritage can be maintained. Research in Wisconsin prairies suggests species losses can be expected over time in small, isolated prairies at rates that can deplete 50% of the flora in about 50 years (62). At risk in particular are species of short-stature, nitrogen-fixing species (e.g., legumes and New Jersey Tea [*Ceanothus americanus*]), and species with small seeds. Observed rates of species losses were greatest on moist sites compared to dry sites (62); however, dry prairies also have lost low-stature forb species that are habitat specialists (63). These observations suggest that with typical modern fire return intervals, a more rapid decline can be expected in wet prairies compared to prairies on more elevated topographic positions. Few wet prairies persist today in part due to fire absence but also due to drainage activities and conversion to agriculture. Biennial burning appears necessary to maintain mesic and wet-mesic prairies and limit encroachment by woody and non-native species (61). Trends in unburned prairies on sandy soils (sand prairies) suggest there have been losses among native species and increases among non-native species while burned prairies have increased in native species richness and had declines in non-native species (64).

TABULATING REMAINING PRAIRIE - THE INAI AND RAILROAD PRAIRIE SURVEYS

Results from the Illinois Natural Areas Inventory (INAI) indicate that only about 2,496 acres (0.013%) of the original prairie remain in a relatively undegraded condition (65; data revised in 2007). Prairie remnants mostly are small and isolated, like islands in an agricultural sea (Fig. 4.3). The majority among size classes are in the 1–5 acre category (44%) and, of the 231 prairie remnants recognized by the INAI, 79% are smaller than 10 acres and 22.5% are less than 1 acre (Fig. 4.4). Had the goal of the pioneers been to eliminate prairie from the Prairie State, a 99.99% success rate surely would have seemed unimaginable.

A particularly dramatic example of prairie habitat loss can be found regionally in Illinois. The Grand Prairie Natural Division (as a concession to reality, recently coined the Central Corn Belt Plains Ecosystem [see Chapter 2]), at nearly 13 million acres, is the largest Natural Division in Illinois. Only about 475 acres (about 0.004% of total area) of relatively undisturbed prairie (Grades A and B) have been identified by the INAI in this region. The 9,531,000-acre Grand Prairie Section of this natural division contained mostly species-rich prairie on silt-loam soils—the “black soil” prairies. However, only 213 acres (about 0.002% of the total in the early 1800s) of relatively undegraded prairie have been identified in this section. Champaign County in east-central Illinois was estimated to have about 592,300 acres of prairie; currently, a single acre qualifies for the INAI and only following extensive restoration at this pioneer cemetery plot (Fig. 4.5)

An important refuge for prairies, particularly in the Grand Prairie Natural Division, is in pioneer cemeteries (Fig. 4.5), a fitting resting place for some of the finest examples of prairie remaining in the heavily agricultural eastern region of the tallgrass prairie ecosystem. Whether these small remnants of our tallgrass prairie natural heritage can persist in isolation is a subject of ongoing research. These small prairies actually have been found to be smaller than they appear. Marginal areas have higher exotic species numbers, lower native plant diversity, and a more ruderal (weedy) species composition among the native species. Further study will determine if these edge zones are stable, expanding, or contracting over time and whether site-level diversity can be maintained (John Taft, unpublished data).

Ironically, the railroads that brought change and enabled the development of an agricultural economy also provided another important refuge for prairies, the so-called "railroad prairies" located in railroad rights-of-way (RR ROW). Railroads were established before the landscape was extensively disturbed and the rights-of-way, which usually extended for 100 feet on either side of the track, often were fenced to keep out livestock. In addition, the RR ROW formerly were managed with periodic fire (as well as many accidental fires) limiting the invasion of woody species. In the last 30 or more years, many of the remnant prairies along the railroads have disappeared or become degraded as a result of fire absence, herbicide use, and other disturbances (e.g, installation of fiber optic cables, vehicle trespass, and cultivation). Furthermore, many of the railroad lines have been abandoned. Frequently, these abandoned ROW, often the only local remnants of native prairie, have been acquired by the adjacent land owner, plowed, and converted to cropland (Fig. 4.6). Nevertheless, some prairie persists along RR ROWs, although much has been degraded (see sidebar on Railroad- roadside Prairies).

Figure 4.3. Prospect Cemetery Prairie Nature Preserve in Ford County, Illinois. Surrounding lands primarily are agricultural. Photo by J. Taft.

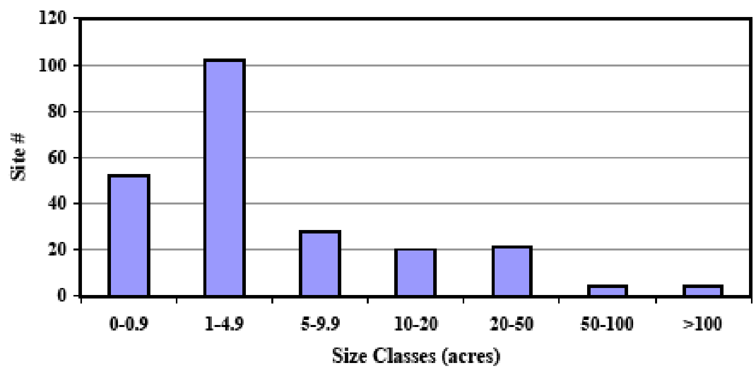


Figure 4.4. Distribution of INAI (Illinois Natural Areas Inventory) grades A and B prairie remnants by size classes.

PART III - COMMUNITY CLASSIFICATION, SPECIES DIVERSITY, AND ONGOING ECOLOGICAL THREATS

Characteristics of Illinois Prairies Today

The numerous prairie community types recognized in Illinois (Chapter 2) reflect the great variety of physiographic conditions found statewide that influence species composition including variation in topography, slope aspect, drainage, bedrock geology, and soil characteristics. Prairie types (Subclasses in the INAI classification) include *Prairie* ("black-soil" prairie on silt-loam soils), Sand Prairie, Hill Prairie, Gravel Prairie, Dolomite Prairie, and Shrub Prairie (67). Other than Hill Prairies and Shrub Prairies, these categories are further classified into community types by distinguishing variation along the moisture gradient (e.g., dry, dry-mesic, mesic, wet-mesic, wet). While total acreage is low, high-quality examples remain of each community type. Prairies on silt-loam soils originally were by far the dominant type; today they account for only about 25% of high-quality remnant acreage. A disproportionate amount of prairie meeting the qualitative criteria for the INAI occur on the more agriculturally unsuitable lands (Fig. 4.8), such as Sand Prairies (49%) and Hill Prairies (18%). The following descriptions are based on typical examples. However, substantial variation exists in species composition as influenced by the moisture gradient and regionally in Illinois.

Figure 4.5. Tomlinson Cemetery Nature Preserve, the last remaining acre of high-quality prairie in Champaign County, Illinois. Pioneer cemetery prairies are among the last refuges for tallgrass prairie in the Grand Prairie Natural Division. Photo by J. Taft.

Prairie—Within Illinois, tallgrass prairie on silt-loam soils, the "black-soil" prairie, was the dominant prairie type. About 636 acres among 88 sites, averaging 7.2 acres, remain in undegraded condition (Figs. 4.8, 4.9). Among community types, wet and wet-mesic prairies were quite common, especially in the Grand Prairie region (see Figure

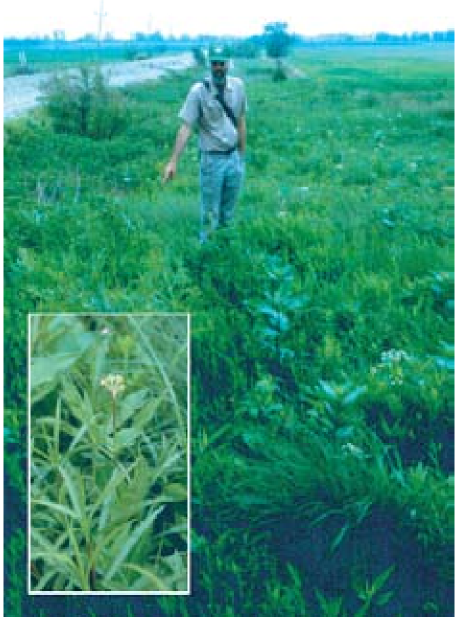


Figure 4.6. Marlin Bowles of the Morton Arboretum points to a population of the federally threatened Mead's Milkweed (*Asclepias meadii*), see inset, discovered in Grade A prairie in a railroad right-of-way (Vermilion County). This population and prairie both were destroyed to increase cropland once the rail line was abandoned and the land was transferred to the adjacent land owner. Photo by J. Taft.

Figure 4.7. Location of prairies identified in a survey of railway and roadside ROWs by William C. Handel (INHS).

Railroad-roadside Prairies by W.C. Handel

To document the current status of prairie in shared roadway-railroad rights-of-way (ROW), an inventory was conducted of remaining prairies throughout Illinois from 2001 to 2003. In previous work, the Illinois Natural Areas Inventory (65) surveyed the state for ROW prairies, identifying only those areas that met criteria for relatively undisturbed, high-quality prairie (66). However, no comprehensive survey for remnant prairies in shared ROW had been conducted. Such areas have provided local refugia for native prairie species; however, typical vegetation management in these ROW involve mowing and herbicide applications, severely threatening the continued existence of these remnants. A main goal of the survey was to identify all remaining prairie habitat in these shared ROW to reduce or eliminate these damaging management practices where prairie was present. To assist with the field survey, maps were prepared using Geographic Information System (GIS) data layers of all areas where there were shared ROW within 200 feet of a rail line. This mapping effort indicated that there were 3,511 miles of shared ROW in Illinois that potentially could have prairie (or savanna) vegetation. The survey was conducted during the growing season months of April to October by region in the state (Fig. 4.7).

A qualitative rating class was assigned to prairie remnants (1 [highest], 2 [intermediate], or 3 [poor]). Some remnants included two or more quality classes. The type of prairie communities were recorded along with information on the physical dimensions of each remnant, evidence of past management, and perceived threats including presence of non-native species, woody invasion, or anthropogenic disturbances such as mowing, cultivation, or herbicide spraying. Finally, a species list was generated for each remnant. All ROW prairies were inventoried even if they were of extreme low quality. All remnant prairies can be important for the overall preservation of the remaining prairie ecosystem. For example, even degraded remnants provide cover, habitat, and dispersal corridors for grassland flora and fauna, including game species such as Northern Bobwhite (*Colinus virginianus*) and the non-native Ring-necked Pheasant (*Phasianus colchicus*). Also, these linear corridors typically cross many different soil types and soil moisture zones providing a wide range of habitat conditions capable of supporting a diverse mixture of species. Consequently, ROW prairies also provide a valuable source of seed of local ecotypes that can be used in prairie restoration and reconstruction efforts.

The survey found 325 prairie and savanna remnants totaling 564 miles (16% of all shared ROW) totaling about 4,500 acres. The most common type of prairie community found was dry-mesic prairie (72%). Most of the remnants were low quality, Class 3 prairies (65%). Only 13%, 41 out of 325, were considered Class 1. Non-native vegetation occurred in 95% of sites and was the most common threat to native prairie and savanna remnants (Table 4.1) followed by mowing at 41% of sites. Although it is apparent that the roadside prairie and savanna communities are at risk, there are some positive signs. Many of these remnants have the potential for large-scale restoration with proper management. Information gathered from this survey is now incorporated into a GIS database that is being utilized by the Illinois Department of Transportation and the Illinois Department of Natural Resources to facilitate conservation and preservation of the remaining rialroad-roadside prairie and savanna habitat in the state.

2.6), but due to drainage and conversion to agriculture in this region, very little remains. About 294 acres remain in the state, mostly in northeastern Illinois (urban expansion has been slightly more forgiving to prairie than rowcrop agriculture in the corn/soybean belt). Mesic prairie was probably the most common prairie community type throughout Illinois; however, a scant 279 acres remain in a high-quality condition. Details of the composition of mesic black soil prairies are available primarily from these persisting remnants, which as noted tend to be small, isolated fragments, termed "nanoprairies" (68). Nevertheless, these remnants often are very diverse at the local scale (termed point or alpha diversity), averaging 12 to 15 species in 50 cm x 50 cm sampling quadrats, and up to about 160 species in small (e.g., 4-acre) remnants.

Dominant species in mesic prairies include the typical prairie grasses such as Big Bluestem, Indian Grass, Little Bluestem, and Northern Prairie Dropseed as well as several sedges (*Carex* spp.). However, perennial forbs tend to be most abundant in terms of species richness and total percent cover while other species groups such as sedges, nitrogen-fixing species, annual forbs, and hemi-parasites (root parasites that also photosynthesize) also are represented (Fig. 4.10). Dominant forbs include Common Spurge (*Euphorbia corollata*), Pasture Rose (*Rosa carolina*), Heath Aster (*Aster ericoides*), and Wild Strawberry (*Fragaria virginiana*) (19). Other common forbs include Rigid Sunflower (*Helianthus rigidus*), Prairie Phlox (*Phlox pilosa*), Rattlesnake Master (*Eryngium yuccifolium*), Grey-Headed Coneflower (*Ratibida pinnata*), and Rosinweed. The vast majority of diversity, as in most plant communities, is among the numerous species with intermediate or low levels of frequency (i.e., species that have sparse occurrences both within and among sites).

In a monitoring study of three east-central Illinois pioneer cemetery prairies, all on silt-loam soils and between three and four acres in size, 206 species have been recorded of which 160 (78%) are native. Without intervention and control efforts by volunteers and site managers, continued increases among some of the non-native species would threaten the integrity of the sites, all dedicated nature preserves. Some of these problem exotics are:

Kentucky Bluegrass (*Poa pratensis*)
Daylily (*Hemerocallis flava*)
Wild Parsnip (*Parnassia sativa*)
White Sweet Clover (*Melilotus alba*)
Yellow Sweet Clover (*Melilotus officinalis*)
Cut-Leaved Teasel (*Dipsacus laciniatus*)
Smooth Brome (*Bromus inermis*)
Lily-of-the-Valley (*Convallaria majalis*)

In these sites, Kentucky Bluegrass, a species from Eurasia rather than Kentucky, is the most abundant species overall occurring in over 90% of vegetation sample quadrats. Despite these problems, these pioneer cemetery prairies retain a rich diversity of native prairie species and are important relicts of the natural history of the Prairie State (Fig. 4.11).

Sand Prairie—This subclass of prairie occurs primarily in the northern half of Illinois and is located on deep sands deposited by glacial melt waters following the Woodfordian substage of the Wisconsinan glacial advance and on sandy glacial lakeshore deposits (69). The coarse textured sandy soils often were transported locally by wind (termed aeolian sands) after initial deposition forming localized small dunes. Such soils have very limited capacity to store available moisture (or nutrients) for plants; consequently, plant species adapted to drought conditions often are favored (70, 71). Sand prairies include specialized habitats such as sand blow-outs, relatively bare patches created by wind action, with a specialized flora (Fig. 4.12). Where the water table seasonally intersects with sandy deposits, habitat for wet to wet-mesic sand prairies also occurs. Mesic sand prairies occur in intermediate zones between wet and dry soils on relatively richer sandy loam soils.

A total of 37 high-quality remnants of sand prairie are known at this time in Illinois totaling 1,217 acres (modified from 65 using unpublished data from the IDNR Natural Heritage Database). Dry and dry-mesic sand prairies are the most common types with about 776 acres remaining in a high-quality condition compared to 441 acres for mesic, wet-mesic, and wet sand prairies combined (Fig. 4.8). These drier prairies are somewhat more resistant to disturbance than silt-loam tallgrass prairie. Many agricultural weeds are adapted to more mesic conditions of silt-loam soils but are ineffective competitors in dry sand prairies. As efforts to cultivate some fields were abandoned, at some sites portions of the native prairie flora even became reestablished. However, with the expanded use of fertilizers and irrigation, sustained agriculture on these soils became possible and more widespread. Mesic sand prairies have similarity to mesic silt-loam prairies including many of the same invasive species problems. Once weeds become established in mesic sites, they can limit recolonization by prairie species (20).

In dry to dry-mesic sand prairies, dominant species (based on 72) include:

Little Bluestem
Western Ragweed (*Ambrosia psilostachya*)
Beach Three-Awn Grass (*Aristida tuberculosa*)
Panic Grass (*Dichanthelium villosissimum*)
Sand Love Grass (*Eragrostis trichodes*)
Prickly Pear Cactus (*Opuntia humifusa* and *O. macrophylla*)
Goat's Rue (*Tephrosia virginica*)
Golden Aster (*Heterotheca camporum*)
Slender Sand Sedge (*Cyperus lupulinis*)
Gray's Sedge (*Cyperus grayioides*).

Additional characteristic species specifically associated with the Mississippi River sands include (Ebinger, unpublished data):
June Grass (*Koeleria macrantha*)
Rock Selaginella (*Selaginella rupestris*)
Sand Bracted Sedge (*Carex muhlenbergii*)
Smooth Fruited Oak Sedge (*Carex tonsa*)
Hairy Gramma (*Bouteloua hirsuta*)
Specialists in sand blow outs include Beach Heather

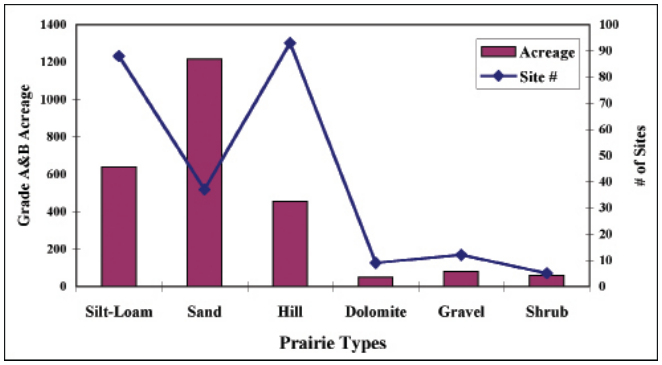


Figure 4.8. Sum acreage and site number among prairie remnants graded A and B by the Illinois Natural Areas Inventory for each prairie subclass.

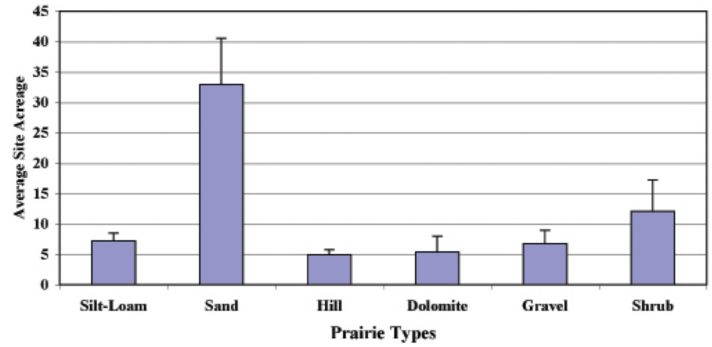


Figure 4.9. Average remnant size for prairies recognized as high quality (graded A or B) by the Illinois Natural Areas Inventory for each prairie subclass. Error bars are standard error.

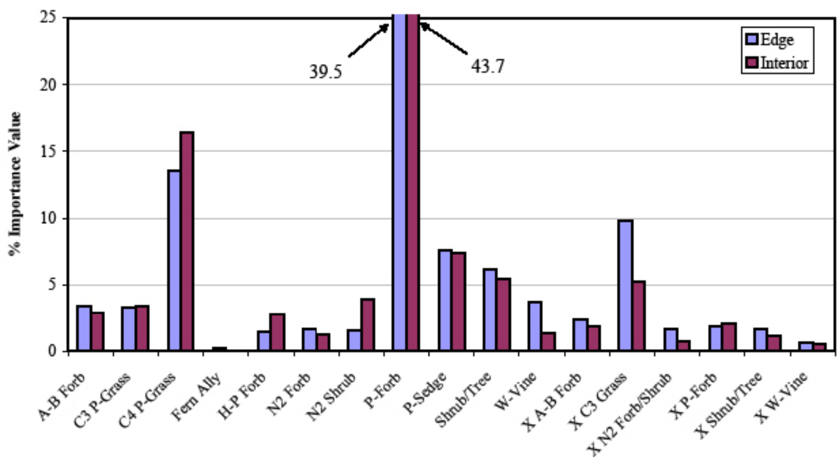


Figure 4.10. Physiognomic group characteristics for edge and interior zones in three high-quality pioneer cemetery prairies, all mesic tallgrass prairies dedicated as Illinois Nature Preserves. X = exotic (non-native), A-B = annual-biennial, P = perennial, H = herbaceous, W = woody, N2 = nitrogen fixing species.

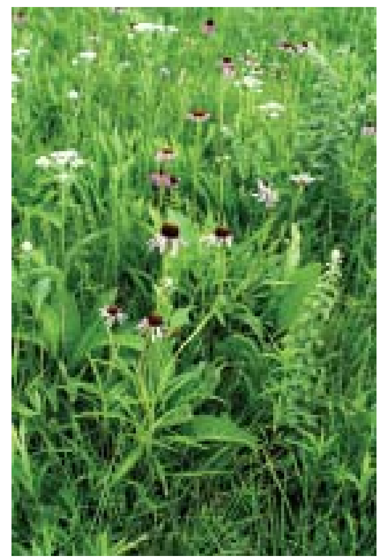


Figure 4.11. Rich assemblage of native prairie species in a mesic prairie remnant in a pioneer cemetery in Ford County (Prospect Cemetery Prairie Nature Preserve). Photo by J. Taft.

Table 4.1. Ecological threats recorded from 325 railroad prairie remnants throughout Illinois.

Threats	# Sites	% of total
Exotics	*309	95%
Mowing	134	41%
Woody invasion	97	30%
Development	19	6%
Cultivation	10	3%
Tree plantings	4	1%
Herbicide or Spraying	3	<1%
Dumping	2	<1%
Digging	1	<1%
Erosion	1	<1%
Recreational vehicles	1	<1%

*Dominant exotics (non-native species) found in RR ROW prairies include Smooth Brome (*Bromus inermis*), Meadow Fescue (*Festuca pratensis*), Wild Parsnip (*Pastinaca sativa*), Reed Canary Grass (*Phalaris arundinacea*), sweet clovers (*Melilotus* spp.), Common Reed (*Phragmites australis*), Autumn Olive (*Elaeagnus umbellata*), and Cut-leaved Teasel (*Dipsacus laciniatus*).

(Hudsonia tomentosa), Umbrella Sedge (*Cyperus grayioides*), Silvery Bladderpod (*Lesquerella ludoviciana*), and the heroic James Clammy Weed (*Polanisia jamesii*) (Fig. 4.13).

Locally in southern Cook County there are fascinating remnants of the dune and swale topography of former Lake Chicago beaches. Prairies occurring on these sites are unique in the close association of moist-soil species in the swales and dry prairie species on the dunes (40). Organic matter accumulation in the swales create ideal habitats for some specialized species including many rare for Illinois. Because of this juxtaposition of habitat types, these remnants can support high levels of diversity.

Like other prairie remnants, most individual sand prairies (46%) are small and less than five acres; however, there are individual sites that are much larger. Consequently, overall, sand prairies average 33 acres, the largest mean size among prairie types in Illinois (Fig. 4.9). The largest prairie remnant of all in the state (5,848 acres [2,367 ha]), known as Lost Mound (formerly the Savanna Army Depot located at the border of Carroll and Jo Daviess counties in northwestern Illinois), was a focus of early prairie studies (70). Lost Mound today contains mainly degraded sand prairie, a result of nearly a century of intensive cattle grazing, but also provides habitat for many rare species in Illinois (72). With the cattle removed and fire gradually being returned to the site, there is great hope for successful restoration of a large and dynamic prairie mosaic, providing habitat for a great variety of prairie plant and animals species, a unique and promising opportunity in the eastern region of the tallgrass prairie ecosystem.

Hill Prairies—Hill prairies are specialized habitats that occur on knolls and slopes often adjacent to major rivers. Four hill prairie community types are recognized in Illinois based on substrate characteristics: loess, sand, glacial drift, and gravel hill prairies (67). Of all prairie types in Illinois, hill prairies today are most numerous with 93 high-quality remnants totaling 453 acres (Fig. 4.8). These range in size from a fraction of an acre to 51 acres with average size about 4.9 acres, the smallest average size among prairie types (Fig. 4.9). Loess hill prairies (Figure 4.14) are the most common, comprising 60% of sites and 84% of acreage and are found mainly in western Illinois along the Illinois, Sangamon, and Mississippi rivers (73, 74). Glacial drift hill prairies are the next most common, comprising 32% of sites but only 9% of acreage; they occur in east-central Illinois (75, 76) and along the west side of the Illinois River, primarily north of Peoria. Gravel hill prairies are limited to northern Illinois, are somewhat similar to glacial drift hill prairies, and are few in number and acreage. Only one sand hill prairie has been identified.

Interestingly, hill prairies often were described by early settlers traveling on the adjacent rivers as parklike grassy eminences above the bluffs, sometimes with scattered oaks. A quote from William Cullen Bryant from 1832 is typical as he described the view from the adjoining Mississippi River: “steep walls of rock, the tops of which were crowned with a succession of little round eminences covered with coarse grass and thinly scattered trees, having quite a pastoral aspect” (77). Several settlers mention fire as a common feature of this landscape (78). Such a landscape setting mostly is a thing of the past and a reminder of the changes and threats to the persistence of these important relicts of our natural history.

Hill prairies persisting to the present time (e.g., Figs. 4.14 and 4.15) are limited to ecologically stressful sites on steep slopes, south to southwest exposures, and on soils with limited capacity for moisture storage (73). While ecologically stressful environments, hill prairies are not so severe that woody encroachment is controlled during periods of fire absence. Woody species typically invading hill prairies include Rough-Leaved Dogwood *(Cornus drummondii*), Smooth Sumac *(Rhus glabra*), oaks, and even Sugar Maple (79). Rough-Leaved Dogwood may be a keystone invader as it is clonal, produces abundant fruits that are dispersed by birds, and by shading herbaceous prairie species it reduces fire effects (80). Infestations of this species may produce a cascading effect by modifying the local prairie environment and permitting other woody species to invade. Based on comparisons of aerial photography during a 37-year period, hill prairies along the Mississippi River in Jersey County declined in area about 62% (81). Hill prairies throughout Illinois continue to decline in area due to woody encroachment and many have disappeared altogether. In a study of nine hill prairies using aerial photography to compare changes in area from 1940 to 1990, decline in total area exceeded 50% for all sites, including some managed with prescribed fire and brush removal (82, 83). The decline of these hill prairies follows a predictable pattern. First woody encroachment from surrounding forest fills ecotonal border zones including ravines, increasing the ratio of prairie edge to prairie interior, and eventually dividing the prairie into smaller, more numerous fragments; the smallest eventually becoming imperceptible in aerial photography. Burning these sites at intermediate rates (e.g., every three to five years) does not appear adequate to maintain them and these prairies are at risk statewide (84). Another source of widespread habitat degradation in hill prairies has been livestock grazing (85).

These dry prairies typically are dominated by species such as Little Bluestem and Side Oats Gramma. Additional dominant species (based largely on 19, 73) include:

Indian Grass
Purple Prairie Clover (*Dalea purpurea*),
Common Spurge
Old Field Goldenrod
Scurfy Pea (*Psoralea tenuiflora*)
Sky Blue Aster (*Aster azureus*)
Leadplant (*Amorpha canescens*)
Yellow Flax (*Linum sulcatum*)
Fringed Puccoon (*Lithospermum incisum*)
Smooth Sumac
Scribner’s Panic Grass (*Dichanthelium oligosanthes* var. *scribnerianum*)
Pale Beardtongue (*Penstemon pallidus*)

Figure 4.12. A blow out in a sand prairie in Mason County, Illinois. Photo by J. Taft.

Figure 4.13. Specialized species of sand blow outs including: A) Beach Heather (*Hudsonia tomentosa*), B) Umbrella Sedge (*Cyperus grayioides*), C) Silvery Bladderpod (*Lesquerella ludoviciana*), and D) James Clammyweed (*Polanisia jamesii*). *Cyperus grayioides* is Threatened and the rest are Endangered species in Illinois.

Figure 4.14. Exposure of loess cap at Revis Hill Prairie Nature Preserve, a loess hill prairie in Mason County, Illinois.

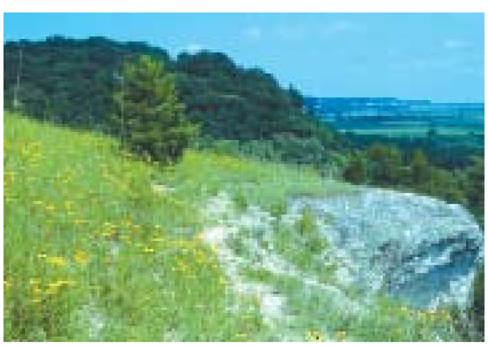


Figure 4.15. Fults Hill Prairie Nature Preserve in Monroe County, Illinois showing margin of limestone glade with spcialized species including the Missouri Orange Coneflower (*Rudbeckia missourien-sis*), a state-endangered species in Illinois.

Wild Petunia (*Ruellia humilis*)
Daisy Fleabane (*Erigeron strigosus*)
Tall Boneset (*Eupatorium altissimum*)
False Boneset (*Brickellia eupatorioides*)

Many species from further west reach their eastern range extent in hill prairies along the Mississippi River, including several listed as threatened or endangered in Illinois:

Spurge (*Euphorbia spathulata*)
Slender Heliotrope (*Heliotropium tenellum*)
Whitlow Grass (*Draba cuneifolia*)
Dwarf Bedstraw (*Galium virgatum*)
Narrow-leaved Milkweed (*Asclepias stenophylla*)

While smaller hill prairies have fewer species than larger remnants and species losses can be expected to have occurred as sites contract in area due to woody invasion (62), small hill prairies still include many conservative species and more than would be predicted based on area alone (84). Similar results have been found with small remnants of silt-loam prairies (86). These patterns suggest that immediate and vigilant efforts to manage remnant hill prairies have the potential to preserve much of their species diversity. Whether these species persist will depend on the level of priority placed on conserving the remaining hill prairies in Illinois.

Dolomite Prairie—Dolomite prairies occur where dolomite is close enough to the surface (e.g., within six feet) to influence species composition (67), primarily along the Des Plaines and Kankakee rivers in Will County. They comprise only about 2% of prairies remaining in Illinois. Moisture classes are dependent on drainage characteristics and depth to bedrock and include dry to wet community types. Many have been degraded by flagstone quarrying and other disturbances including livestock grazing. Formerly, cattle drives to the Chicago stock yards followed the Des Plaines River corridor impacting severely many of the prairies along the way. Nine high-quality remnants are known totaling 49 acres, yielding an average remnant size of 5.4 acres (Fig. 4.9).

Characteristic species depend on moisture conditions. Soils are shallow in dry dolomite prairie and dolomite can be locally exposed. Dominant species are similar to loess hill prairie (e.g., Little Bluestem, Side Oats Gramma). Northern Prairie Dropseed becomes characteristic in mesic dolomite prairies and some species affiliated with calcareous wetlands such as seeps and fens can be found in wet-mesic and wet dolomite prairie including Ohio Goldenrod (*Solidago ohiensis*), Riddell's Goldenrod (*S. riddellii*), Indian Plantain (*Cacalia tuberosa*), and Tufted Hair Grass (*Deschampsia caespitosa*). Several rare species are associated with dolomite prairie (Fig.4.16) including the federally endangered Leafy Prairie Clover (*Dalea foliosa*), False Mallow (*Malvastrum hispidum*), a quillwort (*Isoetes butleri*), and Slender Sandwort (*Minuartia patula*).

Gravel Prairie—Gravel prairies occur on kames or eskers (gravelly mounds deposited by glaciers) and locally on gravel terraces along streams in northern Illinois. Gravel tends to be of a calcareous nature providing a basic pH reaction to these typically well-drained soils (67). Most have been destroyed by gravel mining. Twelve remnants are known totaling 80.8 acres. Average remnant size is 6.7 acres (Fig. 4.9) and gravel prairies comprise about 3.2% of all remaining prairies in Illinois. Typical species include many also found in dolomite prairies (dry to mesic types) together with Pasque Flower (*Pulsatilla patens*), Prairie Smoke (*Geum triflorum*), Low Calamint (*Calamintha arkansana*), Fringed Puccoon, and Rock Sandwort (*Minuartia stricta*).

Shrub Prairie—This community type occurs on acidic sandy soils of the Chicago Lake Plain and Kankakee Sand Area. Only five high-quality remnants are known totaling 60 acres (Fig. 4.8). Characteristics shrub species include Early Low Blueberry (*Vaccinium angustifolium*), Black Huckleberry (*Gaylussacia baccata*), Hardhack (*Spiraea tomentosa*), Black Chokecherry (*Aronia melanocarpa*), and Purple Chokecherry (*A. prunifolia*). Mosses form a nearly continuous ground layer (67). Hazel thickets (*Corylus americana*) also were a feature of some prairie border areas (87), but few extensive examples remain.

How Many Prairie Species Are There?

Many prairie plants have broad ecological amplitude making the designation of a taxon as a prairie species somewhat arbitrary. For this reason, tallying a total number of vascular plant taxa for the variety of prairie communities is unavoidably imprecise. Nevertheless, an estimate of 800 to 850 plant species for Illinois prairies has been made (82) based on combined lists (e.g., 73, Evers unpublished data, and 88, 89). These lists, however, include several notably uncharacteristic prairie species (e.g. oak and maple species) that were recorded from one or more sites. Although this estimate of plant species richness in Illinois prairie is broad in consideration, it is noteworthy that a similar number of plant taxa (ie., n=862) was estimated for prairie communities for the midwestern United States (90).

Carving up the state's natural vegetation cover has served as an interesting but tragic experiment. The question might be: What effect would reducing the original approximately 20 million acres of prairie in Illinois to a mere 2,496 acres, or 0.01%, have on the overall total number of plant species? It might be expected given this harsh treatment that many of the prairie species would be at risk of extinction or at least extirpation from the state. However, of the 680 plant species considered in danger of extinction in the United States and listed by the U.S. Fish and Wildlife Service as threatened or endangered, only eight are found in Illinois (three-quarters are found in California, Florida, Hawaii, Texas, and Puerto Rico [91]). Seven of these broadly can be considered prairie species:

Mead's Milkweed (*Asclepias meadii*)
Decurrent False Aster (*Boltonia decurrens*)
Dune Thistle (*Cirsium pitcheri*)
Leafy Prairie Clover (*Dalea foliosa*)

Figure 4.16. A) Leafy Prairie Clover (*Dalea foliosa*), a species listed as threatened by the US Fish & Wildlife Service, occurs in a few dolomite prairies in northeastern Illinois. Photo by M. McNicoll. B) Slender Sandwort (*Minuartia patula*), a winter annual species listed as state threatened, is a species of limestone habitats. Populations fluctuate greatly from year to year. Under certain circumstances, colonies can be so dense to appear as local patches in snow in late May. Photo by J. Taft. C) False Mallow (*Malvastrum hispidum*), another annual species of bare dolomite habitats. D) Butler's quillwort (*Isoetes butleri*), a fern ally found associated with shallow soils over dolomite in dolomite prairies in northeastern Illinois. The latter two species are listed as endangered in Illinois. Photos by S. Hill.

Lakeside Daisy (*Hymenoxys herbacea*)
Prairie Bush Clover (*Lespedeza leptostachya*)
Eastern Prairie Fringed Orchid (*Platanthera leucophaea*).

Of these, only the Leafy Prairie Clover is listed as endangered (at risk of extinction throughout range), while the others are listed as threatened (likely to become endangered throughout range).

An additional 67 vascular plant taxa previously known from Illinois are considered to be extirpated from the state (92). Surprisingly, only five of these were possibly prairie species:

Gaillardia (*Gaillardia aestivalis)*
Carolina Phlox (*Phlox carolina* var. *angusta*)
Thismia (*Thismia americana*, an Illinois endemic that probably is extinct)
Wild Blue Larkspur *(Delphinium carolinianum* var. *penardii*; only the variety extirpated)
Prairie Lettuce (*Lactuca ludoviciana*).

With the single exception of Prairie Lettuce, these taxa apparently always were quite scarce in Illinois (93).

About 15% of the native Illinois vascular flora is listed by the Illinois Endangered Species Protection Board (IESPB) as state threatened or endangered, about 339 species at last listing (94). A further unexpected result of the tragic experiment is that only nine of these taxa listed as state threatened or endangered are more or less dependent on silt-loam prairie (93) with an additional 12 taxa occurring in silt-loam prairies as well as other prairie community types (Table 4.2). While few prairie species have been extirpated and relatively few species restricted to silt-loam prairie are listed as threatened or endangered, with broad consideration of all prairie habitats in Illinois, about 103 species (28% of all state threatened and endangered plants) are listed as state threatened or endangered (93). This comprehensive list includes about 12% to 13% of the Illinois prairie flora.

Why has this tragic experiment only cost Illinois citizens five prairie plant species, four of which originally were quite scarce? If the total prairie remaining had been one 2,496-acre parcel in the heart of the Grand Prairie Natural Division, success at retaining diversity with such extraordinary habitat loss would have been far lower. Instead, about 231 much smaller parcels of high-quality prairie occur scattered throughout much of the state (Fig. 4.17) in a variety of prairie habitat types, each with its own unique set of species as well as core species similar to most types. This variety of prairie habitats is the result of diverse ecological conditions found statewide and accounts, to this point, for the sustained richness of the Illinois prairie flora.

This brief overview of prairie communities provides an indication that the prairies of Illinois comprise a diverse assemblage of plant (and animal) species associated with a wide range of ecological conditions. As site geological, topographic, and moisture characteristics influence soil types, so too do they influence species composition with no two sites exactly alike. However, few citizens of Illinois have the privilege of observing this range of prairie types. Scientists and conservationists working to protect, manage, and conduct research on these last remnants of prairie, like canaries in the catbird seat, are keenly aware of their vulnerability. While threats are apparent to these last remnants of tallgrass prairie, resources can be brought together to make sustaining prairie in the Prairie State a long-lasting priority so that more citizens are afforded the opportunity to gain an appreciation of our shared natural heritage.

The hope that such commitment can be made is supported by a growing interest by the general public in restoring and reconstructing prairie habitats (see Chapters 13 and 14). The aesthetic values of prairie landscapes and the potential value of prairie plants in a system of sustainable agriculture is drawing attention from several sources. Efforts are being made to develop one of the native grasses (eastern gamma grass [*Tripsacum dactyloides*]) into a perennial grain crop (95) and to expand the use of warm-season native grasses as a source of forage in combination with cool-season domestic grasses. New initiatives also are examining the potential for tallgrass prairie plantings to serve as biofuels (e.g., 96). Some plantings have been used for

Table 4.2. Plant species found in silt-loam prairie that are listed as threatened or endangered by the Illinois Endangered Species Protection Board (94). * Species also listed by the U.S. Fish and Wildlife Service as federally threatened or endangered.

SCIENTIFIC NAME	COMMON NAME	STATUS
Species of Silt-Loam Prairie		
Elymus trachycaulus	Bearded Wheat Grass	ST
*Ascleapias meadi*i	Mead's Milkweed	SE, FT
Bechmannia syzigachne	American Slough Grass	SE
Boltonia decurrens	False Aster	ST, FT
Camassia angusta	Wild hyacinth	SE
Lactuca ludoviciana	Prairie lettuce	SE
Platanthera leucophaea	Prairie White-fringed Orchid	SE, FT
Sabatia campestris	Prairie Rose Gentian	SE
Sisyrinchium montanum	Mountain Blue-eyed Grass	SE
Species of Silt-Loam and Other Prairie Communities		
Asclepias ovalifolia	Oval Milkweed	SE
Calopogon tuberosus	Grass Pink Orchid	ST
Cypripedium candidum	White Lady's Slipper Orchid	ST
Cypripedium parviflorum	Small Yellow Lady's Slipper Orchid	SE
Cypripedium reginae	Showy Lady's Slipper Orchid	SE
Juncus vaseyi	Vasey's Rush	SE
Phlox pilosa ssp. *sangamonensis*	Sangamon Phlox	SE
Silene regia	Royal Catchfly	SE
Spiranthes vernalis	Spring Ladies' Tresses	SE
Tomanthera auriculata	Auriculata False Foxglove	ST
Tradescantia bracteata	Prairie Spiderwort	ST
Trillium viride	Green Trillium	SE

Figure 4.17. Distribution of prairie remnants recognized as Grade A or B by the Illinois Natural Areas Inventory. Each dot represents a prairie remnant (n = 231).

Figure 4.18. Spring burn at Unity East Grade School Prairie Reconstruction, Champaign County, Illinois. Photo by J. Taft.

erosion control of drainageways and an increasing number of primary and secondary schools are planting prairie as an educational resource (Fig. 4.18).

SAVANNAS AND OPEN WOODLANDS

The topic of savannas might conjure images of scattered acacias and herds of grazing elephants, giraffe, and zebra. But such savannas, reliant on interactions among grazing animals, landscape variables, and fire (97), are not just a feature of African landscapes; rather, they occur throughout many parts of the world including North America and particularly in midwestern states such as Illinois (9, 98). Nevertheless, maps illustrating the dominant vegetation types in Illinois at the time of settlement generally show only two basic formations: prairie and forest (see Fig. 3.7). But the sharp dividing line depicting the boundary between prairie and forest is more a measure of convenience of scale and difficulties in mapping variable boundaries than a reflection of reality. Fires that contributed largely to the maintenance of tallgrass prairie typically did not stop abruptly at a forest border but rather these fires often contributed to the formation of a patchy continuum from open prairie to closed forest termed the prairie-forest ecotone (12, 99, 100).

Some prairie groves (101) may have been exceptions to the prairie-forest continuum because they typically occurred as islands, often dominated by fire-tolerant Bur Oaks, that dotted the Grand Prairie region in Illinois. These occurred in protected areas where fires may have been less regular. Such groves were described as having fairly sharp outlines with few trees extending into the prairie (102). Nevertheless, judging from the compostional and structural changes ongoing in remnant groves (e.g., 103, 104), these also were affected by periodic fire.

Savanna has been defined as a habitat with scattered, open-grown trees, with or without shrubs, and a continuous herbaceous ground cover (105); in the Midwest, these include many species of grasses and forbs also found in prairie. Woodland generally refers to a partially closed canopy, with or without a shrub stratum, and a ground cover including dominance of grass and sedge (graminoid) species, forbs, and woody plants (seedlings and vines) with a greater predominance of species found in ecotonal zones and fewer prairie species. To address the range of structural variation found in the prairie-forest continuum and in prairie groves, for convenience these collectively are referred to here as savannalike habitats. Midwestern savannalike habitats have several unifying characteristics: 1) scattered trees typically with an open-canopy structure (relative to trees in a closed forest); 2) overstory dominance by a few species of oak; 3) a majority of floristic diversity contained in the ground cover, usually rich in species associated with tallgrass prairie and ecotonal zones including grasses, sedges, and forbs; and 4) fire-tolerant species and dependence on fire for maintenance of diversity and stability (9).

CLASSIFICATION AND TRENDS IN SAVANNALIKE HABITATS

Classification of Savannalike Habitats

Several efforts have been made to classify vegetation along the prairie/forest continuum. Distinctions between these major vegetation types can be somewhat arbitrary and have been interpreted in a variety of ways (Fig. 4.19). Vegetation can be classified according to dominant plant species for plant community classification (e.g., bur oak savanna) or growth form and environmental conditions yielding a natural community classification (e.g,. mesic savanna). Because of individualistic species interactions, conservation agencies in the Midwest typically use a natural community system of classification (e.g., 67, 106).

Three basic savanna types (subclasses) are recognized in Illinois (67): *Savanna* (generally on fine-textured soils), *Sand Savanna* (Fig. 4.20), and *Barrens* (Fig. 4.21). Barrens is a term that has been applied to a wide variety of habitats. As used here, barrens refer to local inclusions of a prairielike flora and savanna structure within a predominantly forested landscape. These savanna types are further distinguished by soil-moisture characteristics. These natural communities often occur associated with other vegetation types (e.g., dry to dry-mesic upland forest, flatwoods, prairie) with indistinct boundaries that could vary over time.

Transitions between natural community types, such as from savanna to forest, can be bidirectional depending on fire frequency (Fig. 4.22). Prior to the establishment of the agricultural landscape in Illinois and the resulting isolation of remnant natural communities, transitions among vegetation types were readily facilitated by landscape connectivity and generally unrestrained opportunities for migration among individual plant species. However, the contemporary constraints on species movement due to habitat fragmentation strongly limits the potential species pool (107) and the capacity for bidirectional changes among associated habitats without losses in species diversity. These constraints on floristic relay with vegetational changes are a major concern regarding conservation of savanna and open-woodland habitats.

Savannalike Habitats at the Time of Settlement (Early 1800s)

Savannalike communities form by two basic processes: trees invading prairie with periodic fire absence, and prairie invading woodland during periods of greater fire frequency (Figure 4.22). The presettlement distribution has been estimated for deep-soil, tallgrass savannas (98) and the Eastern Prairie-Forest Transition zone (12). A total area of about 30 million acres of tallgrass oak savanna has been estimated for the Midwest (98). However, neither estimate included the region of the Ozark Plateau, the southern portion of the Illinoian till plain, or the Shawnee Hills region. Considering the vegetation documented in these regions consisting of open woodlands and local inclusions of a prairie flora (108, 109, 110), the extent of savannalike communities considered here expands somewhat beyond the region of tallgrass savanna and transition zone (Fig. 4.23).

Based on distribution of soil types transitional between forest and prairie and detailed county-level presettlement vegetation maps (e.g., 111, 112, 113), savannalike communities, including deep-soil tallgrass savanna (98) and more shallow-soil variants (114), were widespread and relatively common in Illinois. The estimates for total prairie and forest in Illinois (see Fig. 3.7) include most savannalike habitats in the forest category. Areas with very sparse trees (e.g., a few trees per acre) probably were mapped in the GLO surveys as prairie.

Trends Since Settlement

For a time, many settlers continued the aboriginal practice of using broadcast-scale fire on a nearly annual basis, in some cases up to the 1920s when it was considered to be a "savage custom" to be strongly discouraged (115). With the following national campaign of fire suppression featuring Smokey Bear, fire frequency declined precipitously by the 1930s. As an indication of fire dependence, in just a few decades of reduced fire, many savannalike habitats persisting to that time in the Midwest were altered by a conversion to woodland and closed forest (20, 165). Stand closure, a result of increasing tree density, eventually was followed by the patterns of reduced oak regeneration seen today (see Forest section). Understanding the role of fire in the maintenance of oak dominance (116) was not immediately apparent to many foresters and conservationists throughout much of the twentieth century and in some districts remains controversial.

Generally, along the gradient from open prairie to closed forest, there are predictable changes in vegetation structure and composition. For example, the importance of graminoid species declines and woody plant seedlings, saplings, trees, and vines increase (117). A principal difference between tallgrass savanna and open woodland communities is the composition of matrix graminoid species. While many of the dominant prairie grasses (e.g., Big Bluestem, Indian Grass, Little Bluestem, and Porcupine Grass [*Stipa spartea*]) were important in open savannas (other than *Stipa*, these are warm-season species with the C4 photosynthetic pathway), woodlands are more characterized by the presence of somewhat more shade-tolerant grasses (i.e., cool-season species with the C3 photosynthetic pathway) such as Wood Reed *(Cinna arundinacea),* Bottlebrush Grass *(Elymus hystrix),* Woodland Brome *(Bromus pubescens),* several panic grasses *(Dichanthelium* species), and several sedges (e.g., *Carex pensylvanica, C. albicans, C. muhlenbergii, C. hirsutella*). The transition from prairie-grass dominance to woodland-grass/sedge dominance can be abrupt, suggesting prairie grasses share a common threshold of shade tolerance (118). The accumulation of litter with increasing density of trees is known to reduce the yield of shoots and favor rhizomatous mid grasses compared with bunch grasses dominant in prairies (119). These compositional characteristics provide a gauge for interpreting transition phases in the prairie-forest continuum. Along this continuum from full sun to light-limited communities (e.g., prairie to forest), there is a shift in competition and resource allocation patterns among plants from primarily below ground (roots) to primarily above

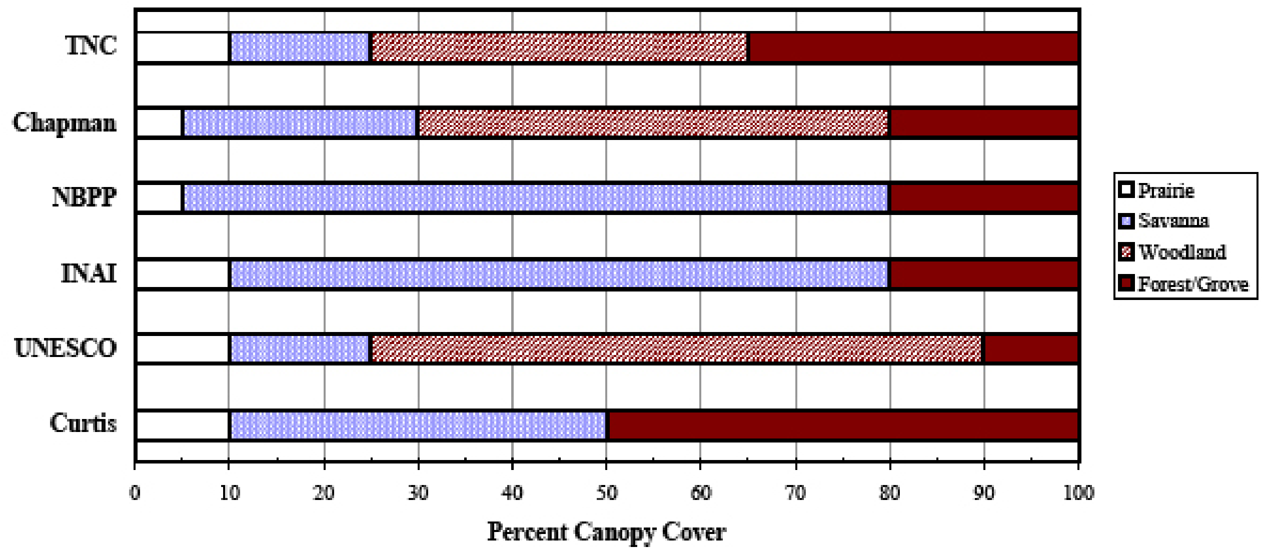


Figure 4.19. Classification schemes for prairie, savanna, woodland, and forest communities according to percent canopy cover (modified from 9). TNC = The Nature Conservancy, NBPP = North Branch Prairie Project, INAI = Illinois Natural Areas Inventory.

Figure 4.20. Sand savanna dominated by Black Oak (*Quercus velutina*) at Illinois Beach State Park, Lake County, Illinois. Photo by J. Taft.

Figure 4.21. Gibbons Creek Barrens, a dry barrens community in Pope County, Illinois. Photo by J. Taft.

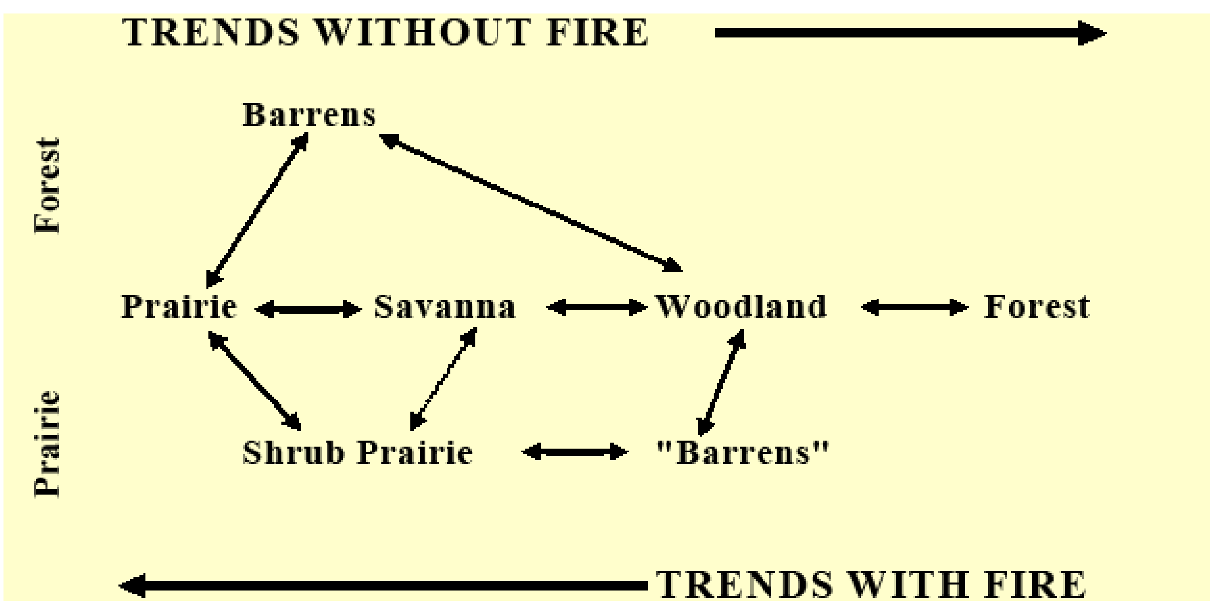


Figure 4.22. Diagram of habitat transitions with and without fire in forested vs. prairie regions. The trends imply increasing or decreasing fire frequency (modified from [9]).

ground (120). Fire often is prescribed to reverse these trends (see Chapter 14) by reducing litter accumulation and the density of woody plants and their shading effects.

The extent of a shrub-sapling layer in savannalike communities can provide a gauge to recent fire history. With reduced fire frequency, a shrub/sapling stratum typically formed including hazel, plums, sumacs, poplars, and oaks (87, 108). In places, large shrub and oak grub-dominated (oak resprouts) thickets were characteristic of transitional zones between savanna and prairie (121, 122, 123). Hazel remains a common species in closed oak woodlands throughout Illinois; however, no reproduction occurs in dense shade. These contemporary sterile populations probably represent remnants from past hazel thickets overtaken by the forest and thus could be considered artifacts of the former disturbance-mediated savanna/open woodland ecosystem.

Savannalike communities, perhaps more than other vegetation types, have been greatly changed as a result of habitat fragmentation and altered natural disturbance cycles. Foremost among these alterations has been a decline in fire frequency, resulting in at least partial transition towards closed woodland and forest habitats at many sites. Consequent to these changes, the once widespread oak savannas have become among the rarest plant communities in the Midwest (98).

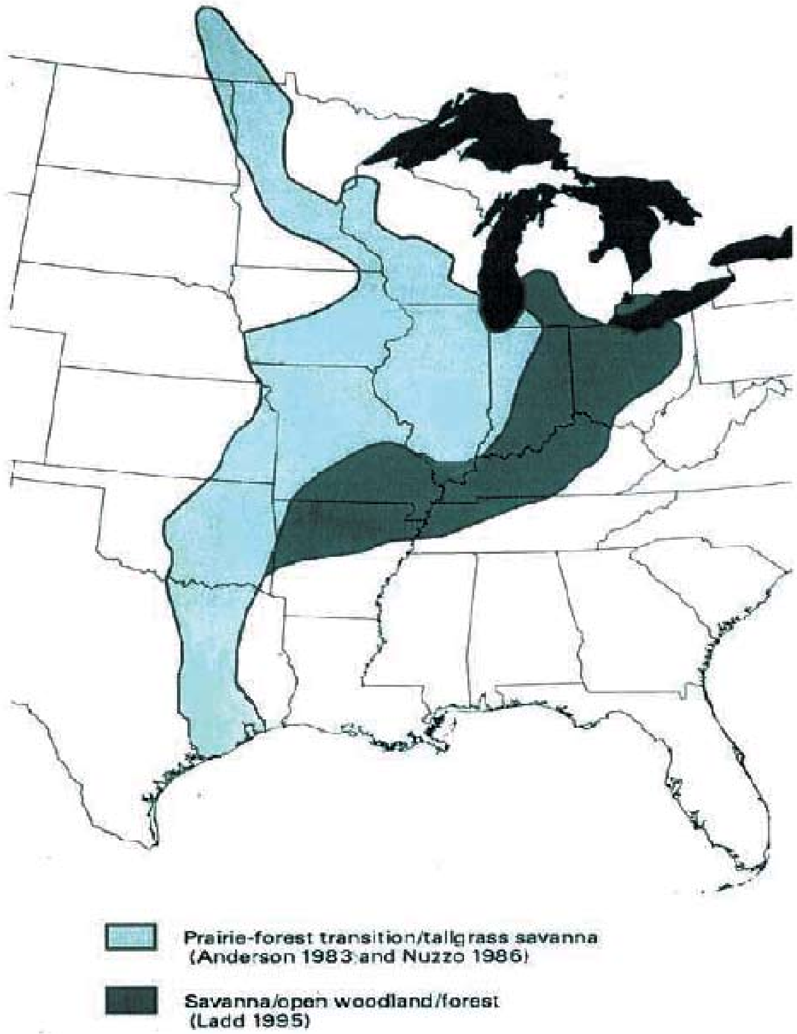


Figure 4.23. Distribution of the prairie-forest and savanna/open woodland transition zones in midwestern North America (modified from 9).

CONTEMPORARY STATUS OF SAVANNALIKE COMMUNITIES

Tallgrass savannas in several midwestern states have been estimated to include 113 noteworthy sites totaling 6,442 acres of relatively high-quality tallgrass savanna habitat, about 0.02 % of the estimated previous extent (98). Presently in the Midwest, former savanna and open-woodland habitats still can be recognized on sites with rich silt-loam soils by the scattered occurrence of large, open-grown oaks often now within closed woodland. In addition to these relicts, local features of surface geology have contributed to the persistence of savannalike habitats. Droughty conditions found where sand deposits are located and where bedrock is near the surface, typically where bluffs occur along the major rivers and in unglaciated regions, have retarded vegetational changes during extended periods of fire absence. Because these environmental conditions limit agricultural use, similar to prairies described previously (Fig. 4.10), such areas are disproportionately represented among natural savanna remnants (Fig. 4.24). For example, the Illinois Natural Areas Inventory (INAI) has delineated only 87 acres among nine sites of relatively undisturbed savanna on silt-loam soils compared with a total of 1,204 acres among 16 sites on sandy soils (65, 124). The INAI also identified 132 acres of dry to mesic barrens at 19 sites. Of these 44 savannalike remnants totaling 1,424 acres, sites on deep silt-loam soils account for only 6.1% of total area and 20% of remnants. Most savanna remnants are small and in the one- to five-acre range; however, 14 sites (32% of total) have been identified that are greater than 20 acres (Fig. 4.25). Most of these larger savannas (79%) are on sandy soils. In addition to these natural areas, many savannalike areas have been structurally maintained or created by livestock grazing (Fig. 4.2). Typically, the ground cover at pastured sites is degraded and characterized by an abundance of non-native species.

Despite widespread habitat loss and degradation, field botanists in the Midwest have empirical knowledge of characteristic species of savannalike habitats (Table 4.3). As with findings in Wisconsin where only six species were found to be typical of oak openings (20), few of the species in Table 4.3 are limited to savannas. Rather, many have broad ecological amplitude occurring also in prairie, woodland, and other habitats. As a result, few savanna species of the Midwest are globally rare (none are listed by

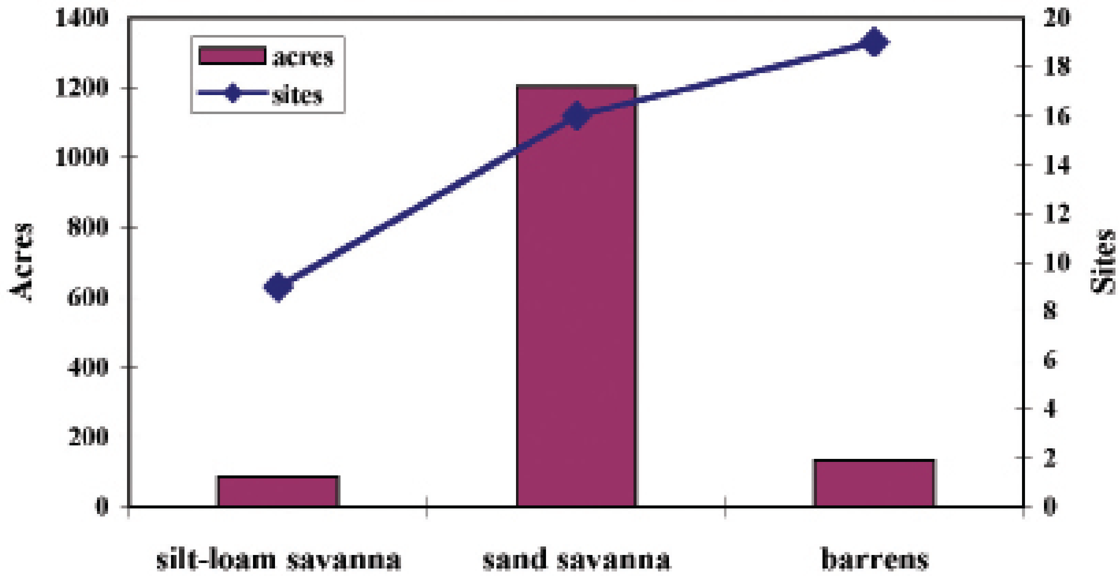


Figure 4.24. Sum acreage and site number of high-quality savannas recognized by the Illinois Natural Areas Inventory showing data by savanna subclasses.

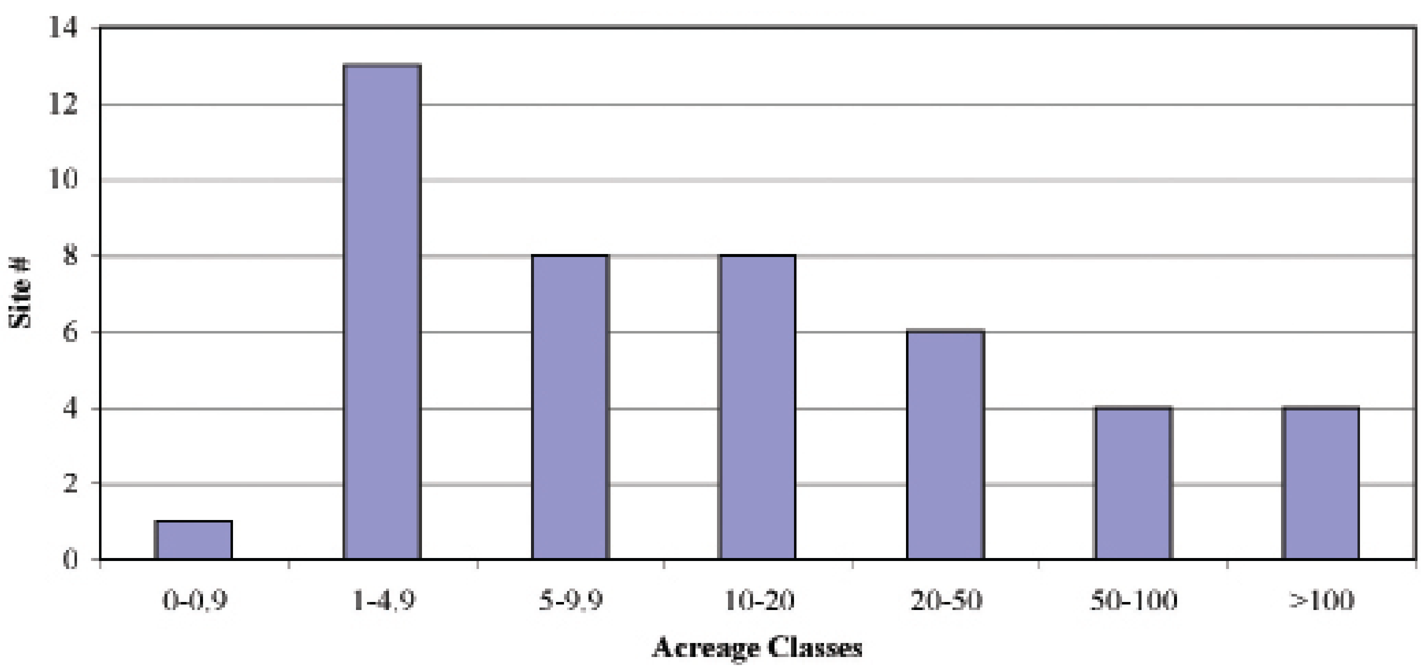


Figure 4.25. Size-class distribution among sites for high-quality savanna remnants recognized by the Illinois Natural Areas Inventory.

Table 4.3. Select list of 50 characteristic species of savanna and open woodland habitats. Species listed as state threatened (ST) and State endangered (SE) are indicated. Species indicated by S are characteristic in sandy soils. Note that these species, while occasionally found in other habitats, signal savanna. Many other important savanna species (e.g., prairie grasses) are not listed because their presence does not necessarily suggest savanna since they occur regularly in other community types (e.g., prairie or forest).

Common Name	Scientific Name
Bird's Foot Violet	*Viola pedata* - S
Black-Jack Oak	*Quercus marilandica*
Blue Toadflax	*Linaria canadensis* - S
Blunt-Leaf Sandwort	*Moehringa lateriflora*
Buffalo Clover	*Trifolium reflexum* (ST)
Canadian Milk Vetch	*Astragalus canadensis*
Culver's Root	*Veronicastrum virginicum*
Dwarf Bindweed	*Calystegia spithamaea*
False Dandelion	*Krigia biflora*
False Sunflower	*Heliopsis helianthoides*
French Grass	*Psoralea onobrychis*
Goat's Rue	*Tephrosia virginiana* - S
Hairy Bedstraw	*Galium pilosum*
Hairy Meadow Parsnip	*Thaspium barbinode*
Hairy Mountain Mint	*Pycnanthemum pilosum*
Hairy Wild Lettuce	*Lactuca hirsuta*
Hazel	*Corylus americana*
Indian Physic	*Porteranthus stipulaceus*
Kittentails	*Besseya bullii* - S (ST)
Large Ground Plum	*Astragalus crassicarpus* var. *trichocalyx* (SE)
Mullein Foxglove	*Dasistoma macrophylla*
New Jersey Tea	*Ceanothus americanus*
Pale Indian Plantain	*Cacalia atriplicifolia*
Pale Vetchling	*Lathyrus ochroleucus* (ST)
Pennsylvania Oak Sedge	*Carex pensylvanica*
Post Oak	*Quercus stellata*
Purple Coneflower	*Echinacea purpurea*
Purple Milkweed	*Asclepias purpurescens*
Round-Fruited Panic Grass	*Dichanthelium sphaerocarpon*
Royal Catchfly	*Silene regia* (SE)
Sangamon Phlox	*Phlox pilosa* subsp. *sangamonensis* (SE)
Savanna Blazing Star	*Liatris niewlandii* (ST)
Shooting Star	*Dodecatheon meadia*
Slender-Leaved Panic Grass	*Dichanthelium linearifolium* - S
Spreading Dogbane	*Apocynum androsaemifolium* - S
Starry Campion	*Silene stellata*
Sweet Fern	*Comptonia peregrina* (SE)
Tall Alumroot	*Heuchera americana*
Tall Forked Chickweed	*Paronychia canadensis*
Thicket Parsely	*Perideridia americana*
Upland Boneset	*Eupatorium sessilifolium*
Violet Collinsia	*Collinsia violacea* (SE)
Virginia Spiderwort	*Tradescantia virginiana*
Wild Hyacinth	*Camassia scilloides*
Wild Lupine	*Lupinus perennis* - S
Wild Quinine	*Parthenium integrifolium*
Wolf's Bluegrass	*Poa wolfii* (ST)
Wood Angelica	*Angelica venenosa*
Yellow Pimpernel	*Taenidia integerrima*

the USFWS as threatened or endangered) although many are regionally scarce and listed as state threatened or endangered (Table 4.3). For this reason, much of the conservation focus on savannas is at the community level rather than a focus on individual species recovery. However, capturing and preserving the dynamic spatial heterogeneity of savannalike systems within set preserve boundaries is particularly challenging in a highly fragmented landscape. In small reserves of fire-dependent savannalike natural communities, habitat may not always be available for species dependent on a particular stage in the dynamic continuum (125). Such reserves are likely to require intensive management activities that maintain or enhance population sizes, existing levels of diversity, and prevent vegetational changes from greatly altering the preserve target community (126).

FOREST

Since the early 1800s, Illinois' forests have undergone dramatic changes in total extent as well as habitat composition and structure. Few if any areas remain that have not been cut, grazed, or altered by land-use activities. Fires that previously were commonplace in prairie and savanna habitats also entered forests influencing species composition and stand structure; however, extensive periods of fire absence have led to major changes in current forests. Among the compositional changes has been a shift from oaks to more shade-tolerant maples and elms. Furthermore, many non-native species have invaded and become invasive, leading in some cases to replacement of native forest species. This section describes these trends in two parts. Part I provides an overview of spatial trends from the time of European settlement to the present, including overstory species regeneration dynamics and protection status of remaining forests. Part II summarizes major forest community types found in Illinois including current forest composition, diversity, and health. Chapter 15 of this volume describes selected results from the forest monitoring component of the Critical Trends Assessment Program. Chapter 16 describes how tree species might respond to climate warming based on a series of predictive models.

PART I—FOREST TRENDS

Forests at the Time of European Settlement (Circa 1820)
At the time of the first European-American settlements in Illinois, woodlands and forests covered about 15.3 million acres, or 42% of the land area, more than triple the current extent. As noted in Chapter 3, Illinois was systematically surveyed by the General Land Office during the period 1807–1844, establishing the familiar coordinate system of Township, Range, and Section. Surveyors, starting with southern Illinois and working northward, primarily were charged with dividing the land into sections and townships; however, they also prepared plat maps and made notes on the vegetation they encountered. These data provide unique insights to the appearance of the landscape and the distribution of forest and prairie prior to the extensive land cover alterations that followed settlement. Large expanses of forest existed at the time of Euro-American settlement with the greatest concentrations in the western and southern regions (see Fig. 3.7). However, based on the boundaries of the current 102 Illinois counties, most had some forest area. Only 21 counties, all in the Grand Prairie Natural Division (see Chapter 2), had less than 20% forest cover.

Forests, particularly upland stands, at this time differed from most current stands by their exposure to occasional fires. Oaks, including potentially 13 of the 20 species native to Illinois, were dominant in the overstory of upland areas (the remaining species primarily are bottomland species). Oaks greater than a few inches diameter are capable of enduring low-intensity fires typical of woodland/forest stands, favoring their dominance and ecological significance. In contrast, maples are favored in more closed and shaded stands and, when young, tend to be fire sensitive. According to the early surveyor records, Sugar Maples were quite scarce compared with modern forests (127), suggesting fire was a widespread and general phenomenon. The spreading form of old oaks in the few remaining old-growth stands is a reminder of the formerly more open conditions that existed when these trees became established.

Characteristics of the landscape had great influence on forest distribution in Illinois. Forests primarily were concentrated in areas of greater topographic relief such as the dissected terrain of riparian corridors where there was some fire protection (52). For example, about three-quarters of all forest cover in Illinois is associated with slopes greater than 4%. In contrast, most prairie vegetation (82.3%) occurred on landscapes with less than 4% slopes (7). Most of the timbered land associated with this low-slope category occurred in floodplains or the formerly extensive flatwoods of the Illinoian till plain (described in Part II).

Forest Trends Since Settlement
Extensive forest clearing, grazing by livestock, fire absence, and shifts in native species composition, as well as exotic species infestations, have greatly altered Illinois forests since the early 1800s. Only about 16,452 acres of forest land remains in a relatively undisturbed condition (65, 124 updated in 2007), about 0.1% of the acreage at the time of settlement. In other words, 99.9% of forest lands have been altered appreciably, though some have recovered somewhat from past disturbances. As a result, together with the near complete elimination of prairie (see Prairie section) and dramatic losses of wetland acreage (see Chapter 5), Illinois ranks 49th among the 50 states, next to Iowa, in the percent of land converted from its potential vegetation type (128, 129).

The pattern of deforestation of primary forests in Illinois can be deduced by the estimates of forest land cover in the early 1800s and in periodic forest surveys comprehensively beginning in 1924 (Fig. 4.26) and following accounts (e.g, 130, 131, 132, 133). Many early settlers mistakenly believed the prairies were too infertile to support trees, thus forests at first were the primary lands utilized for agriculture. However, with the development of the steel, self-scouring moldboard plow, settlers discovered that prairies could be cultivated and made productive cropland. Subsequently, prairies were converted to cropland at an astonishing rate (see Prairie section). Over 300,000 people settled in the prairie regions during the 1830–1840 period, and since railways were not yet in place, local timber supplies were utilized extensively for housing material, fuel, and fenceposts. Most of the timber in the prairie counties disappeared during this period.

By 1860, the timber industry began to flourish in Illinois. By 1870, 92 of the 102 counties had manufacturing industries based on wood products and total forestland in the state had been reduced to an estimated 6.02 million acres (130), 39% of original coverage. During the 1880s, total annual lumber production within Illinois reached over 350 million board feet, or 2.2 times the present rate (Fig. 4.27). Lumber production continued to increase until 1880, after which it began to decrease due to limited resources. By 1923, only about 22,000 acres of the original 15.3 million acres of primary forest remained, although because of regrowth from timbered stands, total acreage was just over 3 million acres. Late nineteenth century deforestation rates in Illinois compare with, or in some cases exceed, late twentieth century deforestation rates in tropical areas such as the Rondonia region of Brazil and Malaysia (134). History (in this case, unsustainable extraction of natural resources) does indeed repeat itself.

Forest area in Illinois reached its minimum extent in about 1920 with 8.5% statewide coverage (22% of presettlement acreage). During the next 80 years, area of forest land cover increased by about 50% (130, 132) to 4,525,300 acres (Fig. 4.26) with the greatest increase during the period from 1924 to 1948. Total forest cover in 2005 was about 12.7% of the state. This trend partially can be attributed to a reduction in cattle grazing and conversion of pastures and hayfields to forest. In 1998, 11% of timberlands (excluding protected forest acreage) also were used as pasture, down from about 14% in 1985, leading to improved rates of canopy tree regeneration. Grazing in forest habitats by domestic livestock such as cattle can be destructive, affecting not only tree regeneration but also tree growth, tree mortality, and water quality (132). While a relatively small percentage of forest land currently is grazed, it is hard to find forests in Illinois that do not bear the signature effects of cattle grazing. Perhaps most salient is the effect on understory vegetation, yielding a composition dominated by weedy native and non-native species known as grazing increasers such as (* = non-native species):

Black Snakeroot (*Sanicula odorata*)
White Snakeroot (*Eupatorium rugosum*)
Pokeweed (*Phytolacca americana*)
Enchanter's Nightshade (*Circaea lutetiana*)
Missouri Gooseberry (*Ribes missouriense*)
Black Raspberries (*Rubus allegheniensis*, *R. pennsylvanica*)
Multiflora Rose* (*Rosa multiflora*)
Amur Honeysuckle* (*Lonicera maackii*).

The effects can be so long lasting that such woodlands have been described as being in a state of botanical purgatory (135). Over-abundant White-tailed Deer continue these destructive effects today.

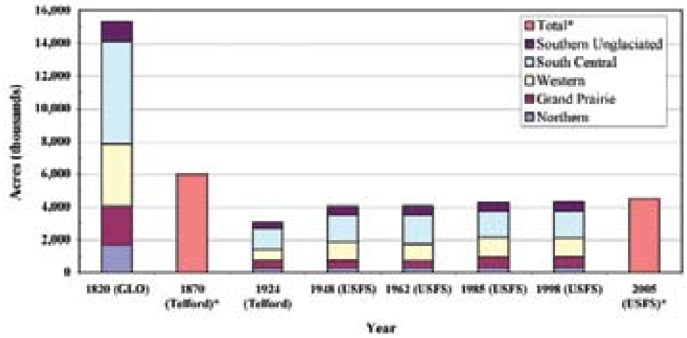


Figure 4.26. Area of forest land in Illinois by region since European settlement. *regional data not available. For a map of regions, see (137).

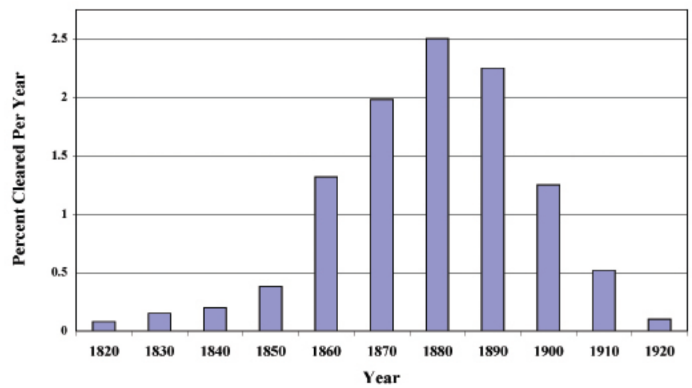


Figure 4.27. Estimated rate of forest clearing and lumber production statewide in Illiniois from 1820 to 1920. Source: 137.

The Current Status of Illinois Forests

The current forest area in Illinois of about 4,525,300 acres is 29.6% of the presettlement (1820) extent (Fig. 4.26). This amount reflects a gradual increase, about 0.087% annually, from the lowest extent a century ago. While modest, this increased forest land is a dramatic difference from the peak harvest period of the late 1800s (Fig. 4.27). Most forest in Illinois (82%) occurs on private lands followed by federal, corporate, state, and local government land holdings (Fig. 4.28). Of the current total forest area, most is upland forest and about 18% is bottomland forest and swamp (136).

The dominant age classes in 1998 for forest parcels in Illinois are in the 41–60 year range (Fig. 4.29). Although this appears to be a contrast from 1985 when the most prevalent forest areas were in the 61 to 80-year range (137), the differences are attributable to a revised analytical approach that now considers understory trees in assessing stand age characteristics (132). As with the analysis based on 1985 data, the proportion of oak-hickory forest types remains much greater in the older age classes while maple-beech and elm-ash-cottonwood forest types proportionately are much more important in the younger age-class stands (Fig. 4.29).

Another method of measuring forest resources besides area coverage is by volume of growing stock based on biomass estimates. This takes into account both area and tree size. Total net volume of growing stock in Illinois forests increased 109% from 1962 to 2005 (Fig. 4.30). The

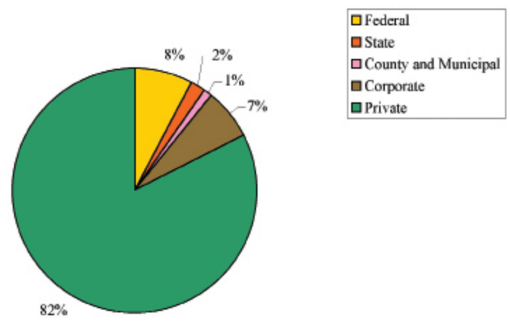


Figure 4.28. Area of timberland by ownership class as of 2005. Total timberland area at time of survey was 4,087,000 acres. Source: (132).

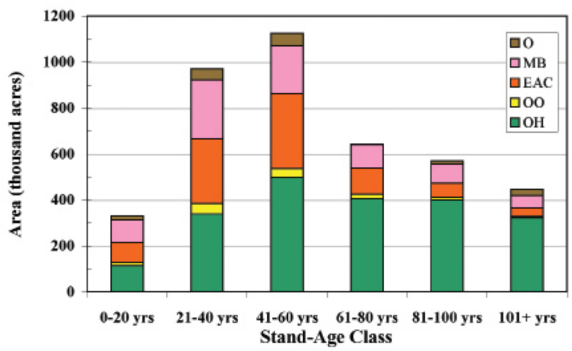


Figure 4.29. Distribution of size-classes by total area of forest types in Illinois. Source: (132). O = oak, MB = maple-beech, EAC = elm-ash-cottonwood, OO = oak and other , OH = oak-hickory.

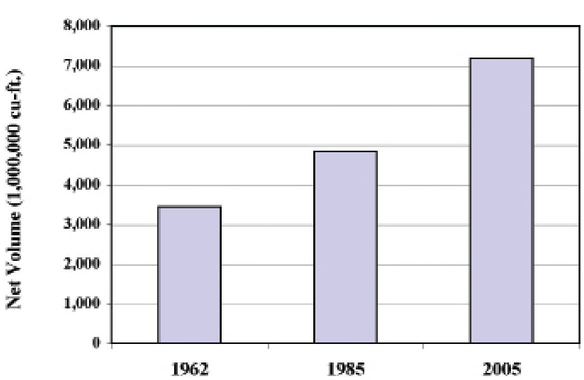


Figure 4.30. Total net volume of timberland growing stock in Illinois. Source: (131, 133).

volume of softwoods has increased over 800% since 1962 as area and age of pine plantations have increased; however, softwoods remain a minor component of total forest land biomass (Table 4.4). The greatest total volume of growing stock is among oaks because of their continued overall dominance in larger size classes (Fig. 4.31). Percentage increases for oak species ranged from 64% to 75% for White and Red Oak species groups, respectively. Hickories (*Carya* spp.) were next in total volume of growing stock, increasing 113% between 1962 and 2005; soft maple (primarily *Acer saccharinum*) ranked third in total growing stock volume among identified species groups and showed an increase of 150%. The largest percent increase in net volume growing stock was among Yellow Poplar (*Liriodendron tulipifera*) with a 359% increase from 1962 to 2005 (Table 4.4). Trends in total area for forest types show prominent changes from 1962 to 1985 (137) with oak-hickory and elm-ash-cottonwood forest types declining in area while maple-beech had a 12-fold increase. By 1998, the last year of comparable data from the USDA Forest Inventory and Analysis program (132), the oak-hickory forest type appears to have stabilized while there is some increase in elm-ash-cottonwood and modest decline in total area of stands classified as maple-beech forest (Fig. 4.32).

Regional patterns differ with regard to forest increase and decrease between 1962 and 1998 (Fig. 4.33). Many counties, particularly in the northern half of the state, show dramatic increases in forest acreage. Counties with net decline in acreage mostly are concentrated in the region of the Illinoian till plain. Decline is particularly concentrated in counties bordering the lower Kaskaskia River. Forests bordering the lower reaches of the Kaskaskia River form one of the largest contiguous blocks of forest remaining in the state, most of it privately owned. Continued logging in this region likely will lead to fragmentation of this large forest block.

Forest Fragmentation—Habitat conversion has led to extensive fragmentation of forest habitats in Illinois and this fragmentation has consequences for both plant and wildlife species. For example, neotropical migrant birds require large blocks of uninterrupted forest for successful nesting habitat (138) and predators such as Bobcats also require large unbroken tracts of forest (see Chapter 6). Edge zones of forest fragments also can be environmentally and biologically distinct from interior zones, particularly south and west-facing aspects where, compared to forest interior areas, wind and light exposure is greater, humidity lower, and a distinct floristic composition (139). An analysis of the distribution of forest patch sizes in Illinois determined there were 10,121 forest parcels greater than 40 acres (the minimum detectable size in the analysis) and the average patch size was 358 acres (137). These fragments accounted for 85% of forest acreage in Illinois while the remainder occurred in numerous fragments < 40 acres. Most fragments identified (> 40 acres) were in the 40–100 acre range (45%) and only 10% were larger than 600 acres (Fig. 4.34). Most INAI forests (high-quality, Grades A or B) are in the 20- to 50-acre range (Fig. 4.35).

Immigration of forest species into fragments, especially plants, is limited by the nature of the surrounding landscape and distance to nearest similar habitat. Maintenance of a species pool is dependent on immigration opportunities to compensate for population declines occurring as a result of disturbance of other factors. As forest fragments become smaller and more isolated, immigration opportunities become more and more limited to weedy native and adventive species that are predominant in the landscape. Maintenance of a viable pool of native species is one of the chief objectives in habitat conservation. With the majority of forest lands in private ownership (Fig. 4.28), this highlights the important role individual private landowners, landowners associations, and conservation groups can play in the maintenance of Illinois' native biodiversity.

Tree Species Regeneration, Fire, and the Maintenance of Oak—The state tree of Illinois is White Oak (*Quercus alba*), an appropriate choice given its statewide distribution and dominance as a canopy species in many upland forests throughout the state. However, many forests on upland sites show an alarming trend—there is insufficient regeneration of canopy species, particularly White Oak (132), to sustain oak dominance in many Illinois forests. Oak seedlings may be present, and a few small saplings, but very few individuals are surviving to larger sizes (140, 141). Oaks in general do not thrive under shaded conditions (most are classified as shade intolerant or intermediate) and increasingly shaded conditions can lead to conversion of forest types from predominantly oak-hickory to dominance by other species such as the elm-ash-maple group (142, 143, 144). For example, the decline of the oak-hickory forest type observed in statewide forest inventory data from 1962-1985 (Fig. 4.32) was attributed to the maple take-over phenomenon (137).

These trends of poor oak regeneration and increases among shade-tolerant species such as Sugar Maple can be linked to a decline in fire frequency in the highly fragmented modern landscape, particularly when compared to previous fire-return intervals such as before and during early periods of settlement (115, 141, 144). While recent trends appear more promising for total area of oak-hickory forest in Illinois (Fig. 4.32), throughout the eastern U.S. including Illinois, data continue to suggest oak regeneration is limited (145, 146, 147, 148). Reasons to sustain oak forests are many. Prominent among them is their significant ecological importance in an evolutionary context, the value of oak timber for fuel, building, furniture, and visual appeal, and the fact that oak forests provide essential habitat for a multitude of wildlife and plant species (149).

These patterns of forest regeneration are not uniform from site to site. Differences exist depending on habitat conditions and site history. Oak regeneration typically is poor to marginal in mesic to dry-mesic stands and thus these can be considered compositionally unstable. However, on dry open woodland sites oak regeneration actually can be excessive leading to a structurally unstable stand. Local variation within the same forest type can be attributed to different disturbance histories. Due to a wave of regeneration of mesophytic species (those with intermediate moisture reqiurements), many forest stands can be described as both compositionally and structurally unstable (see SIDEBAR—Tree Recruitment Patterns).

Increased shading as a result of take over by maple and/or other species has been shown to result in declines in diversity in the ground-cover stratum (93, 141, 150), particularly in upland forests, woodlands, and savannas which support many light-dependent herbaceous species. This attrition of species diversity has particular ramifications in a highly fragmented landscape where opportunities are limited for immigration of species to compensate for declining diversity. In some cases, shading is so great that the forest floor is bare but for leaf litter.

Illinois Natural Areas Inventory (INAI)—The INAI (65) established criteria for grading forest quality based on standards including a minimum stand age (90 years or older), size (with rare exceptions, minimum of 20 acres), and ecological integrity (limited disturbance from grazing, logging, or other anthropogenic sources of habitat degradation). The INAI identified 149 forest parcels statewide meeting these criteria (graded A or B [see Chapter 2]) totaling 16,452 acres, about 0.36% of total remaining forest (124). These include 3,718.6 acres of Grade A (essentially undisturbed) and 12,733.5 acres of Grade B forest remnants (slightly disturbed). Of these high-quality stands, about 9,133 acres (55%) are floodplain forest communities, and the majority of high-quality stands of all types range in size from 20 to 50 acres (Fig. 4.35). High-quality remnants were found in 60 of the 102 counties statewide. Lake and St. Clair counties contain the largest

Tree Recruitment Patterns—Tree recruitment trends can be seen in tree size classes when data are from similar habitat conditions. A forest stand is considered self-sustaining and compositionally stable when dominant species show a reversed J-shaped curve among size classes (i.e., many more small diameter trees than large-diameter trees). However, throughout Illinois and elsewhere in the Central Hardwoods Region, the pattern of oak regeneration suggests that under current conditions, we can expect a decline in the importance of oaks in future forests. Trends in an old-growth oak grove (Baber Woods Nature Preserve) show increasing importance of Sugar Maples and other species in small-to-medium size classes and declining regeneration of the canopy-dominant oaks (Fig. 4.36). A forest survey throughout Kendall County in Illinois provides an example of compositional and structural instability. While oaks are dominant among the larger canopy trees, there are few in the smaller size classes; rather, there is a proliferation of species mostly absent from the larger size classes (Fig. 4.37). Oak regeneration differs among dry-mesic upland forest parcels at Beaver Dam State Park (BDSP). Some units, particularly those included in a fire-management program, show some regeneration of oaks while many other species predominate the small size classes (Fig. 4.38). Other units at BDSP demonstrate both compositional and structural instability (Fig. 4.39). In contrast, regeneration of trees in the White Oak group (particularly Post Oak [*Quercus stellata*]) in dry sandstone barrens in southern Illinois is typical of a compositionally stable (oak will continue to dominate) but structurally unstable community (Fig. 4.40) since the openness of the habitat (including prairie species) likely would decrease without intervention such as prescribed fire (see Chapter 14).

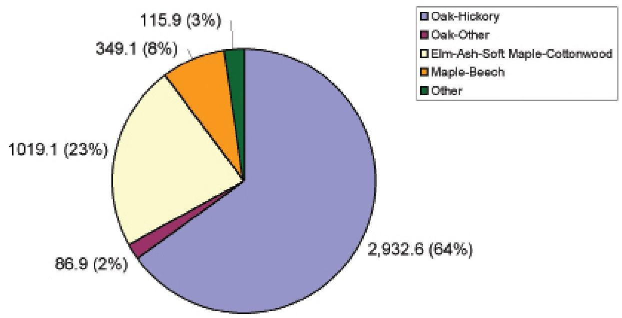


Figure 4.31. Area of forest types in Illinois based on U.S.D.A. Forest Inventory and Analysis data. Source: (133).

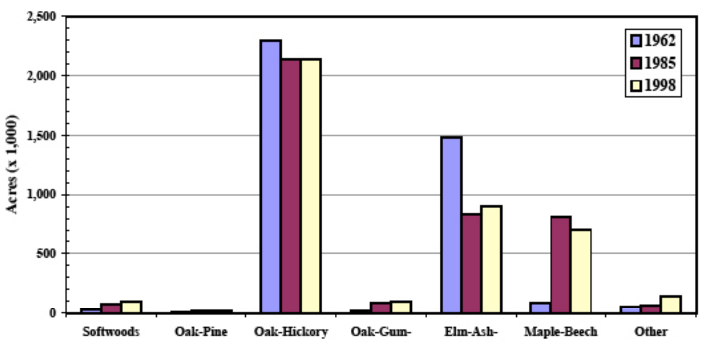


Figure 4.32. Trends in aerial extent of forest types comparing Forest Inventory and Analysis data from 1962, 1985, and 1998. Source: (131, 132).

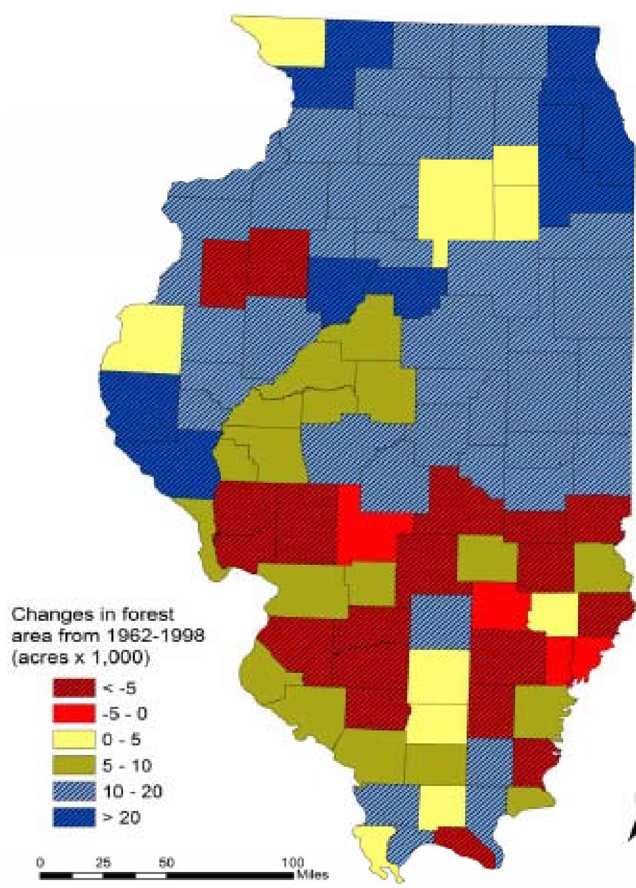


Figure 4.33. Changes in forest area by county (acres x 1,000) based on 1962 and 1998 data. Data source: (132, 151).

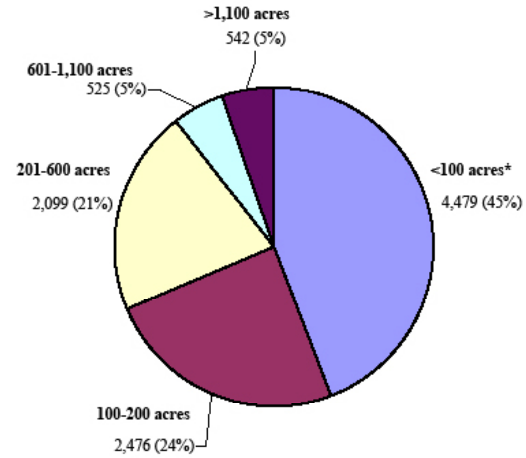


Figure 4.34. Parcel numbers by land-area classes for forest land in Illinois. *Minimum detectable size in analysis was 40 acres. Source: (137).

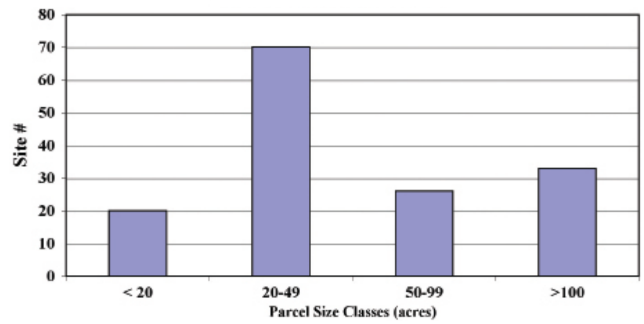


Figure 4.35. Size distribution of Grade A and B forest parcels recognized by the Illinois Natural Areas Inventory (INAI).

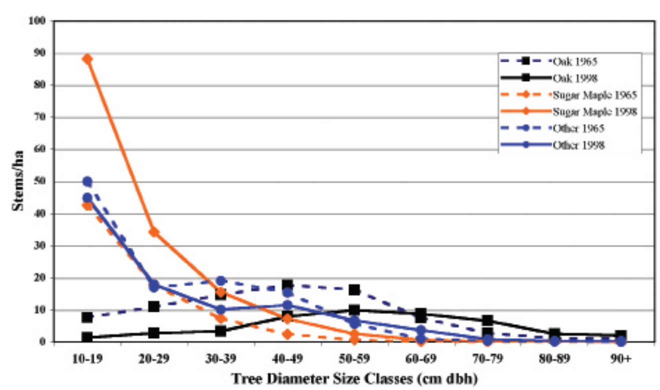


Figure 4.36. Size-class distribution of trees at Baber Woods Nature Preserve, Edgar County, Illinois comparing trends in 1965 and 1983. Source: (162).

Table 4.4. Net volume (thousand cubic feet) of growing stock on forestland in Illinois by species group for 1962, 1985, and 2005. Source: 131, 133, 137). [1]Included in Other Softwoods in 1962 survey. [2]Included in Other Hardwoods in 1962 survey.

Softwoods	1962	1985	2005	Change (1962–2005)	% Change
Loblolly-shortleaf Pine	15,200	64,700	69,854	54,654	360
White Pine[1]	-	16,800	83,615	-	-
Red Pine[1]	-	12,000	20,064	-	-
Eastern Red Cedar	2,400	11,400	31,788	29,388	1,225
Bald Cypress	6,800	8,900	7,009	209	3
Jack Pine[1]	-	700	5,181	-	-
Other Softwoods	700	3,00	11,577	10,877	1,554
TOTAL SOFTWOODS	25,100	117,500	229,088	203,988	813
Hardwoods					
Red Oak	701,800	1,062,400	1,230,774	528,974	75
White Oak	739,700	1,017,600	1,210,108	470,408	64
Other Hardwoods	223,100	203,500	670,690	447,590	201
Hickory	343,900	522,500	733,857	389,957	113
Soft Maple	259,200	341,600	648,333	389,133	150
Cottonwood spp.	114,100	157,800	299,2	185,105	162
Hard Maple	99,800	163,100	260,003	160,203	161
Ash	218,200	261,000	373,923	155,723	71
Sycamore	123,300	134,600	261,148	137,848	112
Black Walnut	77,500	119,100	209,585	132,085	170
Yellow Poplar	26,400	51,800	121,094	94,694	359
Basswood	25,800	54,100	63,829	38,029	147
Sweetgum	58,600	45,100	87,125	28,525	49
Tupelo & Black Gum	13,900	28,000	20,239	6,339	46
Beech	14,500	12,100	15,385	885	6
Aspen spp.	9,100	1,900	4,820	-4,280	-47
Elm	367,700	267,400	292,836	-74,864	-20
Hackberry[2]	-	93,500	202,883	-	-
Black Cherry[2]	-	87,700	149,238	-	-
Willow[2]	-	50,300	64,421	-	-
River Birch[2]	-	36,800	40,379	-	-
Butternut[2]	-	5,700	1,329	-	-
TOTAL HARDWOODS	3,416,600	4,717,600	6,961,204	3,544,604	104
TOTAL ALL SPP.	3,441,700	4,835,100	7,190,292	3,748,592	109

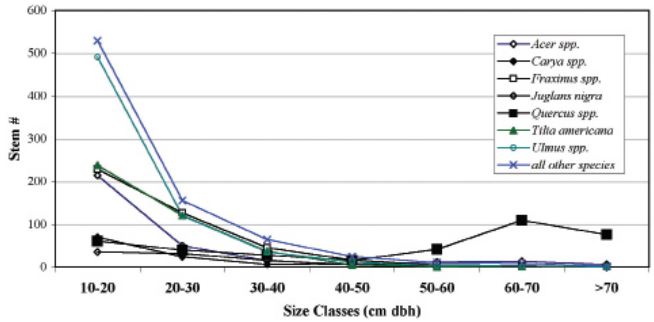


Figure 4.37. Size-class distribution of trees based on 135 0.05-ha forest sampling plots throughout Kendall County, Illinois. Most oak recruitment is Red Oak (*Quercus rubra*).

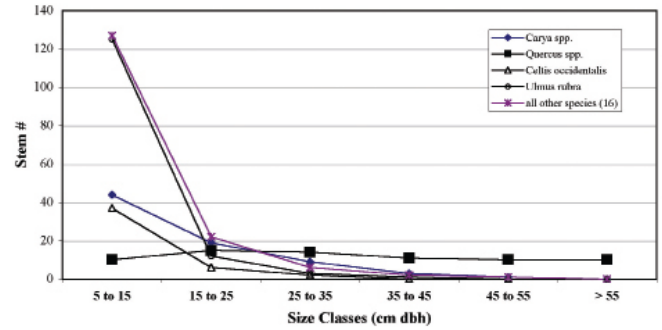


Figure 4.39. Size-class distribution of trees in forest parcels at Beaver Dam State Park with no recent fire management.

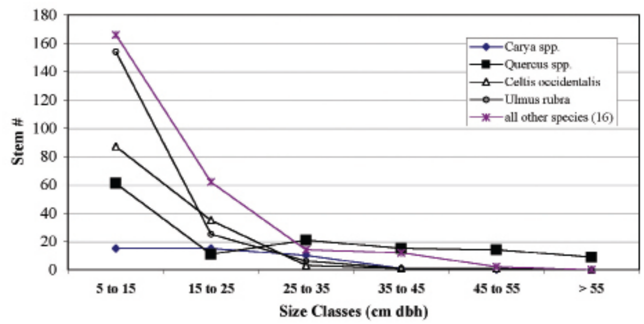


Figure 4.38. Size-class distribution of trees in Beaver Dam State Park. Data from parcels recently burned, or in one case, relatively recently released from grazing.

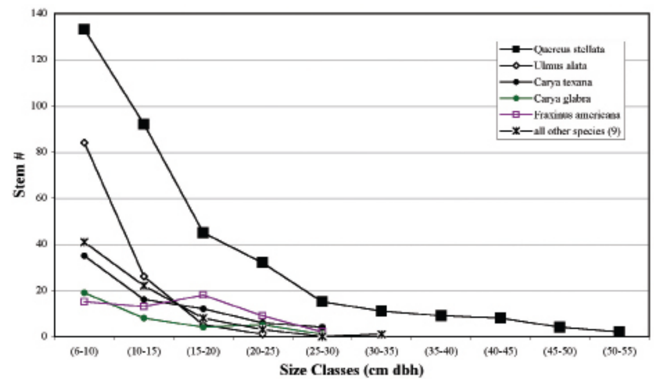


Figure 4.40. Distribution of size-classes in a dry sandstone barrens in Pope County, Illinois. Source: (163).

number of forested natural areas with 10 each followed by Washington County with a total of eight. Adams County has the most extensive acreage of high-quality forest, with a total of 4,950 acres of floodplain forest at a single site on an island in the Mississippi River. St. Clair County ranks second in acreage with 1,484 acres of high-quality forests distributed among the 10 sites. The integrity of many of these forests is threatened by invasion of exotic plant species (see Chapter 12) and excessive deer browse.

Forest Reserves—The INAI provides a focused framework for forest conservation. Not all sites qualifying for the INAI are protected in forest reserves, and not all forest reserves meet the criteria for INAI natural areas; however, it is a goal to provide protection in some form for forest communities that retain high ecological integrity and the Illinois Nature Preserves Commission has protection tools that can assist private landowners in meeting this goal. As previously noted, the majority of forest acreage in Illinois is private and classified as commercial forest (133). Forest lands in some type of reserve status have increased from 109,900 acres of "non-commercial" forest in 1962 to 244,200 in 1998 (132, 151) and the proportion of total "reserved timberland" has increased during this period from 2.8% to 5.6% of total forest acreage (Fig. 4.41). These reserved forest lands include state parks, county forest preserves, nature preserves, and other lands excluded from commercial forestry (132). For area of forest designated primarily for conservation of biodiversity, this 5.6% of protected forest lands in Illinois falls well below the 11.2% global average, or 11.8% average throughout North America (152).

PART II—NATURAL COMMUNITIES, SPECIES COMPOSITION, AND DIVERSITY

Illinois is positioned in the prairie-deciduous forest ecotone of the Midwest with forests classified as belonging primarily to the oak-hickory forest type, based on a broad classification of forests throughout the eastern United States (153). Two other major forest types are present at the state's margins. A region classified as having the maple-basswood forest type occurs in the far northwest while western mixed mesophytic forest occurs in the far southeast. These forest regions are based on the predominant tree species; other forest types occur locally within these regions depending on soil types and moisture relations. For example within the oak-hickory region, it is common for oak-hickory species to dominant slopes and ridges while maple-basswood may occur in protected ravines and along streams (140, 166).

The natural community classification system established as a framework for the Illinois Natural Areas Inventory identified four forest subclasses: *Upland forest, Sand forest, Floodplain forest*, and *Flatwoods* (67). Each is classified further into natural communities based, with the exception of *Flatwoods*, on soil moisture factors.

Floodplain forests (Fig. 4.42A) are found along riparian corridors and are differentiated into wet, wet-mesic, and mesic communities depending on flooding frequency and duration. For *Upland forest*, five community types have been recognized (Fig. 4.42 B–F): wet-mesic upland forest (typically associated with seeps or poorly drained upland swales), mesic upland forest, dry-mesic upland forest, dry upland forest, and xeric upland forest. Of *Sand forests*, only dry, dry-mesic and mesic soil-moisture classes are recognized and these are found in the major sand regions in Illinois. *Flatwoods* are distinguished regionally with northern flatwoods, sand flatwoods (only found locally on lake plains in northeast Illinois), and southern flatwoods found south of the Wisconsinan glacial boundary (see sidebar on Southern Flatwoods). Additional classification may be warranted to recognize flatwoods on the coastal plain and to differentiate differences in available soil moisture among southern flatwoods (154).

Southern Flatwoods—Southern flatwoods (Fig. 4.43) is a type of oak woodland found locally in the lower Midwest that typically is strongly dominated by Post Oak and thus often called Post Oak flatwoods. These woodlands were predominant in the Southern Till Plain Natural Division. They are characterized by a level aspect and a claypan subsoil horizon, a zone termed an argillic horizon, characterized by a sharp increase in clay content (154, 155). Because variation in composition and structure of forest stands due to steepness of slope and degree of exposure (aspect) is absent, flatwoods provide a unique insight into the role soil characteristics alone can have on tree composition, stand structure, and patterns of diversity. The claypan limits water movement (permeability) leading to seasonally moist or saturated surface soils with a perched water table during spring months, and extremely dry surface soils during the summer months from evapotranspiration. The depth to the claypan varies from about one to two feet (30–60 cm). On sites with relatively deeper soils (depth to claypan closer to two feet), White Oak can be a co-dominant species with Post Oak. With decreasing depth to the claypan, Post Oak increases in dominance. Where depth to the claypan is shallow (e.g., one foot) and/or where sand content in surface soils increases, Black-jack Oak (*Quercus marilandica*), a species known for its tolerance of droughty and low-nutrient conditions (156), becomes more common. As depth to the claypan and available water-holding capacity of the soil increases, so does tree density (Figs. 4.44, 4.45). Highlighting the influence of overstory tree density (and thus shade) on herbaceous species diversity, as tree density increases, ground cover species richness declines (Fig. 4.46). Flatwoods occurred within a mosaic of prairie and forest, and fire is assumed to have been a factor in maintaining oak dominance. Closed stands tend to have very little or no oak regeneration (Fig. 4.47). In contrast, stands that remain open despite long fire-free intervals, a result of particularly severe environmental conditions (i.e., high sand content in surface soils and shallow depth to claypan), have regeneration that suggests stable replacement (Fig. 4.48). So there is an interaction among soils, trees, and ground cover diversity. Sites with the greatest capacity to store available soil moisture are most prone to compositional and structural instability during long periods of fire absence. In sharp contrast to shaded and unburned stands, a site with a recent history including 20 years of nearly annual fire (Fig. 4.49) was found to have ground-cover diversity more than four times greater than the average for all other stands studied (92).

Species Diversity

While forest habitats occupy only 12.7% of the area of the state, they provide habitat for well over half of the native flora, highlighting the critical role forests play in the maintenance of biodiversity in Illinois. Approximately 1,414 native taxa are found in forest habitats in Illinois, about 61% of the statewide total, and the majority are herbaceous species. Forests provide habitat for a great proportion of the state's rare taxa, as well. Of the 339 species of vascular plants currently listed by the Illinois Endangered Species Protection Board as threatened or endangered in Illinois, about 50% are associated with forest habitats (157).

There are about 508 taxa of woody plants (i.e., trees, shrubs, and woody vines) found in Illinois, depending on how many subspecific taxa are recognized (e.g., varieties, subspecies), representing about 16% of the total Illinois flora including native and non-native taxa. Of all woody taxa, 370 are native and 138 (27%) are non-native. About 69% of these woody species are associated with forest habitats. The most diverse counties for tree species are in the far south. Jackson and Pope counties, each with 123 documented native tree species, have the greatest total. However, on a per-acre basis, little Hardin County (115,994 acres) has the highest tree diversity among Illinois counties with 92 native species (Fig. 4.f25). Hardin County is the southeasternmost county and typically this region has among the greatest annual rainfall statewide (see Fig. 2.8). In fact, the remaining top five ranking counties in terms of density of native tree species are Pulaski, Wabash, Massac, and Alexander, all in far southern and southeastern Illinois (Fig. 4.50). Density of non-native tree species shows a concentration in the far south, along the Wabash and Illinois rivers, and in the highly urbanized northeastern counties where DuPage County has the highest density of non-native species statewide (Fig. 4.51).

Most woody species found in Illinois are classified as shrubs (284) followed by tree species (n=261), and woody

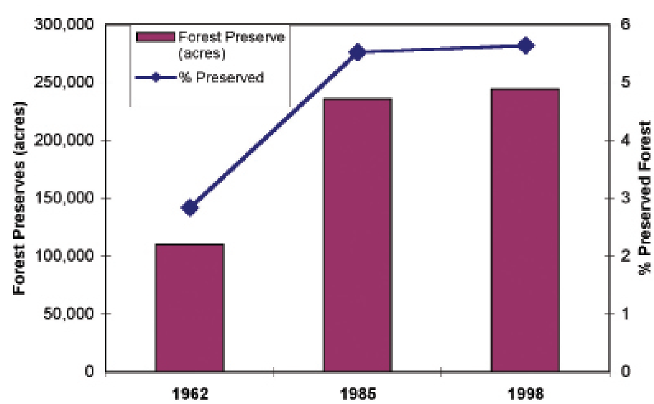


Figure 4.41. Preserved forest lands in Illinois including timberland unavailable for forest utilzation through statute or regulation (e.g., nature preserves, State parks, county forest preserves, and other protected or regulated areas). In 1962, these were referred to as "noncommercial" forests. Data sources: (131, 132, 151).

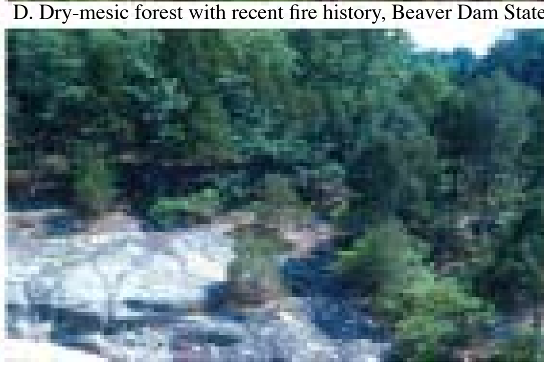
A. Floodplain forest along the Sangamon River.

B. Wet-mesic upland forest, Vermilion County, Illinois.

C. Mesic upland forest, Vermilion County, Illinois.

D. Dry-mesic forest with recent fire history, Beaver Dam State Park.

E. Dry upland forest, Pope County, Illinois.



F. Xeric upland forest, Pope County, Illinois.

Figure 4.42 A–F. Representative forest habitat types in Illinois. Photos by J. Taft.

Figure 4.43. Old growth southern flatwoods community in Washington County, Illinois. Photo by J. Taft.

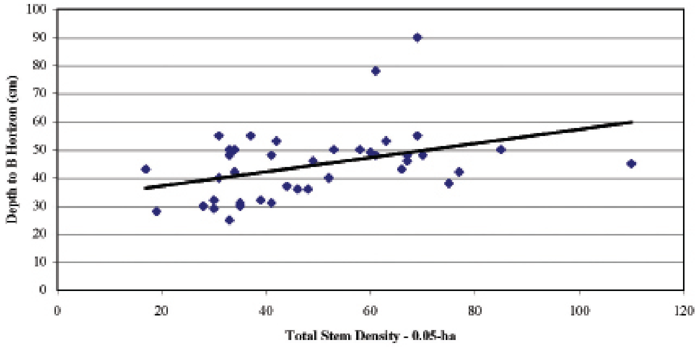


Figure 4.44. Influence of soil depth to woody stem density in flatwoods in the Southern Till Plain Natural Division. The positive correlation is statistically significant ($p < 0.05$). Depth to B is depth to claypan subsoil horizon. Source: (154).

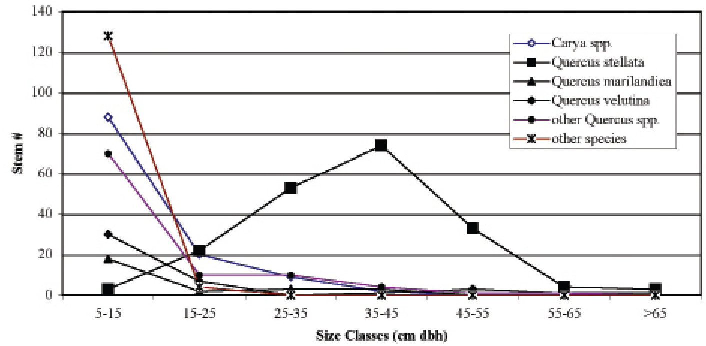


Figure 4.47. Typical size-class distribution of trees in flatwoods of the Southern Till Plain Natural Division.

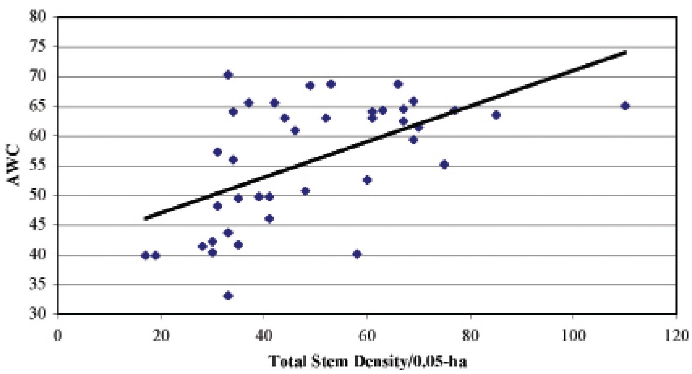


Figure 4.45. Relationship between woody stem density and soil available water-holding capacity (AWC) in flatwoods of the Southern Till Plain Natural Division ($p < 0.0005$). AWC integrates soil depth (depth to claypan) and soil texture. Source: (154).

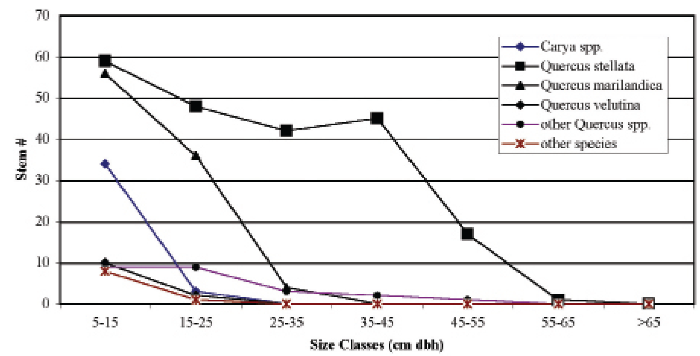


Figure 4.48. Size-class distribution patterns of trees in flatwoods growing on former lake plain in Kaskaskia River corridor in Washington County, Illinois where surface soils are high in sand content and, thus, have low available water-holding capacity.

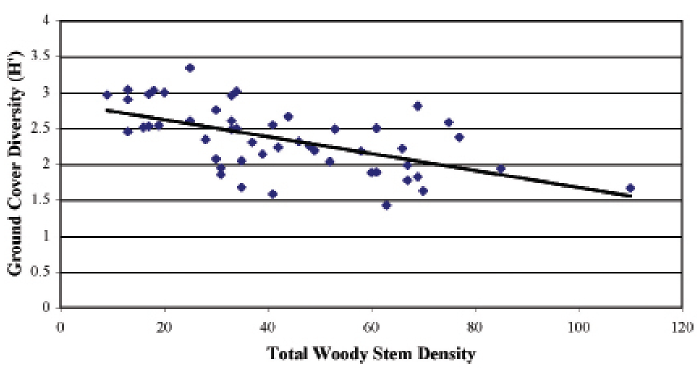


Figure 4.46. Relationship between woody stem density and ground-cover diversity (Shannon Index H') in flatwoods of the Southern Till Plain Natural Division in Illinois ($p < 0.0001$). Source: (154).

Figure 4.49. Lake Sara Flatwoods (top) in Effingham County following a 20-year period of annual burns. Contrast with this flatwoods with a site on the same soil type (bottom) lacking recent fire near Mt. Vernon in Jefferson County. While tree densities (stems > 5 cm dbh) differ greatly (284 vs. 465), basal area estimates are similar (20.2 vs. 24.7 m^2/ha) and differ largely due to different fire histories. Photos by J. Taft.

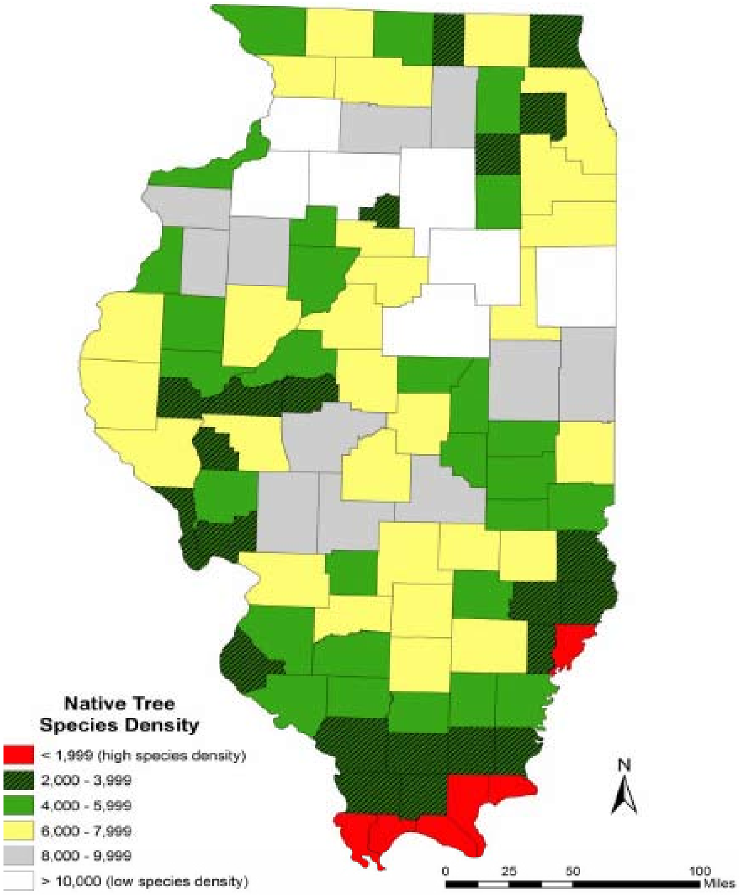


Figure 4.50. Density of native tree species on a per area basis (county area divided by number of tree species). The lower the number (darker shades), the greater the density of tree species.

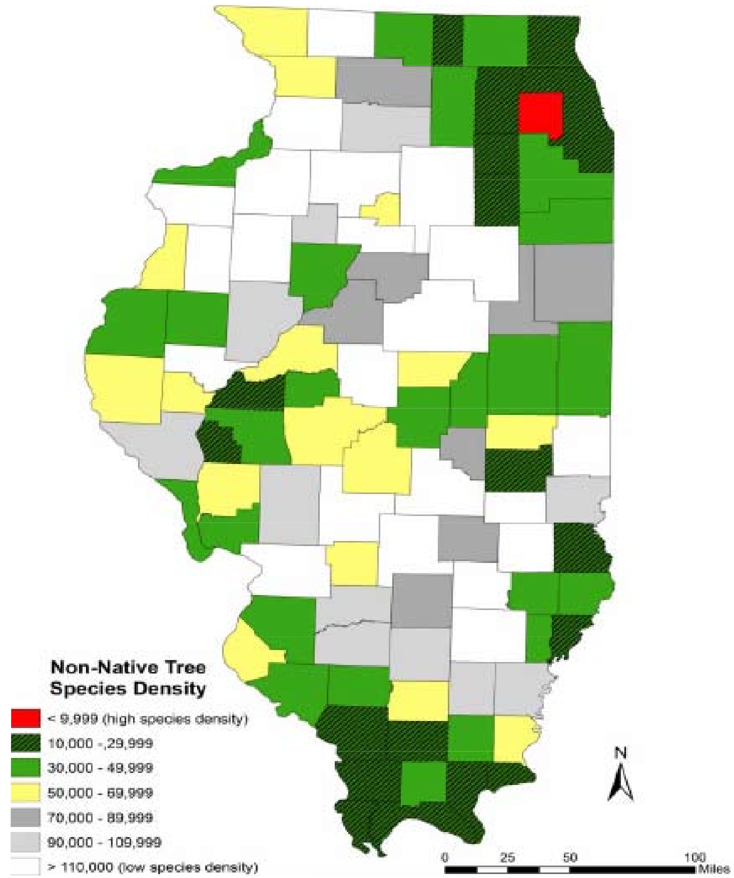


Figure 4.51. Density of non-native tree species on a per area basis (county area divided by number of tree species). The lower the number (darker shades), the greater the density of tree species.

vines (n=47). These totals exceed 508 taxa since many can be classified as either shrub or tree, or in some cases vine or shrub (137). Genera of trees with the most native species include oaks (*Quercus*—20 spp.), hawthorns (*Crataegus* —15 spp.), cherries and plums (*Prunus*—11 spp. [including 2 shrubs]), hickories (*Carya*—10 spp.), maples (*Acer*—8 spp.), and ashes (*Fraxinus*—6 spp.). Diverse genera of native shrubs include willows (*Salix*—15 including 1 hybrid), dogwoods (*Cornus*—11 spp., including 2 classified as trees), *blackberries (Rubus*—9 spp.), arrowwood and nannyberries (*Viburnum*—8 spp.), blueberries (*Vaccinium*—8 spp.), and roses (*Rosa*—7 spp.). Woody vine genera with the most native species are grapes *(Vitis*—6 spp.), (*Clematis*—5 spp.), and honeysuckles (*Lonicera*—4 native spp.).

Among forest trees, the great majority are broad-leaved deciduous species. There are seven native conifer trees in Illinois including four pines:

Jack Pine (*Pinus banksiana*—probably extirpated)
White Pine (*Pinus strobus*)
Red Pine (*Pinus resinosa*—native population possibly extirpated)
Short-leaf Pine (*Pinus echinata*)
Tamarack (*Larix laricina*)
Northern White Cedar (*Thuja occidentalis*)
Eastern Red Cedar (*Juniperus virginiana*).

With the exception of Eastern Red Cedar, these are all scarce and limited in distribution to marginal counties. In fact, three of the four pines are listed as endangered species in Illinois and two other conifers (Northern White Cedar and Tamarack) are listed as threatened. Some of these species are widely cultivated and in some cases (especially White Pine) distinguishing whether an occurrence is a native population or escaped from cultivation is not always readily apparent.

Non-native Species

Some of the most invasive adventive species in Illinois occur in forest habitats and these species infestations threaten the integrity of forests throughout the state (see Chapter 12). Some of these species include Common and Glossy Buckthorn (*Rhamnus cathartica* and *R. frangula*), Japanese Honeysuckle (*Lonicera japonica*), numerous shrubby honeysuckle species and their hybrids, Garlic Mustard (*Alliaria petiolata*), and Multiflora Rose (*Rosa multiflora*) (158). Conditions that promote the infestation and spread of exotics in forests include habitat fragmentation, altered natural disturbance cycles, burgeoning populations of White-Tailed Deer, and even invasion of exotic earthworms that promote rapid decomposition of leaf litter (159). Many of these exotic species germinate best on bare mineral soil; conditions that promote exposure of bare soil, including increased shading, can enhance habitat suitability for these species.

FOREST HEALTH

Forest health is affected negatively by certain insects, tree diseases, and weather extremes such as severe drought and prolonged flooding. Currently, the greatest insect infestation threats involve three exotic pests: the Asian Longhorn Beetle, Gypsy Moth, and Emerald Ash Borer (133). Asian Long-horned Beetles were first discovered in Illinois in the Chicago area during 1998. Favored host tree species include maples (native and non-native), Horsechestnut, and willows. Vigilant eradication efforts including quarantined infection zones appear for now to have reduced the pest. Gypsy moths, whose larvae are capable of defoliating a forest, were introduced from Eurasia to North America in 1869 and have had a devastating effect on eastern forests, but have yet to have major impacts in Illinois where they have been found in the northeastern counties. Traps placed throughout central and southern Illinois in 2005 captured only eight individuals, all in different counties (133). Attempts to slow the spread from the northeastern counties apparently have been successful. The Emerald Ash Borer, a beetle whose infestations of ash trees typically results in tree death, was discovered in southeastern Michigan in 2002 and spread to Illinois presumably in fire wood. It now threatens the ashes throughout the state.

Oak wilt is a fungal disease of oaks that disrupts translocation of water to leaves and can be fatal. It can be transferred by sap-feeding beetles, which are attracted to tree wounds, including recently pruned branches (133). Tree pruning should not occur during the April through July period to limit cross infections (160). Oak wilt can weaken trees, especially in the red oak group, making them susceptible to other diseases such as Hypoxylon canker (141). Dutch elm disease, a fungal disease introduced from Europe, has been established in Illinois for over 50 years and has had an impact on the abundance of elms throughout the state. Mortality continues although persistence of elms throughout Illinois, including American Elms, suggests some trees are less susceptible than others. Root graphs are a means of transfer enabling the disease to spread quickly through elm-dominated areas.

SUMMARY

There is great diversity of natural habitats in Illinois, with surface geology, landscape features, glacial history, fire history, and human land uses, particularly since European-American settlement, having major influences. Vegetation trends since settlement show tremendous habitat losses for all major terrestrial communities (prairie, savanna, open woodlands, and forest). Prairies persist as numerous small and isolated remnants throughout much of the state. Savannas, like prairies, reduced in extent, are now limited mostly to areas with nutrient poor soils of little agricultural value. Forests, following a period in the late 1800s of unsustainable harvests, are recovering somewhat in total area to where about a third of the original forest cover remains. However, very little original forest remains and most forests today have undergone changes in structure and composition from the original forests. Oak regeneration, in particular, is limited, suggesting a trend towards dominance by other species such as elms and maples. Invasive species including many that are non-native are an increasing threat to the long-term sustainability and integrity of Illinois ecosystems. Nevertheless, high levels of diversity remain in many plant communities and opportunities remain to conserve much of this diversity. However, insufficient resources for habitat management, including applications of prescribed fire in prairies, savanna, and woodlands, may lead to additional loss of many habitats and an overall decline in diversity.

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