Conservation Assessment
for
Barrens and Glades Natural Communities

USDA Forest Service, Eastern Region

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Steven Olson, Ecologist
Shawnee National Forest
50 Highway 145 South
Harrisburg, IL 62946
618-253-7114

with assistance from and thanks to:
Alice Heikens (00-PA-11091201-050)
and
Jim Bess (00-PA-11091201-060)

This document is undergoing peer review, comments welcome

This Conservation Assessment was prepared to compile the published and unpublished information and serves as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject community, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.

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EXECUTIVE SUMMARY

Barrens and glades occur at scattered sites on the Hoosier and Shawnee National Forests, and are found widely on the Mark Twain National Forest. Expressions of the barrens community on National Forest System lands are currently recognized on the Hoosier at a few sites within the Brown County Hills and the Crawford Escarpment, and at several sites in the Crawford Uplands. On the Shawnee, barrens are found as small remnants in the Cretaceous Hills, and the Greater Shawnee Hills, Lesser Shawnee Hills, and the Illinois Ozarks have more and somewhat larger communities. Barrens and glades are often large within most of the natural divisions found on the Mark Twain.

Barrens are characterized by species of canopy trees tolerant of xeric conditions having a stunted, open-grown appearance, the dominance of native warm-season grasses and prairie forbs, and, in glades, significant exposures of bedrock. The mix of plants and animals inhabiting these sites varies with the canopy openness, internal structure of the stands, slope, aspect, and other less tangible variables. The barrens is an ecosystem, not merely a hole in the forest filled with prairie plants.

The greatest influence on this community is the lack of active management leading to habitat degradation by encroaching woody vegetation into the open parts of the ecosystem. Prescribed fire is often the most efficient management in these areas, but in some cases manual removal of encroaching woody species is appropriate. Interruption of management in these communities can be more detrimental to the recovery of the barrens than not initiating management. Top-killing of many woody species may only serve to encourage denser understory growth, thereby reducing the openness of the barrens.

The barrens community provides habitat for at least 60 Regional Forester Sensitive Species (RFSS), so appropriate management of this habitat is likely to provide for viable populations of these 45 plants and 15 animals. Six of these are high priority for species assessment within the barrens and glades community conservation assessment: *Erynnis martialis*, *Festuca paradoxa*, *Gentiana alba*, *Ophioglossum engelmannii*, *Polytaenia nuttallii*, and *Stenanthium gramineum*. Detailed discussions of these species are included here. Among the other 54 RFSS are three federally listed species known to occur in these habitats on at least one of the Forests (*Asclepias meadii*, *Trifolium stoloniferum*, *Myotis sodalis*). These species have existing recovery plans.

The purpose of this assessment is to bring together the best available information about this community, provide a summary of the character and distribution of barrens across the three Forests, and provide similar information about six RFSS found in this habitat. An additional purpose is to provide the background information necessary to prepare a Conservation Strategy, including management actions to conserve species discussed in this assessment.

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Stan French (Mark Twain National Forest) provided General Land Office survey notes for sites on the Mark Twain National Forest.

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Ellen Jacquart (The Nature Conservancy – Indiana) did a bit of digging for TNC ranking of barrens in the Midwest.

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Sally Weeks (Purdue University) provided images of the Clover Lick barrens on the Hoosier.

COMMUNITY CLASSIFICATION SYSTEM AND SYNONYMS

One of the conservation practices of the USDA Forest Service is the designation of Regional Forester Sensitive Species. Part of that process includes identification of priority species for conservation assessments and strategies. The barrens and glades community conservation assessment is one of the priority assessments resulting from the 29 February 2000 update of the USDA Forest Service – Eastern Region Regional Forester Sensitive Species (RFSS) list. This assessment addresses the barrens and glades natural communities on the Hoosier, Shawnee, and Mark Twain National Forests (Figure 1), and six RFSS found in those communities: mottled duskywing (*Erynnis martialis*), cluster fescue (*Festuca paradoxa*), yellowish gentian (*Gentiana alba*), Engelmann's adder's-tongue fern (*Ophioglossum engelmannii*), prairie parsley (*Polytaenia nuttallii*), and featherbells (*Stenanthium gramineum*).

The objectives of this assessment are to provide the best information available from which to develop a conservation strategy, and to provide a summary of the natural history

and distribution of the Midwestern barrens and glades natural communities and the six RFSS, both range-wide and within the Eastern Region of the Forest Service.

In this assessment, the term "barrens" is used as the more all-inclusive term except where distinctions are beneficial. Discussion of the geographic variability of barrens types is organized around the ecoregions of Keys, *et al*. (1995), and their current descriptions is based on that of state heritage programs or the Forest's classification. Common names of species mentioned in this assessment are listed in Appendix I.

Barrens are natural communities having species characteristic of both prairie and of open timber. They are generally small on the Hoosier and Shawnee, and are considered to be globally imperiled (ranked G2) by The Nature Conservancy (Menges *et al*. 1987, Faber-Langendoen 1999). Glades are a type of barrens where exposed bedrock is prominent. Some types of Ozark "glades" are relatively common on the Mark Twain and may cover thousands of acres. Others are quite small and rare. They share many characteristics and species with the barrens on the Hoosier and Shawnee, but also include some endemic species.

This assessment of the barrens community will: define types of barrens and glades; offer a brief history of their origin; describe the appearance and describe the range of variability at the time of European settlement; enumerate threats to their integrity and their response to management; briefly address the current management situation of barrens across the three Forests; and provide a review of pertinent literature about the community.

The barrens community provides habitat for at least 60 RFSS (Table 1), so appropriate management of this habitat is likely to provide for viable populations of these 45 plants and 15 animals. Six of these species are high priority for assessment within the barrens and glades community conservation assessment: *Erynnis martialis*, *Festuca paradoxa*, *Gentiana alba, Ophioglossum engelmannii, Polytaenia nuttallii,* and *Stenanthium gramineum*. Detailed discussions for the six species are included here. Among the other 54 RFSS are three federally listed species known to occur in these habitats on at least one of the Forests (*Asclepias meadii, Trifolium stoloniferum, Myotis sodalis*). These species have existing recovery plans.

For each of the six RFSS discussed in detail, information on range-wide distribution status and trends; the species ecology, adaptability, and response to disturbance; risks; and pertinent literature will be provided. Species information on the five plants was provided by Alice Heikens of Franklin College (00-PA-11091201-050), and on *Erynnis martialis* by James Bess (00-PA-11091201-060).

People want to give order to their surroundings, and want to call things by the same name consistently so that whoever they may be talking to understands what they are talking about. Hopefully, the other person will have a very similar definition. A barrens is just another item to put in its proper place in a classification scheme.

The natural community known as barrens exists in many forms from the Atlantic coast to the Midwest. ("A biological [or natural] community is an assemblage of species that share the same local environment…. A community or group of communities, together with the physical components of their environment, is called an ecosystem" (Nigh *et al*. 1992).) Among the better known barrens are the New Jersey pine barrens, the serpentine barrens in Pennsylvania, and the shale barrens in West Virginia. While these areas are interesting in their own way, they are beyond the scope of the discussion of the Shawnee Hills, the Ozark Highlands, and associated areas on the Hoosier, Shawnee, and Mark Twain National Forests (Figure 2). Coincidentally, this area largely corresponds with the North American Bird Conservation Initiative definition of the Central Hardwoods Bird Conservation Region (see http://www.manomet.org/USSCP/bcrmaps.htm).

One of the current problems in natural community classification is that some ecologists are trying to find what could be called a "unified theory" for communities at all locations on various substrates, or defining communities exclusively on the vegetation present. This does not a take into account the number of variables involved. For example, a barrens on the Hoosier may be a fraction of an acre, while a glade complex on the Mark Twain may cover thousands of acres. The climate, geology, and history are not the same. The resulting species composition can be very similar, but the frequency of species is often very different. It needs to be acknowledged that a natural community in one area does not need to be just like that in another in order to have the same name. Differing descriptions of various locations are accurate for their geographic locality and history. It also must be remembered that natural communities occur along a continuum of variation, and there are seldom sharp borders between communities. Sites very close to each other geographically can be quite different (Olson 1992a).

A number of classification schemes for natural communities are used in the Midwest. Each state's system is different, and each Forest also has a different method of community identification. It is necessary to have a general understanding of these to explain the variation in barrens on the three Forests. Equating these to each other is challenging (Appendix II).

The Illinois Natural Areas Inventory (INAI) Technical Report (White 1978) is used to describe natural communities throughout Illinois. "Barren" is a type of savanna found in the Shawnee Hills, the Illinois Ozarks, and the Cretaceous Hills. It applies to forests with prairie inclusions, especially in the southern and western parts of Illinois. They are interpreted to have thin soils over rocky substrates, and have grasses and stunted trees. Glades are primary communities, *i.e.*, vegetation growing on bedrock, and are identified on bare sandstone, limestone, and shale. Xeric and some dry upland forests, as defined in the INAI, can be interpreted as barrens.

The Shawnee National Forest Land and Resource Management Plan, Appendix E, set out the barrens classification being used on the Forest. There are ten types: Cretaceous Hills loess, Shawnee Hills loess, Ozark Hills loess, Cretaceous Hills gravel, Ozark Hills gravel, Shawnee Hills limestone, Ozark Hills limestone, sand, sandstone, and shale. The Shawnee's ecological classification system is in the early stages of development.

The INAI is the basis for the Indiana community classification. Barrens, however, are given the same status as forest, savanna, and prairie (Indiana Department of Natural Resources 1995). Barrens are currently defined in Indiana as "terrestrial ecosystems where edaphic drought and infertility prevail" (Homoya 1994). They are found in the Highland Rim and the Shawnee Hills, and occur on chert, limestone, sandstone, and siltstone (Homoya 1994).

The Hoosier National Forest's community classification is patterned after the INAI classification, but barrens are raised to the same level as forests (Olson 1992b). Barrens are of two types: those on calcareous substrates and those on acidic sandstone or siltstone.

The Hoosier Ecological Classification System is based on topography, soils, and vegetation (VanKley *et al.* 1994). It puts barrens found in the Crawford Upland in ecological land type phase (ELTP) 23: *Quercus stellata* / *Eryngium*, dry slopes. These correspond to limestone barrens in the Forest's community classification. Other barrens equate to ELTP 22: *Quercus stellata* / *Vaccinium*, dry slopes corresponding to sandstone barrens. In the Highland Rim, the barrens were not identified as an ELTP, but would correspond most closely to ELTP 10: *Quercus prinus* / *Vaccinium*, dry ridges. These are equated with sandstone and siltstone barrens.

In Missouri, glades are considered primary communities, and are described by their substrate and their soil reaction: acidic barrens occur on igneous, sandstone, and chert; alkaline types occur on limestone and dolomite (Nelson 1985). Some xeric forests and savannas may also equate to barrens, as may some prairies.

The Mark Twain National Forest ecological classification system has been in use since 1981 (Miller 1981). It is based on soils, geomorphology, and vegetation. Barrens equivalents include types: 19 and 21, dry chert forest; 22 and 23, xeric chert forest; 26, glade savanna; 27, dry savanna; 32 and 33, xeric limestone forest; 34, dolomite glade; 35, limestone glade; 36, igneous glade; and 39, xeric igneous forest.

The Nature Conservancy has been developing a National Vegetation Classification since at least 1988 (Faber-Langendoen 1999). This system is based first on the community types, and then on the dominant vegetation present. At least six vegetation associations have been equated with barrens on the Hoosier, at least ten on the Shawnee, and at least 17 on the Mark Twain (Appendix II).

The term "barrens" was used somewhat loosely in the past. Travelers, writers, and botanists in the nineteenth century often used the word to describe the countryside they were in (Bourne 1820, Ellsworth 1838, Engelmann 1863, Flint 1822, Michaux 1805, Oaks 1836). Old editions of regional and state floras, as well as some recent ones, noted species were found in barrens without defining what a barrens was. Synonyms for barrens have included prairie, savanna, oak opening, grassland and glade, each occasionally with modifiers such as brushy or scrub (Engelmann 1866a, GLO surveys). White (1994) provides a summary of how "barrens" (as well as "savanna" and "oak

opening") was used historically in Illinois. These definitions probably hold true for most of the Midwest.

"Barrens" seems to have lost its identity during the last 50 to 75 years. Vestal (1936) suggested that one reason that barrens were less frequently recognized by ecologists was that they had changed so much as to be no longer recognized as a distinct vegetation type. Many barrens appear to be succeeding toward a more forest-like condition (Steyermark 1940, Kimmel and Probasco 1980, Anderson and Schwegman 1991). ("Succession" is the orderly replacement of one vegetation type by another. It typically runs from annual grasses and forbs, through a shrub stage, toward a mesic forest. Any given area would eventually reach the climax vegetation type for the local conditions, *i.e.*, grasslands on the plains, oak forests in the Midwest, and mixed hardwood forests in deep ravines to the east.) Some modern workers merge barrens into forest (*e.g.* Anderson 1970), while others include them in prairies (*e.g.* Braun 1950, DeSelm 1986). A few have decided that a better term is "savanna" (*e.g.* White 1978, Packard 1988).

Barrens defines a character of a landscape and vegetation, but not what species are necessarily present. A composite definition based on historic and recent descriptions might be: The canopy and herbaceous layers are equally important. Canopy closure ranges up to 80 percent, but may occasionally be greater. Trees are short and limby, with obvious trunk taper, appearing singly or in groves. Shrubs can form a dense understory, or be absent. Warm-season grasses often form a nearly complete ground cover, and forbs of open places are usually common. Lichens and mosses are seen on rock, soil, and trees. Leaf litter is abundant, being held in place by graminoids and forbs. ("Forbs" was originally a short-hand for "forest herbs", but it has since been broadened to mean non-woody flowering plants that are not graminoids. "Graminoids" are the herbs that are grass-like in appearance, *i.e.*, grasses, sedges, and other similarly non-descript plants.) Soils are usually thin. Seasonally, soil moisture ranges from mesic to dry. These communities are usually located on south- to west-facing aspects, or on knobs and ridges, exposed to the drying effects of sun and wind. There may be significant amounts of exposed bedrock. Barrens grade into dry upland forests, woodlands, and prairies. Succession to a forest-like condition may be rapid with the exclusion of periodic disturbance.

DeSelm (1986) described a wide variety of open-canopied natural communities in the eastern United States including marshes, bogs, prairies, glades, barrens, and savannas. Some believe that barrens was a stage of succession between prairies and forests (Nielson 1939). DeSelm (1981) determined that barrens are a successional form of glades on sandstone, limestone, and dolomite, and in fresh-water marshes. Quarterman (1950) believed that deciduous forest would develop on glades over time. The barrens are ecologically unstable in the absence of fire, rapidly succeeding toward mesic conditions and increasing the numbers of shade tolerant plants (Packard 1988). However, barrens appears to be a fairly stable community in certain situations, noting large tracts in the Ozarks. The forest/prairie ecotone, the blend zone between the two communities, would not be a barrens (Hutchison *et al*. 1986).

Several types of barrens exist in the region under consideration (Table 2). Because some of rock formations in the geologic systems in this region are thin, especially in the Shawnee Hills, types of barrens may occur in close proximity to each other. These are separated by the substrate which they are developed on and, vary by the eco-regional subsection they occur in (Keys *et al*. 1995). Descriptions of these subsections are summarized in Appendix III. Physical characteristics of barrens on the various substrates are described here in approximate order of abundance.

Dolomite barrens (glades) are common in the Ozark Highlands on the Mark Twain. These dolomites are primarily Ordovician aged. Formations are often massive. They are stony with many exposed ledges cropping out at regular intervals (Martin, no date). The soil surface contains more chert inclusions where soil is deeper (Cisco, no date). The thin bedding within the dolomite and impermeable layers below keep moisture in the glades until relatively late in the growing season (Erickson *et al*. 1942), but xeric conditions prevail. Reaction is alkaline. Sites are fertile, and species diversity is high.

Sandstone and siltstone barrens occur in much of the Shawnee Hills, the Highland Rim, and at scattered areas of the Ozark Highlands. The difference between siltstone and sandstone is particle size, sand being larger. These barrens are quite variable and occur on each of the Forests. The sandstones may be Pennsylvanian or Mississippian aged in the Shawnee Hills, Mississippian aged in the Highland Rim, and Ordovician aged in the Ozarks. Slopes are usually gentle. Soils are thin, and the community often had glades within it. Barrens on sandstone bedrock often have the character of glades: *i.e*., lots of exposed bedrock and vegetation occurring most densely at the margins and in fractures within the rock. They are usually linear features following the tops of escarpments. Those on the Shawnee "are the best developed and most extensive of their kind east of the Mississippi River" (Baskin and Baskin 1983). Reaction is typically acidic, but some formations vary toward alkaline. Conditions are usually infertile, and diversity is often low.

Igneous formations occur only in southeastern Missouri. Igneous barrens occur in the St. Francis Knobs and Basins and the Current River Hills. This bedrock is of Precambrian age. There may be a thin loess deposit locally. They are found on broad domes and narrow ridges. Reaction is acidic. Fertility and resulting species diversity is low.

Limestone barrens occur in the Shawnee Hills and in the Ozark Highlands on all three Forests. Limestone in the Shawnee Hills are Mississippian aged, and those in the Ozarks are Devonian and Mississippian aged. Formations are usually thin. In the Crawford Upland of the Shawnee Hills, the limestone is often weak, easily friable, and shaly. Soils are often only weakly developed. Conditions are fertile, but tree growth is restricted due to droughtiness of these sites. They generally occupy long, narrow strips on steep slopes. Reaction is alkaline, and diversity is high.

Chert barrens occur on National Forest System (NFS) land only in the Ozark Highlands, although one site has been found on the Mitchell Karst Plain in Indiana. ("Chert" is equivalent to flint, a micro-crystalline form of silica associated with limestone (Harris *et al*. 1977).) They are of Mississippian and Devonian age. The formations are very dry

because of the hardness of the material makes it insoluble and impermeable to water (Palmer 1910). Soils are poorly developed. Reaction is acidic. Fertility and diversity are rather low.

Gravel barrens are found in the Cretaceous Hills in southern Illinois (Hutchison *et al*. 1986). This type of barrens is described only from the Shawnee. Tertiary-age gravels are deposited on top of Cretaceous gravels. There may be a thin cap of loess in which the soil is developed. Topography is of low ridges and knobs. Reaction is acidic. Fertility is low, but species diversity can be relatively high. Gravel barrens also appear in the Illinois Ozarks. Here, topography is steep and diversity is very low.

Loess barrens are found in the Cretaceous Hills, the Shawnee Hills, and probably the Ozarks. These types occur on the Shawnee and in southern Missouri. They are developed in Pleistocene aged loess deposited on top of bedrock formations. "Their soil is a yellow, finely arenaceous loam, and reaches a considerable depth" in the Cretaceous Hills (Engelmann 1866a). Their topography mirrors the underlying substrates. Reaction is somewhat alkaline. Fertility and species diversity are high.

Shale barrens occur in the Illinois Ozarks (Heikens *et al*. 1994). Shale barrens are found in southwestern Illinois, but none are known on NFS land. They appear on Devonian aged formations. The nature of the shale makes them rapidly eroding, and soil is poorly developed. They are on steep south-facing slopes. Reaction is acidic. Fertility is fairly high, but other characteristics of the sites keep species diversity low.

Sand barrens are found in the Cretaceous Hills. There is only one known extant example of this community on the Shawnee. They are in Recent aged sands on the inside bend of stream channels. Reaction is slightly acidic. Fertility is fairly high, and plant diversity is high.

"Glades" are a type of barrens having significant exposures of bedrock and may occur in association with barrens having more soil. In the geographic area under consideration, the bedrock may be sandstone, limestone, dolomite, or more rarely other materials, such as shale, chert, or igneous rocks. The canopy of stunted trees is typically very open. Glades are more likely to have *Juniperus virginiana* than other barrens because fires in the past could not carry across bedrock for lack of fuel (Guyette *et al*. 1980). Species composition in the glades is basically the same as in other barrens in a given locality, but is more strongly influenced by bedrock composition. The ground vegetation is sparse. Lichens are abundant on rocks, but are absent from friable materials. Leaf litter is held only around the patchy herbaceous vegetation and around the perimeter of the openings. These sites are extremely droughty. Soils in glades do not develop typical profiles and are often simply a mixture of rock, mineral soil and humus. Such sites are slow to succeed because of the lack of soil.

Galloway (1919) noted the original definition of a glade was "… an open space in a wood", adding that his definition included "any rocky place whether trees still surround it or have been removed." The term was used in Missouri and Kentucky to describe thin

soiled slopes with sparse grasses and *Juniperus virginiana* (Sauer 1927). The use of "glade" as a synonym for grassland became rare after the early 1800's (Sauer 1927).

Prairies are covered by tall grasses and a wide variety of forbs. They have no or only scattered trees along waterways or in ravines. The densely intertwined root systems of the vegetation often form an extensive sod where conditions are appropriate. In drier situations, grasses and forbs to take on a bunch-forming character. Prairies often occurred on flat uplands but they graded into barrens where the landscape was more broken in character (Engelmann 1863). Baskin and Baskin (2000) recommend using the term "prairie" for prairie grass dominated openings of the Ozarks and Midwest, and that "glades" should be used for edaphic climax dominated by summer annual grasses on limestone or dolomite bedrock.

Flatwoods are usually closed-canopied natural communities, *i.e.*, forests. There are few shrubs in the understory. They range through southern Indiana, southern Illinois, and southeastern Missouri (Menges *et al*. 1987). Upland flatwoods formerly occurred across most of Missouri (Nelson 1985), and are considered woodlands, so could be considered equivalent to barrens. This community type often shares a number of species with barrens, and has been included as barrens in some community classifications (Vestal 1936). They may occur with barrens, making the distinction difficult, as noted by Engelmann (1865 cited *in* White 1994). Southern flatwoods are usually located in the floodplains of medium to large streams, or on terraces occupied by post-glacial lakes just to the north and to the south of the Shawnee Hills. Leaf litter is abundant, but may be matted in places where water sits for extended periods. Although they are usually flooded in the early part of the year, flatwoods dry out during the heat of the summer. Most flatwoods have a fragipan in their soil profile. They may be slower to succeed than barrens with fire suppression. Species composition is different in barrens and flatwoods, but there is considerable similarity. Flatwoods are not considered to be a type of barrens in this assessment, and will not be further addressed in this assessment except where necessary for clarification.

The term "savanna" typically refers to grasslands with few or no trees, especially in tropical areas. Canopy can range from 10 to 80 percent, with the local possibility of being beyond these limits. Soils are often intermediate between forest and prairie. They were probably maintained by fire before settlement (White 1978). "Savanna" was used as a synonym of "prairie" by some early settlers, particularly those of English decent (White 1994). Savannas in the Ozark Highlands have open-grown trees with a herbaceous groundcover, and maintained by low-intensity surface fires (Guyette and Cutter 1991). Savannas are not considered to be a type of barrens (although it may be considered a junior synonym), and will not be further addressed in this assessment except where necessary for clarification.

Woodlands are rather poorly defined in recent community classifications. They are intermediate in character between forest and savanna, barrens, or prairie. The tree canopy is typically no more than 80 percent, but can be as little as 15 percent or as much as 100 percent (Faber-Langendoen 1999). Ideally the understory is very open with more plentiful shrubs than savannas. Herbaceous vegetation includes species of both forest

and prairie. Pine and pine-oak woodlands in Missouri may be considered barrens, although they are more productive than typical barrens (T. Nigh, Missouri Department of Conservation, pers. comm.). The term "woodlands" will be used here as needed.

Native oldfields often have many herbaceous species of barrens. It is likely that these sites were fairly open at the time of European settlement and were therefore fairly easy to put into agriculture, initially as subsistence farms. Many were abandoned before Eurasian grasses became "popular", so that native plants were nearby to recolonize the sites. Eurasian grasses and forbs are also generally less well suited to the conditions found in the barrens. Many of these old fields were severely eroded, and erosion is continuing on some sites. When acquired by the federal government for inclusion in the NFS, open areas such as these were often planted to pine. A large portion of these plantings failed, because the species are not adapted to this habitat. These sites should not be considered barrens, but should be managed as refugia for species of the habitat.

DESCRIPTION OF COMMUNITY

The Origin of Barrens

There is no single reason for the existence of barrens. Many factors come into play: mid-continental location, glacial history, geology, climate, species distribution, and species behavior, to mention a few. The location of this region in the center of the continent has an influence on: the weather patterns coming from the west; the humidity from the Gulf of Mexico; the Great Plains grassland species to the west; and the spread of those plants and animals in part by way of migratory herds of grazers and browsers after glaciation.

A common feature across the barrens of the Hoosier, Shawnee, and Mark Twain National Forests is the presence of prairie herbs. Because of the plants common to the barrens throughout this range, there is the implication that at some point in the past prairie grassland was the dominant vegetation of the landscape. However, not all species followed the same "migration" routes and timing (Pielou 1991). Heavy seeded plants generally spread more slowly than those with light seeds. This results in each area being slightly different in species composition and frequency. A similar migration pattern holds for forest species in the region, of course.

Although this region was certainly influenced by Pleistocene glaciation, none of the area was covered by ice. Pollen studies show that deciduous forest dominated the lower Midwest 9,000 years before present (ybp) establishing itself during a warm, moist period following the retreat of the last glaciers (Heikens and Robertson 1994). Grasslands invaded about 8,300 ybp during a warm, dry period. This favored oaks and grassland plants. Because forests were already established, there was probably a time lag in the grasslands taking over as the dominant vegetation type, waiting for some extreme conditions to give the grasses the advantage. Note that this did not happen at the same time over the area of consideration, but slowly spread from the west to the east (Pielou 1991). Forests at that time probably retreated into areas protected from drought, such as deep ravines, or where protected from fires, such as on the east side of streams (Bryant

1981, USDA Forest Service 1999). Over the last 3,000 years, however, conditions favoring forests have again prevailed (Heikens and Robertson 1994). As forests spread back across the landscape, prairie vegetation was relegated to sites which maintained warm and dry conditions, usually edaphically controlled: now the barrens.

"Climax vegetation" assumes that communities succeed to a certain point, then no longer change without some "outside" influence, usually a set-back to an earlier stage of succession. Each climax vegetation type has its characteristic species of plants and animals. "Characteristic species" are those that are typically associated with a particular habitat, but also will occur in other habitats. The climax community concept, while having some convenience in describing stable situations, has generally been found to be inadequate in dynamic ecosystems. It is often more applicable in fragmented landscapes where disturbances stop at property lines (Taft 1999).

"Edaphic" refers to conditions brought on by the soil characteristics of the site, especially as it affects plants and animals. The concept of "edaphic climax" suggests that there may be local controls of soils, geology, and topography that will keep local areas from progressing toward the climax condition typical for the area at large.

Barrens may represent an edaphic climax (if there really is such a thing). Succession has "stopped" at a grassland stage (Steyermark 1940, Erickson *et al*. 1942), although advancing woody species were noted by even some of the earliest observers (*e.g*. Bourne 1820). Avoiding the question about whether or not there is such a thing as "climax vegetation", edaphic or otherwise, it can be said that succession in the barrens is merely considerably slower than the surrounding forests. As one prominent Ozark ecological team noted, "true glades are in a constant struggle against woody invaders" (Kiser and Houf 1985).

Because the location and species composition of most barrens are largely determined by their substrates, it is necessary to briefly discuss the bedrock geology of the Midwest (Figure 3). The Ozark dome, centered in east-central Missouri and flanked to the east by the southwestern rim of the Illinois basin, lies beneath most of the Mark Twain National Forest (Figure 4a). The St. Francis Mountains, situated at the center of the dome, are underlain by igneous rocks of Pre-Cambrian age. The igneous terrane, a portion of a continent with a common geologic history, is partly covered by thick and extensive sedimentary rocks, mainly dolomite, limestone, and sandstone, that were deposited in a shallow seaway during Paleozoic time, but were locally uplifted and eroded during Mesozoic time. What remains are the igneous rocks surrounded by a ring of progressively younger sedimentary formations. Igneous rocks are non-porous. Dolomite is the most common sedimentary rock in the Ozarks. There are karst features in some of the limestone formations in the Ozarks, and there are frequent inclusions of chert (Bretz 1965).

The Shawnee Hills encompasses most of the Hoosier and Shawnee National Forests, as well as parts of western Kentucky. It is at the edge of the Illinois structural basin (Harris *et al*. 1977). All exposed formations are of sedimentary rocks (except for small igneous intrusions at Hick's Dome in southern Illinois). This basin began subsiding during the

Cambrian time and continued through the end of the Paleozoic. An uplift to the south closed off the southern tip of the basin some time before the Cretaceous Period. Several faults in southern Illinois have displacement of over 1,000 feet, exposing various formations; primarily Mississippian and Pennsylvanian aged sandstones, limestones, and shales. The last movements of these faults appear to have been near the end of the Paleozoic (Willman *et al*. 1975). Many of the bedrock formations are the same on both the Shawnee and Hoosier (Willman *et al*. 1975, Shaver *et al*. 1986). However, they have different dips: that on the Shawnee to the north, and that on the Hoosier to the west-northwest (Figure 3). Because of the dip of bedrock geology, conditions that favor barrens are limited to relatively narrow exposures of particular geological formations. The Tertiary gravels overlay the Cretaceous Hills of southern Illinois (Figure 4b). There is a variable layer of Quaternary loess over this gravel as well as over the remainder of the Shawnee Hills (Willman *et al*. 1975).

The Brown County Hills and Mitchell Karst Plain are on the eastern rim of the Illinois Basin, and are composed of older materials than the Shawnee Hills (Figure 4c). These formations are broader (east to west) because of their thickness and their proximity to the Cincinnati Arch (Figure 3). Formations in the Brown County Hills are primarily acidic siltstones, but more alkaline layers are present. The eastern part of these hills was partially covered by outwash from the Wisconsinan glaciers. The karst plain is predominantly limestone and contains many significant karst features.

Topography of this region is generally assumed to be among the oldest on the continent, but there is evidence that many topographic features, especially in the Ozarks, may be less than one million years old, and some less than a quarter of that (Elfrink and Siemens 1998). None of this region was subjected to the direct influence of glacial ice or extension of the Mississippi embayment. Their proximity, however, allowed for deep dissection and head-cutting of streams in the Ozark Highlands and Shawnee Hills. Many if not most remaining barrens are on south to west facing aspects. Many are on steep terrain exposed to the greatest drying forces of wind and sun.

Many barrens were originally described on karst plains while others were on hills, in valleys, or on the slopes in between. The “Big Barrens” of Kentucky, for example, lies on the Pennyroyal Plain and Elizabethtown Plain of the Highland Rim of the Interior Low Plateau, corresponding well with cave-forming limestone formations (McInteer 1942). This area covers about 5,000 to 6,000 square miles (McInteer 1946), and extends into southern Indiana (east of the Hoosier) covering an additional 400 to 500 square miles (Chamberlain 1850, Featherstonhaugh 1844). It appears that subterranean drainage may have influenced the distribution of the community. The ground dries rapidly in karst regions because run-off of the rains quickly drain into the subterranean passageways (McInteer 1946). Areas like this often have deeper soils and the topography is level or rolling. Such conditions make these areas more likely to be settled earlier than the hills and valleys in the Shawnee Hills or places having little soil in the Ozarks. Sauer (1927), however, believed that there was greater correlation with topography because this is not the case on all cavernous limestones. Also, note that not all barrens communities are on limestone bedrock, for example, those on gravels and igneous rocks where cave formation does not occur.

Another point of some discussion: Some believe that, although barrens are dominated by prairie grasses, they should not be considered part of Transeau's (1935) Prairie Peninsula because their potential natural vegetation is forest, not prairie (Baskin *et al*. 1994). Many barrens remnants are not on grassland soils, but instead are on forest soils, so forests regain their territory fairly quickly. However, some inconsistencies have been noted in the Prairie Peninsula. For example, in Missouri, prairie is listed in areas where the General Land Office (GLO) surveyors found only timber and in some barrens areas (Schroeder 1983). Could an argument be made for including the Big Barrens of Kentucky with its many western species in the Prairie Peninsula, but exclude the Tennessee glades with their southeastern species and high degree of endemism? In any case, the question of whether or not the barrens is an extension of the Prairie Peninsula remains a subject of debate (and won't be decided here).

There is frequently a strong correlation with certain soil types and the presence of barrens vegetation. Grass-dominated areas most frequently are found where soil moisture is low, such as on shallow or stony soils such as in barrens, or where there is a pan in the soil profile as in flatwoods (DeSelm 1986). In some instances, the soils reflect the bedrock geology, which is further reflected in the plants present on the site. Many trees appear to be less tolerant of carbonates than grasses in the same area (Barnes 1948).

Fires, whether caused by Native Americans or European settlers or through natural ignition, were probably reason for persistence of barrens in many areas. Infrequent burns may have been enough to maintain barrens under certain conditions (Hutchison 1994). About 40 percent of the corners established by GLO surveyors in Harrison and Washington counties, Indiana, had no trees for bearings (Keith 1984). The maintenance of barrens in this area was probably through autumn fires and topography strongly influenced the vegetation pattern (Keith 1984). These soon disappeared as large tracts with settlement. Barrens in adjacent counties were present, including those on the Hoosier, but much smaller in extent (Keith 1984).

The prevalence of fire in the barrens can be implied from plants and animals having adaptations that allow them to survive fire. The bark of trees is thick and fire resistant. Most woody species have the ability to re-sprout if top-killed by fire. The growing point of many grasses and forbs is at or below the ground surface where they are protected from fire. Many animals require the structure found in barrens as maintained by fire: open canopy, scattered shrubs, and a patchwork of dense and sparse herbaceous vegetation. One years' herbaceous growth provides adequate cover for many small mammals and nesting birds (Ahlgren and Ahlgren 1960). Burrowing an inch into the soil protects many invertebrates from heat and flame (Ahlgren and Ahlgren 1960). However, fires cannot be too frequent, as evidenced by the number of invertebrates that over-winter in the leaf liter.

Habitat fragmentation brought on by European settlement interrupted the pattern of fire across the landscape. Roads, trails, and other characteristics of settlement established firebreaks which would otherwise not have been present. These act as streams, reducing

the size of landscape-scale fires. This allows vegetation to grow into degraded barrens and woodlands.

Other natural events had local effects on the maintenance of barrens. Large ungulates may have influenced the condition of the barrens because bison and elk (or should that be wapiti?) in large numbers can affect the growth of woody plants. This was frequently the case around large salt licks, such as Big Bone Lick, Kentucky, and French Lick, Indiana.

It is well known that Passenger Pigeons formed immense flocks before their extinction. Audubon (1831) once noted an autumn flock of pigeons in the Kentucky barrens near Henderson which continued its passage for three days. Roosts for flocks of this magnitude provided local means of keeping some stands open. A winter pigeon roost in Tennessee woodlands and barrens was four to six miles in circumference (Faux 1819). Other roosts were noted by GLO surveyors in southern Indiana where all timber and other vegetation had been killed, including one near Huntingburg. Nesting colonies could also cover several miles and cause tree damage (Featherstonhaugh 1844).

Climatic factors, such as wind and ice storms, could affect the character of the barrens. Many species are adapted to tolerate and recover from storm damage. The community is dynamic, varying with severity of disturbances. Tornados and severe winter storms could be stand replacing events. After these disturbances, the affected area would become brushy and nearly impenetrable. These would be important refugia for wildlife. Drought could also influence species distribution. Dry conditions can lead to extensive, severe fires a few years after such events (Guyette *et al*. 1980).

Many writers believed that burning by Native Americans was the cause of barrens vegetation (Bourne 1820, Baskin *et al*. 1994), but climate (especially humidity), soils, and subterranean drainage were also involved (McInteer 1942, 1946), and their distribution was geologically decided (Hutchison 1994). The narrow ecotone between many barrens and adjacent communities shows that soils and geology are strong indicators of barrens distribution (Kucera and Martin 1957). Other factors are almost certainly involved as well. "[Barrens] cannot, therefore, be regarded as a relic grassland, but must be considered as an area in which edaphic conditions were unsuited to tree growth, or one that had become deforested, in which the forest islands and tongues were remnants of the vanished forest, not outposts of an invading forest" (Sauer 1927). In other words, saying that "this" (whatever "this" may be) is the reason for the existence of the barrens sounds a little too much like spontaneous generation!

It may be thought too late to determine what the vegetation of the region called the barrens was when the country was settled, but enough may be gathered from early writings to show its general character, and a study of the plants now found growing wild in these parts … and their comparison with those of other parts … gives, it is believed, a fair conception of the plant life of the great treeless areas as they were when the white man appeared…. (Garman 1925)

RANGE OF NATURAL VARIABILITY: HISTORIC DESCRIPTIONS OF BARRENS AND GLADES

It is obvious from numerous of accounts of barrens that they did exist and had a characteristic appearance (Featherstonhaugh 1844, Flint 1822, Michaux 1805, Oaks 1836, Schoolcraft 1819). The following are two of the best descriptions of barrens from early writers. Between them, they describe the Midwestern distribution of barrens, their position on the landscape, their appearance, their quality, and they make a point that barrens are not prairies or forests.

The Barrens, so called from their sterile appearance, are found on the high plains in the west part of Ohio and Kentucky, in Indiana, Illinois and Missouri.
They are generally poorer than the timbered land in their vicinity…. They are spotted with innumerable groves or clusters of stinted oak and hickory trees, of about half the size which the same kind are on the timbered land.
[T]he warm climate urges a spontaneous production of wild grass and weeds somewhat similar to that of the prairies.
Small prairies are sometimes found in the barrens, and the prairies near the heads of creeks are so blended with the barrens in many places, that it is difficult to determine where the one ends or the other begins. (Bourne 1820)

This term [barrens] is used in the west to designate a species of land which partakes, as it were, at once the character of the forest and prairie. The surface is generally dry and more uneven than prairies, and is covered with scattered oaks interspersed at times with pine, hickory, and other forest trees mostly of stunted and dwarfish size…. They rise from a grassy turf, seldom encumbered with brushwood, but not infrequently broken by jungles of rich and gaudy flowering plants, and of dwarf sumac. Among the oak openings you find some of the most lovely landscapes of the west, and travel for miles and miles through varied park scenery of natural growth. (Ellsworth 1838)

Along with the extensive barrens, such as those in Missouri, Kentucky and Tennessee, were countless smaller barrens openings in the matrix of open, oak-dominated forests (DeSelm 1981). These extend well beyond the Ozark Highlands, Shawnee Hills, and Highland Rim. Buffalo Beats on the Wayne National Forest is an example of this community type on the Allegheny Plateau. Bryant (1981) describes a "prairie" on Kansan outwash deposits near Cincinnati. Schoolcraft (1819) in southeastern Missouri saw "at one view, cliffs and prairies, bottoms and barrens, naked hills, heavy forests, rocks, streams, and plains, all succeeding each other with rapidity, and mingled with the most pleasing harmony."

Nearly as frequent as the description of barrens as land with scattered small trees in a matrix of grassland vegetation and small openings in the forest was the reference to fires, whether still burning or just evidence of their having passed (Ladd 1991, Olson 1996). Fires were apparently fairly common across the region under consideration at the time of settlement (Ellsworth 1838, Engelmann 1863, Oaks 1836). There is frequent mention of smoke at certain times of the year by travelers and settlers. For example, "Indian

Summer", which began in October, was a time of smoky skies from the wide-spread burning by Native Americans (Faux 1819).

[The barrens] present appearance was caused by fires,… [M]any of the trees that are standing are partly burnt, and almost every one that is lying down has burnt more or less. The fires in the barrens are generally kindled by the Indians… and burn until the rain or some other cause puts them out. (Bourne 1820)

The conditions of these fires was variable. In describing a woodland fire in Missouri, Featherstonhaugh (1844) "… measured the progress of the fire, and found that it advanced at the rate of about a foot a minute." At the other extreme, there are occasional GLO line notes commenting that timber had been killed by fire.

Succession proceeded quickly when settled or when fires stopped. "When the white people settle on the barrens… fires are seldom seen, a young growth of trees, healthy and vigorous soon springs up…" (Bourne 1820).

Additional accounts from other areas will help to show the consistency of the appearance of barrens across the region delineated by Bourne (1820). Early geologists, such as Engelmann (1863, 1866a,b) and Schoolcraft (1819), often gave accounts of the landscape where there might be economic benefit. Geographers and historians (Chamberlain 1850) described the region to give context to their writing about local features and occurrences. Naturalists, such as Michaux (1805), and physicians, such as Mead (1846), gave accounts because they were interested. These descriptions will be enumerated here within the ecoregions.

The people who may have had the best idea of what a barrens was were the surveyors of the GLO survey. General Land Office (GLO) surveys, established by the Land Ordinance of May 20, 1785, proposed to survey public domain lands before settlement. They rapidly traversed many natural features over long periods of time at all times of the year, and were required to make judgments of the quality of the lands (Hutchison 1988). Significant features of the landscape were noted by the surveyors, including dominant trees and the quality of the land (Hutchison 1988). The surveyors divided the uplands into three distinct vegetation types: timber, prairie, and barrens. The field notes of the surveyors provide the best general descriptions of the character of the Midwestern prairies, forests, and barrens prior to widespread European settlement.

It is apparent that the GLO surveyors knew when they were in a barrens and not in timber or prairie. It was not unusual for surveyors to leave a barrens and enter a prairie or timber. Some barrens occurred where there were no trees large enough to mark for bearings. Other sites had many trees for use as bearings, and yet others were filled with nearly impenetrable brush. The location of barrens in GLO notes often corresponds well with the presence of unusually droughty soils noted in modern soil surveys.

Using first-hand accounts of travelers together with the GLO survey notes, it is possible to visualize what barrens looked like in different parts of the southern Missouri, southern Illinois, and southern Indiana. Accounts may appear to be contradictory, but each

subsection is quite large, so writers and surveyors may not be looking at the same part of the landscape. Authors usually "speak" in general terms when describing an area, while surveyors are being quite specific. The following paragraphs contain, for each ecological subregion in the area under consideration, whenever possible, comments from early authors in that area and a sample of typical line notes, those specifically mentioning barrens, or lines near sites now recognized as barrens, from the GLO surveys.

Although there are a number of historic (pre-1900) descriptions of the character of barrens across their range, few enumerate species of plants (other than trees and brush) and animals. Another problem is equating old common and scientific names with those currently in use. When possible to identify which subsection a historic account refers to, common names of species will be listed here, but scientific names will not be used in this section to avoid confusion (Appendix I). These original descriptions are organized around the 19 ecological subsections having NFS land (Figure 5). Species lists based on recent observations will be noted under "Classification and Description of Barrens".

Ozark Highlands Section

The dominant community in pre-European settlement on the Ozark Highlands of Missouri was open oak woodland (Nelson 1997, Ladd 1991). Schoolcraft (1819) found that most trees in southeastern Missouri were small post oaks. He found shortleaf pine in a narrow band from St. Francis to the Meramec River. However, approximately six million acres in southern Missouri were originally covered with shortleaf pine lands having prairie grasses and forbs dominating the ground flora. Even the poorest sites had extensive stands of grasses. Grape vines were abundant. Although it was referred to as "timbered", it was often further described as "thinly timbered" or "barreny" (Nelson 1997).

The greater part of the Ozark Dome … was … a region of open woods, large areas being almost treeless. [T]he timber growth was not dense enough to hinder in any way the growth of grass. The native 'bluestem' wild grass covered the region with a heavy growth and its burning every fall served to kill every seedling tree…. The region was treeless or nearly so, not because the soil and climate were unfavorable to tree growth, but because the annual fires which burned the dry grass every autumn or winter killed the tree seedlings. (Marbut 1914 cited *in* Ladd 1991)

The term "barrens" was commonly used by GLO surveyors in the Ozarks (about 5,000 section lines) to describe extensive grassy areas (Schroeder 1983). GLO notes in the Ozarks frequently mention prairie of varying quality: "3rd rate" prairie may have been similar to barrens. Trees in these areas are typical of the barrens, namely post oak and blackjack oak. The understory was often called "scrub oak" by the GLO surveyors. The lack of red cedar along the 5th PM in Missouri is indicative of frequent fires through the area (Nelson 1997).

Schoolcraft (1819) listed a number of animals observed in the Ozarks, including wolf, "wildcat" (bobcat), "panther" (cougar), mink, "pole-cat" (striped skunk), squirrels, (Passenger) Pigeons, and (Carolina) Parakeets.

St. Francis Knobs and Basins

Presettlement vegetation was a mixture of forests, open woodlands, glades, and small prairies. Schoolcraft (1819) referred to land near Potosi that was "covered with a very uniform growth of black oaks and post oaks, and in the summer season by a vigorous undergrowth of wild grass, flowers, and vines."

GLO notes for Taum Sauk Mountain, T33N, R3E, sect. 5, east line: "Land rolling poor&c. Timber oak hicky pine &c. Ungth same."

GLO notes for Taum Sauk Mountain, T33N, R3E, sect. 9, south line: "Same as last" (Land hilly & poor. Timber, oak hicky pine &c, ungth same.)

GLO notes for Johnson Shut-ins, T33N, R2E, sect. 19, east line: "Land this mile hilly &poor. Timber oak hicky pine &c. undg the same & vines."

GLO notes for Johnson Shut-ins, T33N, R2E, sect. 18, east line: "Land this mile hilly hilly & poor. Timber oak &pine. Undg hicky oak pine vines &c sasafrass."

Central Plateau

Presettlement vegetation was mostly savanna or grassy woodland, and prairie.

GLO notes for Western Star Flatwoods, T36N, R10W, sect. 12, south line, west line, and north line: "Land and growth as the last" ("Land hilly, not fit for cultivation. Timber B and W oak. Undergrowth open").

Osage River Hills

Presettlement vegetation was deciduous forest and savanna. Schoolcraft (cited *in* Steyermark 1959) referred to thin forests, prairies and glades along the Osage Trace, and traveled through sparsely wooded country interspersed with prairie openings.

Gasconade River Hills

Presettlement vegetation was a mixed (oak and pine) forest and savanna. Schoolcraft (cited *in* Steyermark 1959) wrote that land near the headwaters of the Gasconade was barrens covered with oaks.

GLO notes for T40N, R7W, sect. 33, south line: "Over level land the prairie lies well and is very good."

GLO notes for Solomon Hollow, T35N, R8W, sect. 17, north line: "Land hilly, stony, poor; timber B oak; W. oak, P. oak & Bjack. Undergrowth the same."

GLO notes for Solomon Hollow, T35N, R8W, sect. 17, east line: "Land hilly, stony, poor; timber B oak; W. oak, P. oak & Bjack. Undergrowth the same."

Meramec River Hills

Presettlement vegetation was a mixed oak and pine forest and some savanna. Schoolcraft (1819) noted in the Meramec River part of the Ozark Plateau "… a succession of hills… covered chiefly by oaks and without underbrush. A tall, thick, and rank growth of wild grass covers the whole country…."

GLO notes for T38N, R5W, sect. 32, east line: "For 1st ½ mile land broke and very stony. Soil of 3rd rate unfit for cult. Timber post o[ak] and Black Jack and some hickory. Undergrowth the same."

Current River Hills

Presettlement vegetation was a mixed forest oak and pine, and savanna. Schoolcraft (cited *in* Steyermark 1959) found the area around the Current River had shortleaf pine and shrubby oaks with dense underbrush.

GLO notes for Stegall Mountain, T28N, R2W sect. 19, east line: "Over rocky mountainous thinly timbered pine land. Unfit for cltv. Thickly set with hickory oak & Bjack brushes or saplings."

GLO notes for Stegall Mountain, T28N, R2W sect. 19, south line: "Over a high hill or mountain timbered with pine & oak – covered with a large red rock that is common to these hills – unfit for cltv. Over hilly rocky tho open pine & oak land unfit for cltv."

GLO notes for Stalcup Hollow, T28N, R2W sect. 34, east line: "Over thinly timbered Pine hills – flinty & unfit for cltv. Some oak around the ¼ sect cor."

GLO notes for Stalcup Hollow, T28N, R2W sect. 34, south line: "Over flinty brushy Pine hills unfit for cltv."

White River Hills

Presettlement vegetation was a mosaic of oak and oak-pine forest and woodland, interspersed with extensive dolomite glade/savanna complexes. Schoolcraft (1819) noted a high bluff "capped by a sterile growth of cedars and oaks" on the east side of Beaver Creek. Featherstonhaugh (1844) described the area near Spring River as "open woods." In this area, Schoolcraft (1819) found deer and bear. Featherstonhaugh (1844) added Wild Turkey as a common species.

GLO notes for Gladetop Trail, T24N, R16W, sect. 4, east line: "Timber post oak& blackjack. Land very broken & rocky & unfit for cultivation."

GLO notes for Gladetop Trail, T24N, R16W, sect. 8, east line: “Timber black oak & blkjack. Land mountainous, rocky & unfit for cultivation.”

GLO notes for Gladetop Trail, T24N, R16W, sect. 7, east line: “There are no trees within a reasonable distance for witness trees in secs. 5,6, & 8. Timber post oak very scattering. Land mountainous, rocky and unfit for cultivation.”

Inner Ozark Border

Presettlement vegetation included oak woodland, extensive dolomite glade/savanna complexes, and small prairies.

Outer Ozark Border

Presettlement vegetation included oak forest, savanna, glades, and prairies.

GLO notes for Hawn State Park (a.k.a. LaMotte Glades), T36N, R7E, sect. 11, south line: “Land the W half high hills & Bluffs thinly covered with oak & pine. The E half the same.”

GLO notes for Hawn State Park (a.k.a. LaMotte Glades), T36N, R7E, sect. 11, east line: “Land the S half steep Hills & Bluffs of rock thinly covered with pine & oak tim. The N half the same.”

Black River Ozark Border

Presettlement vegetation was post oak flatwoods on loess covered divides, and mixed oak and pine woodlands on more dissected areas. Featherstonhaugh (1844) said that most of the timber in this area was oak.

Springfield Plain

Presettlement vegetation was mostly prairie with timber along stream courses and in the more dissected border regions.

GLO notes for Wildcat Glade, T27N, R33W, sect. 27, south line: “Land (excepting bottom which is broken and subject in part to inundation) too hilly & stony for cultivation. Timber oak Hickory Elm & sicamore. Undrgrowth oak Hickory & Grapevines.”

GLO notes for Wildcat Glade, T27N, R33W, sect. 27, east line: “Land too hilly & stony for cultivation. Timber oak & hickory. Undergrowth oak Hickory Grapevine Dogwood & sassafras.”

Illinois Ozarks

Presettlement vegetation was mostly white oak, black oak, and hickory forest. "On the summit there are a few stunted pine trees, growing on cliffs of nearly naked chert rock" (Worthen 1868). The Pine Hills area of southern Illinois also had black oak, white oak, hickory, black gum, and more rarely post oak (Worthen 1868).

GLO notes for near Pine Hills, T11S, R3W, sect. 3, south line: "set ¼ sect post in a kind of a barren, no timr near."

GLO notes for near Pine Hills, T11S, R3W, sect. 11, east line: "this mile hilly land thin soil, timr oak, hicky &c, undg oak, hicky, grapevines &c."

Upper Gulf Coastal Plain Section

Barrens west of the Cumberland River, now within Land-Between-the-Lakes National Recreation Area, occurred on gravel deposits. Ridgetops were generally open and ravines had brushy oak woodlands dropping into bottomland forest. Trees and brush species included white oak, black oak, rock chestnut oak, and black oak. Typical prairie grasses and forbs were abundant. Among the wildlife known in the area were Carolina Parakeets, Greater Prairie-Chicken, and black bear. Herds of bison migrating along the ridge between the Tennessee and Cumberland rivers had developed a wide "trace".

Cretaceous Hills

Presettlement vegetation was extensive barrens dominated by warm-season grasses and oak brush.

The main body of… Pulaski county… may be designated as oak barrens. They consist of alternations of gently sloping, more or less sharply rolling or broken ridges.… The growth… is characterized by an abundance of small, brushy bitter oak, an upland variety of the southern red oak, a tree which is hardly found any where farther north, and replaces the black oak and black jack, which diminish in numbers and soon disappear, when the bitter oak begins to prevail. The bitter oak usually forms a dense under brush, together with an abundance of hazel, sassafras and sumack, and is more or less interspersed with large bitter oak, together with some post oak, white oak, black oak, barren hickory, pignut hickory, black gum, in some places small yellow poplar, in others a few winged elm; at some points, also, with laurel oak and the scalybark hickory. (Engelmann 1866a)

Grape vines were also found (Engelmann 1866b). "The oak brush is generally quite small, and the tall barren grass… still prevails" in southern Pope and Massac counties (Engelmann 1866b).

GLO survey notes for the Dean Cemetery, West, area, T15S, R6E, sect. 27, south line: "2d rate barren land gently rolling, thinly timbered."

GLO survey notes for the Dean Cemetery, West, area, T15S, R6E, sect. 15, east line: "2d rate barren land."

GLO survey notes for T14S, R5E, sect. 25, west line: "set 1/4 sec. post where a w. oak 15 in N 4 W 350 lk no other timber… Land rolling – poor brushy & 3d rate – barrens -."

One corner of one section in the township was set in a "prairie", while all others were in barrens (Hutchison *et al*. 1986).

Interior Low Plateau, Shawnee Hills Section

The southern limits of the Shawnee Hills where it adjoins the Highland Rim along the Dripping Springs Escarpment near Mammoth Cave is better known historically than most of the Shawnee north of the Ohio River. There were more and larger navigable rivers south of the Ohio (Tennessee, Cumberland, Green, Barren) than to the north (Wabash, Blue, Saline) which provided corridors for exploration and settlement. Michaux (1805) and Croghan (1787-1794) provide descriptions of both the Shawnee Hills and Highland Rim in this vicinity. Croghan's journal of this part of "Virginia" provide descriptions of the region along the rivers south of the Ohio.

Engelmann (1866a) noted that barrens in southern Illinois merged into heavily timbered post oak, black oak, blackjack oak, and hickory hills. An old name for mockernut hickory is "barren hickory" (Engelmann 1866a). The ridges of southern Illinois often had redcedar, farkleberry, winged elm, and shadbush (Palmer 1921).

There was a large area east of the Cumberland River described as "barren land" on a map produced in 1795. As much as 70 percent of this area may have been treeless.

Crawford Uplands

Presettlement vegetation was forest dominated by white oak and beech.

GLO survey notes for Clover Lick, T5S, R1W, sect. 20, east line: "poor barren grassy hill; much flint stone; shrub oak."

GLO survey notes for English Reservoir, T2S, R1E, sect. 21, south line: "barren hills; brushy/barren brushy hills; very little timber, some oak on west end."

Crawford Escarpment

The presettlement forest was dominated by beech and white oak.

GLO survey notes for Faucett Cemetery area, T2N, R2W, sect. 15 south line: "high brushy barren ridges, poor barren, stony hills, dry 3rd rate land."

GLO survey notes for Faucett Cemetery area, T2N, R2W, sect. 3 south line: "worst of 3rd rate hills, barren and brushy, poor barren stony hills, dry 3rd rate land."

GLO survey notes for Faucett Cemetery area, T2N, R2W, sect. 5, west line: “poor hilly barrens (corner in a barren, no timber).”

GLO survey notes for Faucett Cemetery area, T2N, R2W, sect. 11, south line: “3rd rate; tops of hills barrens; oak.”

GLO survey notes for Leavenworth barrens, T3S, R2E, sect. 31, west line: “rough hill land, very brushy.”

GLO survey notes for Leavenworth barrens, T3S, R2E, sect. 31, east line: “thin soil, oak and hickory.”

Greater Shawnee Hills

Presettlement vegetation included a variety of oaks, hickories, sugar maple and beech. Prairies in southern Illinois had scattered groves of trees, and GLO notes describe some of the prairies as ”brushy” (Anderson and Anderson 1975).

Much of the Shawnee National Forest was “Hilly barrins, very brushy, 3rd rate.”

GLO survey notes for Cave Hill area, T9S, R7E, sect. 35, south line: “very hilly rocky & poor, oak hickory &c, ungth dogwood, oak.”

GLO survey notes for Cave Hill area, T10S, R7E, sect. 2 west line: “hills, quarries of stone, post oak, wo, blackjack.”

Lesser Shawnee Hills

The presettlement forest was dominated by beech, black oak, and white oak.

GLO survey notes for Cave Creek refer to nearby bottomlands and swamps.

Interior Low Plateau, Highland Rim Section

Mitchell Karst Plain

Presettlement vegetation included large tracts of treeless barrens. “The road passes through the barrens, presenting the usual views of woody islands, wide openings covered with flowers, deep sinks, thick rows of bushes and tangled vines shading the path, and a few clearings, with burned trees rising like tall black masts, from seas of verdure” (Oaks 1836).

Flint (1822) did not seem to care for the barrens in part because there was little shade to ride in. Michaux (1805) “was agreeably surprised to see a beautiful meadow, where the grass was from two to three feet high.”

The barrens of Harrison, Orange and Washington counties (IN) had very little timber, but had abundant shrubs and grass (Chamberlain 1850). Shrubs include plum, oaks, and hickories (Chamberlain 1850), hazel and briars (Flint 1822), and rose (Oaks 1836). Among forbs present were sweet-William, white ladyslipper, and sunflowers (Oaks 1836). Oaks (1836) offered this description of the barrens in Harrison County: "Trees, principally oak, are thinly interspersed at a few yards distance from each other, sometimes forming picturesque groves, like the wood islands of the prairies." Trees were often too small to be used as building material or fencing (McInteer 1942).

GLO survey notes for Post Oak-Cedar Nature Preserve, T4S, R2E, sect. 11, east line: "broken land, thin soil, oak and hickory timber."

Michaux (1805) noted that cane was common in certain parts of the barrens region.

Rabbits and deer were common (Oaks 1836).

Brown County Hills

Presettlement vegetation was dominated by white oak, beech, and black oak. There were no barrens described by the GLO surveyors in the Brown County Hills.

GLO survey notes for Fork Ridge area, T7N, R3E, sec. 33, south line: "Land hilly stoney poor, oak, chestnut oak."

GLO survey notes for Fork Ridge area, T7N, R3E, sec. 35, east line: "hilly, oak, hickory, undergrowth dogwood."

RANGE OF NATURAL VARIABILITY: COMMUNITY DISTRIBUTION AND CONDITIONS

As shown in the community classification discussion, nine different substrates for barrens are recognized in the 19 subsections having NFS land (Figure 5). Barrens occur at various locations throughout the Shawnee Hills (Hoosier and Shawnee), the Upper Gulf Coastal Plain (Shawnee), the Highland Rim (Hoosier), and the Ozark Highlands (Shawnee and Mark Twain). Glades, *i.e.*, barrens with a lot of exposed bedrock, occur in the Shawnee Hills and the Ozarks Highlands (Baskin and Baskin 1985). Comparisons of the barrens show the variability in tree, shrub, and herbaceous vegetation across the subsections within the barrens region (Table 3).

Tree species occurring in the barrens may attain large size in other communities, but conditions here usually keep them stunted. Species occurring in the barrens are those which can withstand droughty conditions, such as *Quercus stellata*, *Q. marilandica*, and *Q. prinus*. Although *Juniperus virginiana* occurs throughout the region, it is a natural component only in glades because of the thin soils. They would not naturally occur in barrens having deeper soils since occasional fires would eliminate them while consuming dense herbaceous vegetation as it burned across the landscape.

The barrens flora contains some western species, some coastal plain species, and many widespread species (DeSelm 1986). *Schizachyrium scoparium*, a frequent dominant of barrens, is of southeastern origin, while *Andropogon gerardii* and *Sorghastrum nutans* have a western (prairie) origin (Baskin *et al*. 1994). There are some plant species endemic to the Ozark glades, including several RFSS, but none appear to be endemic to the Shawnee Hills, Brown County Hills of the Highland Rim, or Cretaceous Hills within the Upper Gulf Coastal Plain. "Endemic species" are those which are restricted to a particular region.

Many of the plants found in the barrens are the same as those found in the prairies of Illinois, such as *Eryngium yuccifolium, Echinacea purpurea, Asclepias tuberosa*, and *Liatris* spp. (Garman 1925). Other species found in Illinois barrens are *Helianthus* spp., *Aster* spp., *Solidago* spp., *Antennaria plantaginifolia,* along with many other composites, *Baptisia lactea, Potentilla* spp., *Lespedeza* spp., *Tephrosia virginiana, Desmodium* spp., *Pycnanthemum* spp., and prairie grasses and sedges (Vestal 1936).

Steyermark (1940) developed a list of species characteristically found in the Missouri glades. The majority of these plants listed also occur throughout much of the region under discussion. *Quercus marilandica* and *Quercus stellata* invade the knobs and alkaline glades. Herbs include *Tephrosia virginiana, Aster patens,* and *Desmodium rotundifolium.* On acidic sites *Vaccinium pallidum, Orbexilum pedunculatum, Hieraceum gronovii*, and *Ceanothus americanus* are frequent. *Cunila origanoides, Danthonia spicata,* and *Solidago ulmifolia* occur on upland flats.

Although open portions of the barrens are dominated by prairie plants, groves and more densely-canopied parts lack these in favor of more shade tolerant species. Over 100 species appeared on list assembled by Mead (1846). Several "savanna" plants (Packard 1988, 1991) have wide distributions, and inhabit barrens in this region as well as the oak openings north of the Wisconsinan glacial boundary. Most of these are from Mead's (1846) list from western Illinois. Among species on the Shawnee Hills, are *Asclepias purpurascens, Cacalia atriplicifolia, Elymus* spp., *Lespedeza violacea, Panicum latifolium, Dasistoma macrophylla*, and *Frasera caroliniensis.*

Species characteristic of barrens and glades will grow in some disturbed areas (Baskin and Baskin 1985). Native oldfields, roadsides, and quarry sites are areas where barrens plants may persist or even thrive on occasional disturbances.

Winter annuals are most abundant on limestone in very shallow soils, less than 5 cm in depth (Baskin and Baskin 1985). Summer annuals may be in the same areas or where soil is up to 25 cm deep (Baskin and Baskin 1985).

It is probable that, as with vascular plants, there is a successional progression of the non-vascular flora. This has been demonstrated on the glades in central Tennessee (Quarterman 1950).

The presence of barrens is important to a number of animals. Because many barrens have south or west exposures, these areas clear themselves of snow rapidly, and are important feeding areas for animals during winter. They also warm up more quickly during the spring of the year (Kiser and Houf 1985).

It is well known that edge habitat provides necessities for many wildlife species. A large proportion of these are barrens species. It appears that narrow ecotones are providing a facsimile of the formerly widespread barrens habitat. Among such species are *Meleagris gallopavo, Melanerpes erythrocephalus, Polioptila caerulea, Sialia sialis, Icteria virens, Icterus spurius,* and *Myotis sodalis*.

Dominant plants on sandstone barrens across the region are *Quercus stellata, Q. marilandica, Vaccinium arboreum, Schizachyrium scoparium,* and *Danthonia spicata*. *Ulmus alata, Juniperus virginiana,* and *Q. velutina* are characteristic woody species. Characteristic herbs in the region include *Opuntia humifusa, Cheilanthes lanosa, Hypericum gentianoides,* and *Clitoria mariana*. *Flavoparmelia baltimorensis, Cladonia furcata,* and *C. polycarpoides* cover exposed rock surfaces. *Dicranum scoparium* and *Leucobryum glaucum* are characteristically found in this habitat (White 1978). Siltstone barrens have *Helianthus divaricatus* and *Tephrosia virginiana* (Homoya 1994). *Sceloporus undulatus hyacinthinus* frequently observed (White 1978).

Limestone barrens have *Quercus stellata, Q. marilandica,* and *Q. muehlenbergii* as dominant trees. *Schizachyrium scoparium, Sorghastrum nutans, Bouteloua curtipendula, Echinacea purpurea, Lithospermum canescens, Eryngium yuccifolium,* and *Physostegia virginiana* are characteristic herbs. *Andropogon gerardii, Panicum virgatum,* and *Sporobolus heterolepis* are other common grasses. *Quercus* spp., *Cornus florida, Rhamnus caroliniana,* and *Juniperus virginiana* tend to invade open sites.

Chert glades dominant plants include *Quercus stellata, Q. marilandica,* and *Schizachyrium scoparium*. Characteristic species include *Selaginella rupestris, Sporobolus neglectus, Camassia scilloides, Coreopsis lanceolata,* and *Rhus copallinum* (Yatskievych 1999). *Cheilanthes lanosa* grows in fissures in the rocks. Steyermark (1940) found lichens, mosses, *Opuntia humifusa, Talinum parviflorum, Eragrostis capillaris, Crotonopsis linearis,* and *Isanthus brachiatus*.

Gravel barrens are dominated by *Quercus stellata, Q. marilandica, Carya ovalis, Schizachyrium scoparium,* and *Danthonia spicata*. Characteristic species include *Vaccinium arboreum, Ceanothus americanus, Lespedeza hirta, Hieraceum gronovii, Krigia biflora,* and *Helianthus divaricatus*.

Shale glades only consistent dominant plant is *Schizachyrium scoparium* (Heikens *et al*. 1994, Yatskievych 1999). Trees associated with this community are *Quercus marilandica, Q. stellata,* and *Juniperus virginiana*.

Loess barrens are dominated by *Quercus stellata, Q. marilandica, Carya texana, C. ovata, Vitis* spp., *Schizachyrium scoparium, Andropogon gerardii, Sorghastrum nutans, Elymus* spp., *Liatris* spp., and *Lespedeza* spp. Characteristic species include *Q. velutina,*

C. ovalis, Rhus copallinum, Ceanothus americanus, Sassafras albidum, Danthonia spicata, Koehleria pyramidata, Helianthus divaricatus, and *Clitoria mariana*.

Ozark Highlands (222A)

The Ozark-Ouachita Highlands Assessment (USDA Forest Service 1999) gives an extensive review of the conditions in the Ozark region. The Missouri Ozark Forest Ecosystem Project (MOFEP) looks at a number of variables of forest management in the Ozarks (Brookshire and Shifley 1997). From species lists presented and ELTs considered in the MOFEP study area, many sites have barrens-like characteristics. Harris and Ladd (2000) have been cataloguing the lichen flora of the Ozark Highlands for about 15 years. Their importance in glade communities may make them useful in habitat monitoring.

Characteristic vascular plant species in the Ozarks include *Pinus echinata, Vulpia octoflora, Lechea mucronata, Sorghastrum nutans, Eragrostis spectabilis,* and *Isoetes melanopoda*.

Missouri dolomite glades are dominated by *Schizachyrium scoparium, Bouteloua curtipendula, Sorghastrum nutans,* and *Sporobolus heterolepis* (Nelson and Ladd 1981b). They also have *Andropogon gerardii* and *Panicum virgatum* as common grasses. Characteristic species include *Arenaria patula, Aster sericeus, Buchnera americana, Carex meadii, Echinacea pallida, Oenothera missouriensis, Dalea purpurea,* and *Viola pedata*. *Quercus* spp., *Cornus florida*, *Rhamnus caroliniana,* and *Juniperus virginiana* tend to invade these open sites. *Castelleja purpurea* and *Lesquerella filiformis* are restricted to dolomite glades in southwestern Missouri (Yatskievych 1999).

Porteranthus stipulatus and *Astragalus distortus* are characteristic on shale glades in the Ozarks.

St. Francis Knobs and Basins (222Aa)

Barrens in the area of Taum Sauk Mountain (Figure 6) have about 60 percent canopy of *Quercus stellata, Q. alba,* and *Q. marilandica*. There is some *Quercus* spp. and *Carya* spp. brush, but the understory is dominated by herbaceous species. *Agrostis elliottiana* is abundant. Common herbs include *Antennaria plantaginifolia, Aster patens, Lespedeza procumbens, L. virginica, Danthonia spicata, Helianthus divaricatus, Carex albicans, Eryngium yuccifolium, Liatris aspera, Cunila origanoides*, and *Lespedeza hirta*. Other species occurring less frequently are *Parthenium integrifolium, Agalinis gattingeri, Andropogon virginicus*, *Rhus copallinum*, and *Schizachyrium scoparium*. *Leucobryum glaucum* and *Polytrichum ohiense* are locally common.

Vegetation in the igneous glades is very sparse, growing mostly in small amounts of soil accumulated between rocks or in cracks of the rocks, and on this soil within the glade. An igneous glade at Taum Sauk Mountain has less than 50 percent canopy of *Quercus velutina* and *Carya ovata*, mostly less than 25 feet tall. There are few shrubs, but it appears that there has been some encroachment by *Quercus* spp. The ground flora is

dominated by *Schizachyrium scoparium*, but *Andropogon gerardii* and *Sorghastrum nutans* are also present. *Danthonia spicata* and *Carex albicans* are common in shaded portions of the site. Exposed rocks are covered by *Cladonia caroliniana, C. strepsilis, Xanthoparmelia* spp., and *Punctelia hypoleucites*. *Flavoparmelia caperata* and *Punctelia rudecta* cover the bark of trees. Common herbaceous plants are *Parthenium integrifolium, Tephrosia virginiana, Agalinis gattingeri, Acalypha gracilens, Agrostis elliottiana, Coreopsis tripteris, Liatris squarrosa,* and *Antennaria plantaginifolia*. *Hypericum gentianoides* is abundant in some areas. Along the edges of this habitat, *Liatris spicata, Helianthus hirsutus, Eryngium yuccifolium, Crotonopsis linearis*, and *Rubus flagellaris* are frequent. Other species in this vicinity are *Ulmus alata, Vaccinium arboreum, Ambrosia bidentata, Bouteloua curtipendula, Cheilanthes lanosa, Diodea terres,* and *Polygala sanguinea*.

A dolomite glade at Johnson's Shut-ins State Park (Figure 7) has no canopy because of recent management. There had been *Juniperus virginiana,* but a grove of *Quercus stellata* and *Carya ovalis* remains. The dominant grass is *Schizachyrium scoparium*, but *Panicum virgatum, Aristida purpurascens,* and *Sporobolus neglectus* are common. There is considerable exposed bedrock covered by *Lecanora muralis* and *Caloplaca saxicola*, but much of the rock is gravelly. Abundant forbs include *Echinacea pallida, Dalea purpurea, Aster patens, Rudbeckia missouriensis, Bouteloua curtipendula, Silphium terebinthinaceum,* and *Verbena canadensis*. Other common plants are *Hypericum prolificum, Hedyotis nigricans, Silphium integrifolium,* and on low outcrops *Pellaea atropurpurea*. The interspersed woodlands have shrubs of *Quercus muehlenbergii, Rhamnus caroliniana, Ulmus alata, Cercis canadensis, Cornus florida* and *Rhus aromatica*. Herbs present are *Desmodium nudiflorum, Cimicifuga racemosa, Brachyelytrum erectum, Solidago ulmifolia*, and *Smilax bona-nox*.

Central Plateau (text provided by S. Amelon, NCFES) (222Ab)

Broad level uplands in the northern sections of the Central Plateau typically exhibit flatwoods or savanna characteristics (Figure 8). Western Star Flatwoods has 50 to 60 percent canopy of *Quercus stellata, Q. marilandica,* and *Q. velutina.* Some areas have saplings of *Quercus* spp. and *Carya* spp. with additional shrub components that include *Sassafras albidum* and *Prunus americana.* The understory is dominated by herbaceous species including *Eleocharis tenuis, Carex flaccosperma, C. umbellata, C. complanata, Agrostis hyemalis, Danthonia spicata,* and *Panicum lanuginosum.* Other species occurring less frequently are *Lespedeza procumbens, L. virginica, Schizachyrium scoparium, Crotonopsis elliptica, Parthenocissus quinquefolia, Juncus tenuis tenuis, Potentilla simplex, Penstemon digitalis,* and *Aster patens* (Figure 9).

More rolling uplands are characterized by oak savanna. Several savannas near the Big Piney River characteristically have 50 to 70 percent canopy of *Quercus stellata, Q. marilandica,* and *Q. velutina.* Understory woody vegetation include saplings of the overstory species with *Vaccinium vacillans, Vitis cinerea, Toxicodendron radicans*, and *Sassafras albidum.* The understory is dominated by herbaceous species including *Parthenocissus quinquefolia, Carex umbellata, Danthonia spicata, Panicum dichotomum,* and *P. lanuginosum fasciculatum.* Other species occurring less frequently

are *Lespedeza repens, Amphicarpaea bracteata, Schizachyrium scoparium, Cunila origanoides, Desmodium nudiflorum, D. glabellum, Antennaria plantaginifolia, Eupatorium rugosum, Lespedeza procumbens, Asclepias verticillata, Aster linariifolius,* and *Aster patens.*

The geology of this portion of the Central Plateau consists of cherty dolomite of the Roubidoux formation. Roubidoux sandstone outcrops on the upper sideslopes are common. At lower elevations, Gasconade dolomite outcrops on the side slopes resulting in a matrix of small dolomite glades interspersed with savannas. Typical vegetation of the glade areas include *Schizachyrium scoparium, Panicum virgatum,* and *Bouteloua curtipendula*. There is a small amount of canopy, especially near the edges that include *Quercus stellata* and *Q. marilandica*. Other woody species include *Rhus aromatica, Juniperus virginiana,* and *Fraxinus americana*. Additional grasses found here are *Andropogon gerardii* and *Sorghastrum nutans*. Herbaceous species include *Liatris aspera, Aster linariifolius, Euphorbia corollata, Helianthus angustifolius,* and *Rudbeckia missouriensis*. Species frequent in other parts of the glade system include *Allium canadense, Ruellia humilis, Asclepias tuberosa,* and *Asclepias viridiflora*. Additional species in this area include *Amorpha canescens, Baptisia bracteata, Coreopsis palmata, Desmodium rotundifolia, Hedyotis nigricans, Solidago ulmifolia, Vitis aestivalis, Hieracium gronovii,* and *Liatris cylindracea.*

Typical mammals of the habitats are *Odocoileus virginianus, Canis latrans, Lynx rufus, Procyon lotor, Sciurus niger, Marmota monax, Sylvilagus floridanus, Myotis septentrionalis, Lasiurus borealis, Pipistrellus subflavus, Peromyscus leucopus,* and *Blarina carolinensis.*

Typical birds of the habitats are S*pizella pusilla, Sayornis phoebe, Passerina cyanea, Melanerpes erythrocephalus, Sialia sialis, Polioptila caerulea, Contopus virens, Vermivora pinus, Piranga rubra, Baeolophus bicolor,* and *Dendroica dominica.*

Typical herptofauna of the habitats are *Notophthalmus viridescens louisianensis, Ambystoma opacum, A. annulatum, Bufo americanus, Eumeces fasciatus, Sceloporus undulatus hyacinthinus, Elaphe obsoleta, Virginia valeriae elegans,* and *Terrapene carolina triunguis.*

Typical invertebrates of the habitats are Cyrtacanthacridinae, *Ceuthophilus maculatus, Oecanthus* spp., *Neoconcephalus* spp., *Melanoplus* spp., *Orchelimum silvaticum, Gryllus pensylvanicus, Melanoplus keeleri, Conocephalus nemoralis,* and *Allonemobius fasciatus.*

Osage River Hills (222Ac)

No sites were visited in this subsection during preparation of this assessment.

Gasconade River Hills (222Ad)

One of the sandstone barrens at Solomon Hollow (Figure 10) does not have an extensive "pavement", but does have small rock outcrops with numerous rock fragments on the surface. Other openings in this area have greater "pavements". These are covered by *Cladonia caroliniana, C. strepsilis, Pleopsidium chlorphanum,* and *Hedwigia ciliata*. Canopy trees include *Quercus marilandica, Q. stellata,* and *Q. alba* forming a canopy of about 60 percent. There are many *Quercus* spp. shrubs as well as *Vaccinium arboreum* and *V. pallidum*. Dominant herbs are *Tephrosia virginiana, Cunila origanoides, Carex albicans, Aster linariifolius, A. patens, Solidago ulmifolia, Schizachyrium scoparium, Baptisia lactea, Porteranthus stipulatus, Antennaria plantaginifolia, Aristida purpurascens,* and *Sorghastrum nutans*. The surrounding dry upland forest has most of the same species suppressed by shade.

The Gasconade Island glades are developed on Gasconade dolomite. This area has a very open canopy. Bedrock exposures account for about 20 percent of the grounds surface. *Schizachyrium scoparium* and *Sorghastrum nutans* dominate the open parts of the site. Canopy trees around the perimeter are mostly *Quercus stellata* (Figure 11).

The Bald Ridge savanna area has variable canopy closure ranging from 40 to 80 percent. *Quercus stellata* dominates where the canopy is more open, and *Schizachyrium scoparium, Sorghastrum nutans,* and *Rhus copallinum* are dominant in the understory. Where the canopy is more closed, *Quercus velutina* becomes more common (Figures 12 and 13).

Meramec River Hills (222Ae)

Barrens communities in the Meramec River Hills are found on the Gasconade dolomite. *Quercus stellata* and *Q. velutina* are the dominant trees. The open portions of these barrens are rather diverse. *Parthenocissus quinquefolia, Rhamnus caroliniana, Symphoricarpos orbiculatus,* and *Amorpha canescens* are frequent woody species. Common graminoids include *Carex retroflexa, C. umbellata, Panicum boscii, Andropogon gerardii,* and *Schizachyrium scoparium.* Forbs present include *Amphicarpaea bracteata, Desmodium nudiflorum, Eupatorium rugosum, Coreopsis palmata, Lespedeza virginica,* and *Rudbeckia hirta*.

Current River Hills (222Af)

The dolomite barrens at Stalcup Hollow in the Peck Ranch Conservation Area has fairly large rock outcrops of one to eight feet high and up to 50 feet long (Figure 14). Rock and gravel fragments account for about 30 percent of the surface. The opening is dominated by *Sorghastrum nutans* and *Andropogon gerardii,* with *Bouteloua curtipendula, Schizachyrium scoparium,* and *Panicum virgatum* also being frequent. Shrubs include *Juniperus virginiana, Cotinus obovatus,* and *Quercus* spp. forming a 20 percent canopy. Common herbs are *Rudbeckia missouriensis, Aster patens, Sporobolus vaginiflorus, Nothoscordum bivalve, Ambrosia bidentata, Hypericum gentianoides, Silphium*

terebinthinaceum, Echinacea pallida, Liatris aspera, Elymus virginicus, Kuhnia eupatorioides, and *Ratibida pinnata* (Figure 15).

The more closed canopied barrens above this site is dominated by *Pinus echinata*, *Quercus coccinea, Q. marilandica,* and *Q. stellata*. The understory is open, but shrubs and saplings of these species are common especially at the ecotone. The ground is about 50 percent exposed rock and cobbles covered by shield and crustose lichens. Common herbs are *Carex albicans, Danthonia spicata, Lespedeza procumbens, Tephrosia virginiana, Baptisia lactea, Coreopsis palmata,* and *Smilax bona-nox*.

There is a large barrens/glade/woodland complex on Stegall Mountain at the Peck Ranch Conservation Area (Figure 16). It is dominated by *Schizachyrium scoparium* and *Quercus stellata*. There are large igneous exposures covered by *Cladina* spp., *Placidium lachneum, Cladonia caroliniana, Punctelia hypoleucites,* and *Pleopsidium chlorphanum,* as well as dry site mosses. Rock covers about 15 percent of the area. Canopy closure varies from 10 to 80 percent, averaging around 60 percent over the extensive system. Canopy trees include *Quercus stellata, Pinus echinata, Q. marilandica, Q. coccinea,* and *Carya ovalis*. Many of these are only 20 to 30 feet tall. *Quercus* spp. shrubs are common, and *Rhus copallinum* is frequent. Other common graminoids include *Andropogon gerardii, Sorghastrum nutans, Carex albicans, Danthonia spicata,* and *Eragrostis spectabilis*. There is a great diversity of herbs within this area. Some of the more conspicuous species include *Cunila origanoides, Tephrosia virginiana, Crotonopsis linearis, Coreopsis palmata, Hypericum gentianoides, Helianthus divaricatus, Lespedeza violacea, Monarda russeliana, Liatris squarrosa, Parthenium integrifolium, Aster patens, Cassia fasciculata,* and *Rosa setigera* (Figures 17 and 18).

Junonia coenia is occasionally seen, and *Sceloporus undulatus hyacinthinus* is common.

White River Hills (222Ag)

Dolomite glades form extensive complexes. Rock outcrops are low linear features, often gravelly. One example along the "Gladetop Trail" (Figure 19) is dominated by *Schizachyrium scoparium, Panicum virgatum,* and *Bouteloua curtipendula*. There is no canopy, but there are numerous small *Quercus stellata* and *Q. marilandica*. Other woody species include *Rhus aromatica, Diospyros virginiana, Juniperus virginiana, Celtis tenuifolia,* and *Cotinus obovatus*. Additional grasses found here are *Sporobolus neglectus, Andropogon gerardii* and *Sorghastrum nutans*. Abundant herbs include *Croton monanthogynus, Echinacea pallida, Grindelia squarrosa, Palafoxia callosa, Aster patens,* and *Silphium laciniatum*. Additional herbs include *Liatris aspera, Kuhnia eupatorioides, Tephrosia virginiana, Aster linariifolius, Euphorbia corollata, Helianthus angustifolius,* and *Rudbeckia missouriensis*. *Lecanora muralis, Caloplaca saxicola, Psora russellii,* and *Placynthium nigrum* occur on exposed rock and on bark of trees and shrubs. Species frequent in other parts of the glade system include *Allium stellatum, Heliotropium tenellum, Ambrosia bidentata, Agave virginica, Ruellia humilis, Isanthus brachiatus,* and *Asclepias tuberosa*. Additional species in this area include *Bumelia lycioides, Rhus aromatica, Ulmus alata, Silphium terebinthinaceum, Delphinium carolinianum, Dalea purpurea,* and *Penstemon tubaeflorus* (Figure 20). *Colaptes*

auritus, Cyanocitta cristata, Poecile carolinensis, and *Coluber constrictor* are found here, as are *Pyristia lisa* and *Lynx rufus*.

The forest adjacent to this area is dominated by large, open-grown *Quercus stellata*. The next smaller size class of trees are also *Q. stellata,* but do not appear open grown. Stands are dense with a third generation of *Q. stellata, Q. marilandica, Q. velutina,* and *Carya* spp. In the understory are *Carya* spp., *Quercus alba,* and *Q. muehlenbergii* shrubs, as well as *Cercis canadensis*, *Rhamnus caroliniana,* and *Juniperus virginiana*. Suppressed herbaceous species in the understory include *Carex albicans, Panicum boscii, Tephrosia virginiana, Antennaria plantaginifolia, Vaccinium pallidum, Schizachyrium scoparium, Andropogon gerardii, Sporobolus neglectus, Euphorbia corollata,* and *Eryngium yuccifolium*. Taken together, this implies that these stands were much more open in the past.

Dugesiella hentzi, Crotaphytus collaris, and *Geococcyx californianus* reach the limits of their ranges in the White River glades (Amelon 1991). *Aimophila aestivalis* was first found in Ozark and Taney counties in 1974 and 1975 (Hardin *et al*. 1982).

Inner Ozark Border (222Aj

No sites were visited in this subsection during preparation of this assessment.

Outer Ozark Border (222Ak)

A sandstone barrens with glade-like characteristics at Hawn State Park (Figure 21) is dominated by *Schizachyrium scoparium, Andropogon ternarius, Pinus echinata,* and around the perimeter *Quercus stellata* and *Q. marilandica*. The canopy is less than 20 percent. The adjacent woods have some *Rhus aromatica* and *R. copallinum,* and *Carya ovalis*. A few *Juniperus virginiana* are in the open area. About 50 percent of the ground is exposed rock covered by *Cladonia caroliniana, C. strepsilis,* and *C. mateocyatha*. *Polytrichum ohiense* and other dry site mosses are common. *Quercus stellata, Pinus echinata,* and *Vaccinium arboreum* are the most frequent shrubs. Common forbs include *Hypericum gentianoides, Aster patens, Crotonopsis linearis,* and in the woodland edge *Helianthus divaricatus* and *Cunila origanoides*. Other graminoids in this area include *Aristida purpurascens, Danthonia spicata, Panicum latifolium, Carex albicans,* and *Panicum linearifolium*. *Sceloporus undulatus hyacinthinus* frequents this habitat.

Erickson, *et al*. (1942), described glades in the Outer Ozark Border as sometimes being treeless, but more frequently as having "'islands' of small trees surrounding gullies or ledges of rock."

Black River Ozark Border (222Al)

There is only one recognized small barrens remnant in the Black River Ozark Border. It is on land administered by the U.S. Army. This site was not visited during preparation of this assessment.

Springfield Plain (222Am)

Palmer (1910) offered a species list for the chert glades in southwestern Missouri. Trees of the site included *Quercus stellata, Q. marilandica, Diospyros virginiana,* and *Vaccinium arboreum*. *Melica mutica* and *Arabis laevigata* were found in both the glades and surrounding forest. A number of annual plants were also mentioned: *Aristida* spp., *Eragrostis* spp., *Crotonopsis linearis,* and *Isanthus brachiatus*. No sites were visited in this subsection during preparation of this assessment.

Illinois Ozarks (222Aq)

A small, less than three acres, limestone barrens at Larue Pine Hills Research Natural Area (Figure 22) has a few trees at the edges and in a grove at the top of the spur ridge. This sits on top of the Bailey Limestone and has a thin mantle of Peoria Loess. These are *Quercus muehlenbergii, Q. stellata,* and *Juniperus virginiana*. None are more than 20 feet tall. *Ulmus alata, Vaccinium arboreum,* and *Rhus aromatica* are present as shrubs. The opening is dominated by *Bouteloua curtipendula,* with some *Schizachyrium scoparium* and *Sporobolus vaginiflorus*. *Aster patens* is abundant. Cherty limestone of the Bailey Formation forms low outcrops and is gravelly at the surface. Shield and crustose lichens cover many rocks. Other conspicuous vascular plants include *Allium stellatum, Hedyotis nigricans, Acalypha gracilens, Solidago drummondii, Asclepias tuberosa, Isanthus brachiatus, Andropogon gerardii, Tephrosia virginiana, Amelanchier arborea, Celtis tenuifolia, Ambrosia artemisiifolia, Phlox bifida, Liatris aspera,* and *Solidago ulmifolia* (Figure 23).

A closed canopied barrens occurs at Larue on the top of chert bluffs. The chert is in the Grassy Knob Formation. It is dominated by dwarfed *Quercus stellata,* with a few similarly formed *Q. marilandica* and *Pinus echinata*. The canopy closure is greater than 80 percent. *Vaccinium arboreum* is the only conspicuous shrub. Herbaceous vegetation covers only about 30 percent of the ground, the remainder being chert rock and gravel. *Flavoparmelia* spp. and *Punctelia* spp. cover nearly every available surface. There are some terrestrial mosses. Herbaceous dominants are *Carex albicans* and *Danthonia spicata*. Other associated plants are *Antennaria plantaginifolia, Vaccinium pallidum, Tephrosia virginiana, Amelanchier arborea, Solidago ulmifolia, Carya ovalis,* and *Lespedeza procumbens* (Figure 24).

Gravel barrens, formed from the breakdown of the Grassy Knob chert, in the Pine Hills area are dominated by *Quercus marilandica* and *Pinus echinata*. *Vaccinium arboreum* dominates the understory and *Smilax* spp. are common. *Rhododendron prinophyllum* are occasionally present. The herbaceous ground cover is very sparse (Figure 25).

Barrens formed in the Peoria Loess in the Illinois Ozarks are dominated by *Schizachyrium scoparium* and *Bouteloua curtipendula*. The adjacent woodland border often has *Quercus velutina* and *Q. alba*. Common forbs are *Phlox bifida, Euphorbia*

corollata, Kuhnia eupatorioides, Solidago ulmifolia, and *Dalea candida*. Common herbs in these areas are *Schizachyrium scoparium, Danthonia spicata, Euphorbia corollata, Helianthus divaricatus, Desmodium* spp. and *Lespedeza* spp.

A chert site on the Bailey Formation in Alexander County is dominated by *Quercus stellata, Ulmus rubra, Fraxinus americana, Carya ovata* and *Vaccinium arboreum* with *Chasmanthium latifolium* and *Helianthus divaricatus* in the understory (Heikens *et al*. 1994).

Ozment (1966) found openings dominated by *Schizachyrium scoparium* and *Sorghastrum nutans*, with *Kuhnia eupatorioides, Dalea purpurea* and *D. candida*, and *Pyrus ioensis* at various sites in southwestern Illinois.

Shale barrens on the Grassy Creek Shale have *Quercus stellata, Ulmus alata,* and *Vaccinium arboreum*, with *Schizachyrium scoparium, Helianthus divaricatus,* and *Danthonia spicata* in the understory (Heikens *et al*. 1994).

Kurz (1981) showed differences and similarities in the limestone glade flora in southern Illinois. Over 90 species were found only on glades in the Lesser Shawnee Hills, while 83 species occurred only in the Illinois Ozarks. There were 84 species identified as occurring in both areas.

Upper Gulf Coastal Plain Section (222C)

Most remnant barrens on Cretaceous gravels are small and occur along ridges. One such site at Redd Hollow in the Land-Between-the-Lakes National Recreation Area (LBL) is dominated by *Quercus prinus*, and together with smaller numbers of *Q. velutina* and *Q. alba*, forms a canopy of more than 80 percent (Figure 26). Common shrubs include *Vaccinium arborescens, V. pallidum, V. stamineum, Kalmia latifolia*, and *Smilax glauca*. These form locally very dense thickets. Present in smaller numbers are *Oxydendrum arboreum, Cornus florida*, and *Quercus stellata*. *Dicranum scoparium, D. condensatum, Leucobryum glaucum*, and *Polytrichum* spp. are common. *Cladina* spp. and *Cladonia* spp. are also frequnt on the gravel exposures. *Punctelia rudecta* and *Flavoparmelia caperata* cover the bark of trees. Common herbs are *Danthonia spicata, Carex albicans, Panicum dichotomum, Hypericum hypericoides, Lespedeza intermedia, L. hirta, Tephrosia virginiana, Solidago erecta, S. odora, Cunila origanoides, Panicum boscii, Pteridium aquilinum*, and *Schizachyrium scoparium*.

Other sites on gravels at LBL are dominated by *Quercus stellata, Q. alba,* and *Q. marilandica*, with some *Pinus ehinata* and *Carya ovalis*. Canopy is greater than 80 percent. Shrubs include *Vaccinium arboreum, Prunus serotina, Cornus florida,* and *Ulmus alata*. Common herbs throughout the vicinity are *Cunila origanoides, Lespedeza hirta, Solidago nemoralis, Carex albicans, Danthonia spicata, Baptisia lactea, Panicum dichotomum, Aster patens, Tephrosia virginiana, Andropogon ternarius, Solidago erecta, Symphoricarpos orbiculatus, Tridens flavus, Rubus flagellaris, Schizachyrium scoparium, Liatris squarrosa, Hieraceum gronovii,* and *Kuhnia eupatorioides*. *Dicranum scoparium* is common, as are *Cladonia* spp.

A more open remnant within the Elk & Bison Prairie at LBL is dominated by *Schizachyrium scoparium, Andropogon gerardii,* and *Sorghastrum nutans,* with some *Tripsacum dactyloides*. Forbs in this area include *Echinacea purpurea, Asclepias tuberosa, Cassia fasciculata, Fragaria virginiana, Phlox pilosa,* and *Rosa carolina*.

Cretaceous Hills (222Ca)

Hutchison, *et al*. (1986), described a dozen barrens sites in the Cretaceous Hills. Characteristic species of these barrens included *Asclepias variegata, Helianthus divaricatus, Liatris squarrosa, Parthenium integrifolium, Tradescantia virginiana, Vaccinium arboreum, Lespedeza virginica, Quercus marilandica, Quercus stellata, Carya glabra, Schizachyrium scoparium, Aristida purpurascens, Sorghastrum nutans, Tridens flavus,* and *Smilax bona-nox*.

The barrens at Dean Cemetery, West, is on the upper south slope of a gravel knob (Figure 27). These gravels are of the Mounds Formation. There is a 70 percent canopy of large *Quercus velutina* and *Q. falcata,* with smaller *Q. marilandica*. *Quercus stellata* is a frequent shrub. *Vaccinium arboreum, Rhus copallinum,* and *Cornus florida* are also found around the opening. Much of the ground is covered by *Cladina subtenuis, Cladonia cristatella, Leucobryum glaucum, Dicranum scoparium,* and *Polytrichum ohiense*. *Punctelia rudecta* and *Flavoparmelia caperata* cover the bark of trees. Common herbs include *Danthonia spicata, Carex albicans, Panicum dichotomum, Tephrosia virginiana, Hypericum hypericoides, Pteridium aquilinum, Schizachyrium scoparium, Lespedeza hirta, Carex caroliniana, Smilax glauca,* and *Lechea mucronata* (Figure 28).

Xeric and some dry upland forests merge into barrens in the Cretaceous Hills. A dominant tree in the Cretaceous Hills is *Quercus falcata*. *Corylus americana* was common in open woods (Palmer 1921). *Ceanothus americanus, Zanthoxylum americanum,* and *Prunus munsoniana* were frequent in thickets and woodland borders (Nielson 1939). Apparently, once the area was settled and fires became less frequent, the *Quercus* spp. shrubs grew into forest stands with remnant prairie herbs surviving in the understory and in areas which were kept open.

A mesic barrens on sand is known only to remain in the Cretaceous Hills (Figure 29). There are very few remnants because soils will support forest vegetation and little active management has occurred recently. Dominant plants are *Quercus falcata, Andropogon gerardii, Schizachyrium scoparium, Sorghastrum nutans,* and *Q. alba*. Characteristic species include *Silphium integrifolium, Liatris squarrosa,* and *Gentiana alba*.

Interior Low Plateau, Shawnee Hills Section (222D)

There are small barrens remnants on the Dripping Springs Escarpment at Mammoth Cave National Park (Figure 30). Limestone outcrops covered by lichens and mosses account for about 20 percent of these sites. The dominant trees are *Quercus stellata* and *Q. falcata,* having a canopy closure of about 80 percent. *Cornus florida* and *Rhamnus*

caroliniana are the most conspicuous understory trees. Common herbs include *Smilax glauca, Danthonia spicata, Eupatorium altissimum, Panicum boscii, Pellaea atropurpurea,* and *Phryma leptostachya*.

The area across the Ohio River from the Crawford Escaprment in Kentucky, the Northern Dripping Springs Subsection, has many barrens affinities. Soils are thin, and there are many small outcrops of exposed bedrock. The ridges are dominated by *Quercus velutina* and *Q. stellata*. *Vaccinium arboreum* is common in the understory, as are *Cercis canadensis* and *Cornus florida*. *Danthonia spicata* is abundant. *Rudbeckia hirta* and *Asclepias tuberosa* are very conspicuous. *Smilax rotundifolia* forms dense thickets.

Crawford Uplands (222De)

A sandstone barrens on the Mansfield Formation at Clover Lick (Figure 31) is dominated by *Quercus alba,* with *Carya ovalis* and *Q. coccinea*. There are few shrubs, but *Quercus* spp. saplings are common. *Panicum dichotomum* and *Danthonia spicata* are abundant, and *Carex albicans* is frequent. Common forbs include *Verbesina helianthoides, Helianthus divaricatus, Lespedeza virginica, Aster undulatus, Cunila origanoides, Solidago erecta,* and *Desmodium paniculatum*. Also of note in this area are *Schizachyrium scoparium, Sorghastrum nutans, Tephrosia virginiana, Antennaria plantaginifolia,* and *Aster linariifolius*. Characteristic species include *Hypericum hypericoides, Aster solidagineus, Cunila origanoides, Krigia biflora, Solidago bicolor,* and *Viola palmata* (Figure 32).

A nearby site with less soil development is dominated by *Quercus prinus* and *Smilax rotundifolia*. Because of the low fertility on this site, plant diversity is low. Trees grow poorly. The shrub layer has *Vaccinium pallidum, Sassafras albidum,* and *Quercus prinus* seedlings. There are few herbs, mostly *Danthonia spicata,* with some *Carex albicans, Tephrosia virginiana,* and *Panicum dichotomum*. *Flavoparmelia baltimorensis* covers exposed rock, and *Leucobryum glaucum, Polytrichum juniperinum, Dicranum scoparium,* and *D. condensatum* are common.

Also in close proximity is a limestone barrens on the Vienna Formation at Clover Lick dominated by *Quercus stellata, Sorghastrum nutans,* and *Andropogon gerardii*. The canopy is about 50 percent. *Quercus marilandica* and *Schizachyrium scoparium* are also common. Shrubs include *Cornus florida, Viburnum rufidulum, Vaccinium arboreum,* and *Ceanothus americanus*. Frequent forbs include *Silphium terebinthinaceum, Ratibida pinnata, Eryngium yuccifolium, Asclepias viridiflorum, Liatris aspera, Aster laevis, Gentiana alba,* and *Lespedeza procumbens*. Characteristic species include *Cercis canadensis, Ostrya virginiana, Agalinis tenuifolia, Carex meadii, Scleria oligantha, Thaspium barbinode,* and *Lithospermum canescens*. Also present are *Phlox pilosa, Helianthus mollis, Liatris squarrosa, Solidago rigida, Silphium trifoliatum, Kuhnia eupatorioides,* and in shaded locations, *Aster linariifolius, Elymus virginicus,* and *Symphoricarpos orbiculatus* (Figure 33).

Reptiles which are regularly found in this barrens complex include *Scincella laterale, Sceloporus undulatus hyacinthinus,* and *Heterodon platyrhinos*. *Polioptila caerulea,*

Piranga rubra, Baeolophus bicolor, Passerina cyanea, Melanerpes carolinus, Icteria virens, and *Icterus spurius* are common birds. The most conspicuous mammals are *Sciurus niger* and *Odocoileus virginianus*. Somewhat less conspicuous but also common are *Lasiurus borealis, Peromyscus leucopus,* and *Microtus ochrogaster*. Common lepidopterans include *Speyeria cybele, Phoebis sennae,* and *Erynnis juvenalis*.

The sandstone barrens on the Mansfield Formation at Plaster Creek (Figure 34) has glade-like characteristics with (relatively) significant exposures of bedrock, about 40 percent of the ground, covered by *Flavoparmelia baltimorensis, Cladina subtenuis, Dicranum scoparium, Polytrichum juniperinum,* and *Leucobryum glaucum*. The canopy closure is 50 percent in the most open portions. The dominant species is *Quercus prinus,* with smaller individuals of *Quercus velutina, Q. alba, Q. marilandica,* and *Q. coccinea*. The bark of *Quercus prinus* and *Q. velutina* is covered by *Punctelia rudecta* and *Flavoparmelia caperata*. The dominant shrub is *Vaccinium arboreum,* forming a 30 percent understory canopy. Other common shrubs include *Vaccinium pallidum, Amelanchier arborea,* and *Smilax rotundifolia*. Common herbs include *Schizachyrium scoparium, Tephrosia virginiana, Carex albicans, Scleria pauciflora, Panicum dichotomum, Danthonia spicata, Solidago erecta, Cunila origanoides,* and *Rubus flagellaris*.

Indiana limestone barrens had *Sorghastrum nutans, Schizachyrium scoparium,* and *Andropogon gerardii* as matrix species, with *Asclepias* spp., *Aster* spp., *Helianthus rigida, Liatris* spp., *Silphium trifoliatum,* and *Solidago* spp. (Hutchison 1983). Among species which occur in the Chestnut Oak Upland of Indiana are: *Asclepias viridiflora, Aster linariifolius, Viola pedata, Vaccinium pallidum, Gentiana alba, Lysimachia quadrifolia, Hypericum gentianoides, Kuhnia eupatorioides,* and *Scutellaria nervosa*.

Bacone, *et al*. (1983), described remnant limestone and sandstone barrens in the Crawford Uplands. Glades and barrens were not readily separated by their flora, the major differences being visual attributes. Sandstone glades, however, generally have ericaceous shrubs and a lower diversity of forbs.

Guss (1942) notes a number of plants which reach the southern limits of their range in Indiana or are disjunct in the barrens of Perry and Crawford counties, such as *Asclepias viridiflora, Aster linariifolius, Vaccinium pallidum, Gaylussacia baccata, Gentiana alba,* and *Scutellaria nervosa*.

Menges, *et al*. (1987), found that barrens and flatwoods in southwestern Indiana both had low diversity, but barrens had more unusual species.

Crawford Escarpment (222Df)

Leavenworth Barrens is dominated by *Quercus stellata, Schizachyrium scoparium,* and *Sorghastrum nutans* (Figure 35). *Quercus marilandica* and *Q. muehlenbergii* are also present. Canopy closure is around 60 percent. There are two distinct size classes of the *Quercus* spp., implying that the area was formerly much more open. There are a few shrubs of *Rhamnus caroliniana, Cornus florida, Smilax rotundifolia, Quercus* spp., and

Carya spp.. Common herbs at this site include *Helianthus divaricatus, Eupatorium altissimum, Helianthus rigida, Liatris squarrosa, L. spicata, Silphium terebinthinaceum,* and *Eryngium yuccifolium,* with some *Danthonia spicata*. Herbaceous ground cover is nearly 100 percent.

The area in the vicinity of French Lick has few barrens-like qualities today. The Faucett Chapel area has an open canopy dominated by *Quercus muehlenbergii* and *Stenanthium gramineum* is frequent in the understory.

Chert barrens in Indiana have *Quercus velutina, Andropogon gerardii, Sorghastrum nutans,* and *Danthonia spicata*. Among characteristic species are *Asclepias amplexicaulis, Ceanothus americanus, Coreopsis tripteris, Eryngium yuccifolium, Lespedeza hirta, Strophostyles umbellata, Viola sagitatta,* and *Aristida purpurascens* (Homoya 1994).

Greater Shawnee Hills (222Dh)

The barrens formed on Peoria Loess at Cave Hill (Figure 36) is dominated by *Schizachyrium scoparium* and *Andropogon gerardii*. Canopy closure is about 25 percent. *Koehleria pyramidata* and *Sporobolus heterolepis* are also common. Conspicuous forbs are *Helianthus divaricatus, Lespedeza virginica, Polytaenia nuttallii,* and *Liatris aspera*.

Sandstone barrens on the backslope of Cave Hill is on the Abbott Formation, and is dominated by *Quercus marilandica,* but *Q. stellata* and *Carya texana* are common. Where the soil is deeper, *Quercus stellata* and *Q. alba* dominate. Canopy closure is about 60 percent. The only common shrub is *Vaccinium arboreum,* which often asociates with tangles of *Smilax glauca*. The ground is well covered by *Schizachyrium scoparium, Aristida purpurascens, Panicum dichotomum,* and *Sorghastrum nutans*. Where the canopy is more closed, *Danthonia spicata* is dominant. Common forbs include *Triodanis perfoliata, Rosa carolina, Crotonopsis elliptica, Hypericum gentianoides, Helianthus divaricatus,* and *Opuntia humifusa* (Figure 37).

Sites with less soil on the Caseyville Formation are dominated by *Quercus marilandica* or *Q. prinus* and have a canopy closure of around 80 percent. *Vaccinium arboreum* forms dense thickets. Dominant herbs are *Schizachyrium scoparium, Hypericum gentianoides,* and *Opuntia humifusa* (Figure 38).

Sandstone glades on the Caseyville Formation in this area are rather small, and have *Cladina subtenuis, Cladonia cristatella, C. squamosa, Dicranum scoparium* and *Leucobryum glaucum* covering much of the rock. Vascular plants are *Danthonia spicata, Hypericum gentianoides,* and *Opuntia humifusa*. The few trees are mostly *Quercus marilandica, Q. stellata, Carya texana,* and *Juniperus virginiana* (Figure 39).

Among animals found associating with the sandstone barrens are: *Sceloporus undulatus hyacinthinus, Scincella laterale, Heterodon platyrhinos, Crotalus horridus, Meleagris gallopavo, Melanerpes erythrocephalus, Picoides pubescens, Cyanocitta cristata,*

Baeolophus bicolor, Polioptila caerulea, Sialia sialis, Vireo griseus, Dendroica discolor, Mniotilta varia, Icteria virens, Piranga rubra, Vulpes vulpes fulva, and *Sciurus niger*.

Limestone barrens formed on the Menard Limestone have an open canopy, about 60 percent, of *Quercus muehlenbergii*. *Crataegus berberifolia* may be common. *Quercus velutina, Q. stellata, Juniperus virginiana,* and *Cercis canadensis* are encroaching. The dominant grass is *Andropogon gerardii*. A variety of forbs are present including *Asclepias viridiflora, Dalea candida, Lithospermum canescens, Silphium terebinthinaceum, Ratibida pinnata,* and *Liatris squarrosa* (Figure 40).

One species of grasshopper, which is cryptically colored to resemble shield lichens, may be endemic to the sandstone glades of southern Illinois and western Kentucky.

Lesser Shawnee Hills (222Di)

The limestone barrens on the Ste. Genevieve limestone at Cave Creek Nature Preserve (Figure 41) is very open, less than 20 percent canopy, is dominated by *Quercus muehlenbergii* and a few *Juniperus virginiana*. The opening covers about four acres. Dominant vegetation in the opening consists of *Sorghastrum nutans, Bouteloua curtipendula,* and *Schizachyrium scoparium*. Rocks are covered by crustose lichens and *Grimmia laevigata,* and *Pellaea atropurpurea* and *Cheilanthes feei* occur in fractures of the bedrock. Other common herbs on the opening include *Aster patens, Elymus virginicus, Smilax bona-nox, Kuhnia eupatorioides, Echinacea purpurea, Silphium terebinthinaceum, Liatris aspera, Celtis tenuifolia, Andropogon gerardii, Quercus coccinea, Ratibida pinnata, Agave virginica,* and *Tridens flavus* (Figure 42).

The sandstone barrens on the Aux Vases sandstone above this site has a nearly complete canopy, greater than 80 percent. It is dominated by *Quercus muehlenbergii, Q. alba,* and *Q. stellata*. Around the perimeter are a few cedars and some *Vaccinium arboreum*. *Rhus aromatica* is scattered throughout. Sandstone rocks are covered by *Flavoparmelia baltimorensis* and *Polytrichum juniperinum*. Common herbs include *Solidago ulmifolia, Helianthus divaricatus, Verbesina virginica, Rubus flagellaris, Elymus virginicus,* and *Aster patens*. Other species include *Ulmus alata, Monarda russeliana, Bromus pubescens, Carex albicans, Cunila origanoides, Panicum boscii, Smilax bona-nox,* and *Eupatorium altissimum*. *Scincella laterale* occurs in this area as well.

Ozment (1966) found *Lithospermum canescens, Zizia aptera,* and *Euphorbia corollata*. Kurz (1981) listed 93 plants from the Lesser Shawnee Hills that did not occur in the Illinois Ozarks.

Interior Low Plateau, Highland Rim Section (222E)

Mitchell Karst Plain (222Ek)

The barrens at Post Oak-Cedar Nature Preserve is dominated by *Quercus stellata* and *Andropogon gerardii* (Figure 43). There are three size classes of *Quercus* spp. suggesting the area was more open in the past. Together, their canopy is about 70

percent. Moderate sized *Juniperus virginiana* are scattered on the slope. Shrubs are *Quercus* spp., *Carya* spp., *Cercis canadensis,* and *Rhamnus caroliniana*. Where the canopy is open, *Andropogon gerardii* is abundant and *Schizachyrium scoparium* is common. *Scleria oligantha* and *Danthonia spicata* are common in shaded parts of the area. There are significant limestone outcrops, about 10 percent of the area, which are partially covered by *Dicranum scoparium* and *Leucobryum glaucum*. Common herbs include *Apocynum cannabinum, Physostegia virginiana, Cunila origanoides, Rosa carolina, Helianthus divaricatus, Solidago ulmifolia, Kuhnia eupatorioides, Symphoricarpos orbiculatus, Frasera caroliniensis, Liatris squarrosa, Panicum boscii,* and *Aster drummondii*.

The associated forest at this site is also dominated by *Quercus stellata,* but *Q. shumardii, Q. muehlenbergii,* and *Q. marilandica* are also present. Most of the same herbaceous species of the open parts of the barrens are scattered throughout these woods.

Historically known in this region were *Salix* spp., *Prunus americana, Corylus americana, Rhus copallinum,* and *Vitis* spp. Characteristic herbs include *Solidago* spp., *Aster* spp., *Dodecatheon meadia, Dalea purpurea, Echinacea purpurea,* and *Silphium terebinthinaceum* (McInteer 1946).

Brown County Hills (222Em)

The bedrock of the Brown County Hills subregion on the Hoosier is mostly acidic siltstones in the Borden Group. There are a few small areas that have a barrens-like appearance and species composition. However, many ridges in these hills lack only the prairie species. Otherwise, their character is like that enumerated below. This is in the eastern part of the subregion where glacial outwash may have had an influence on species composition and distribution. The siltstone barrens at Fork Ridge (Figure 44) is dominated by *Quercus prinus*, and with *Q. velutina, Q. alba*, and *Q. coccinea*, forms an 80 percent canopy. The dominant shrubs are *Vaccinium pallidum, Rubus flagellaris,* and *Smilax rotundifolia*. There are also scattered *Quercus velutina* and *Fagus grandifolia* shrubs. The ground flora is dominated by *Carex picta, C. albicans, Danthonia spicata,* and *Panicum dichotomum*. *Dicranum scoparium* and *Leucobryum glaucum* are common. *Punctelia rudecta* and *Flavoparmelia caperata* cover the bark of trees. Common forbs include *Krigia biflora, Antennaria plantaginifolia, Cunila origanoides, Lespedeza intermedia, L. hirta, Liatris aspera, Helianthus divaricatus, Spiranthes cernua, Aster drummondii, Solidago ulmifolia, S. erecta, Orbexilum pedunculatum,* and *Desmodium nudiflorum*. Graminoids at this site include *Panicum boscii, Agrostis perennans,* and *Schizachyrium scoparium*.

CURRENT COMMUNITY CONDITION, DISTRIBUTION AND ABUNDANCE

Barrens and glades communities are scattered on most units of the Hoosier, Shawnee, and Mark Twain National Forests. They vary from degraded “postage stamps” to extensive high quality communities. Some are in protected management areas and others are under general forest management. Some have had continuous management for many years, while others have had none at all. It is certain that neither the Forests nor the states have

identified all sites having barrens. The majority of barrens noted by early settlers and GLO surveyors have been lost to agriculture, development, or succession. Those that remain are too small to easily locate.

Indiana

An estimated 400 to 500 square miles of barrens in the Harrison County region at the time of settlement. Only Post Oak-Cedar Nature Preserve remains as a reasonably large example. Barrens remnants occur in several additional locations in southern Indiana. Of the 29 sites listed as nature preserves in south-central Indiana, about half of the sites contain barrens communities (Indiana Department of Natural Resources 1991). The combined acreage of these sites is over 3,000 acres. It should be emphasized that not all of these areas are nature preserves because of their barrens characteristics. Probably less than half of the acreage is in barrens or dry, open forest community. The acreages listed in Table 2 are from the Indiana Heritage Program Database, and represent the best examples of the community. The difference in acres is a result of a broader definition used here and the inclusion of less high-quality sties.

Hoosier

Within the Interior Low Plateau, Crawford Uplands Subsection, barrens occur on limestone, shale, and sandstone substrates at several locations (Table 4). Four special areas featuring limestone barrens are currently recognized in the Hoosier National Forest Land and Resource Management Plan, totaling 3,229 acres (a recent Forest Plan amendment increased the acreage from 440 acres). Small limestone barrens remnants also fall within two other special areas. There is a small sandstone glade community within one of these special area. Two of these special areas have approved management plans. Other sites having barrens-like attributes are found within the dry forest matrix of the Crawford Upland on the Hoosier, and fall within several different management areas. As management occurs, particularly prescribed fire, these sites will become more conspicuous. There is one limestone barrens in the Crawford Escarpment Subsection within a designated special area. There may be small example of sandstone barrens in this subsection. In the Highland Rim, Brown County Hills Subsection, there are barrens on siltstone. Many of the dry, *Quercus prinus* dominated ridges in these hills may be referred to as barrens. Expressions of this community may occur within a special area and within the Charles C. Deam Wilderness, but those with prominent populations of prairie plants are in the 2.8 management area.

The best examples of barrens on the Hoosier have been under active management, primarily prescribed fire, since 1989. A minimum of 101 additional acres of these communities are protected in state nature preserves as RNA equivalents. The greatest threat to these sites is lack or interruption of active management leading to woody encroachment and invasive exotics leading to habitat degradation. Another threat to their integrity is user-created trails through these sensitive sites. Along with the erosion potential, these trails may provide a pathway for encroachment of non-native plants.

Illinois

Barrens in Illinois were mostly scattered small areas as documented in the GLO notes, but the area in the Cretaceous Hills covered over 150 square miles. Small remnants of this area remain. Other smaller remnants occur at various locations throughout the Shawnee Hills and Illinois Ozarks. The Illinois Natural Areas Inventory (White 1978) noted only 44 acres of relatively high quality barrens at 12 sites in southern Illinois. Other remnant have been located since then, and many of these are being managed by the state to maintain and improve their diversity.

Shawnee

In the Greater Shawnee Hills of the Interior Low Plateaus, barrens occur on sandstone bedrock. In the Lesser Shawnee Hills, barrens occur on sandstone, limestone, and shale (Table 5). There are gravel barrens in the Cretaceous Hills of the Upper Gulf Coastal Plain. There are also barrens on limestone and chert in the Illinois Ozarks. On the Shawnee National Forest, there is about 800 acres of the barrens vegetation type in research natural areas. Another 300 acres exists in state equivalents. On the Forest, additional barrens acreage is contained within nearly 13,000 acres on 37 natural areas which are managed to perpetuate their natural features. Most of these sites are further denoted as either "Botanical Areas", containing significant plant communities, or "Ecological Areas", noting both botanical and animal communities. The greatest threat to these sites is lack or interruption of active management leading to woody encroachment and invasive exotics leading to habitat degradation. Another threat to their integrity is user-created trails through these sensitive sites. Management prescriptions for these areas include selective removal of woody species, elimination of exotics, and the use of prescribed fire to maintain the barrens. Little management has occurred since the mid 1990's, although 20 acres were burned at Dean Cemetery East in 1998, 20 acres at Leisure City in 1997, and 168 acres at Fink Barrens in 1997.

Missouri

The most pressing concern for Missouri glades is of their loss without active management. All Missouri glade acreage was at one time subject to nearly a century of domestic grazing pressure which in many cases removed much of the original highly diverse native glade vegetation, and especially eroding what soil was associated with them. A glade in St. Joe State Park contains relatively deep, intact, and organically-rich soil along with a very diverse assemblage of plant life. Glades described by Julian Steyermark and others as containing *Juniperus virginiana* and many lichens are in fact just artifacts of severe grazing pressure and fire suppression. There is no estimate on how many of the original high quality glades are now covered in *Juniperus virginiana,* but a conservative estimate of greater than 70 percent, and the process continues excepting restoration acreage. Despite having some 500,000 acres of glade types in Missouri, many are disappearing due to abandonment after grazing and *Juniperus virginiana* (and other woody encroachment) invasion.

Mark Twain

In the Ozark Highlands (Table 6), there are approximately 400,000 acres of barrens vegetation on dolomite; 3,000 acres on limestone; 2,000 acres on sandstone; 8,000 acres on igneous rocks; 500 acres on shale; and 200 acres on chert (Nelson and Ladd 1981a). In southern Missouri, there are about 4,900 acres of glades and barrens type vegetation which are protected within state equivalents to research natural areas. Over 50,000 acres of the Forest are available for grazing. An average of 9,000 acres are treated for wildlife habitat improvement annually. Some barrens and glades habitat, including a glade with a federally threatened species, occurs within a designated wilderness area. Between 7 and 20 percent of the landscape is to be maintained as open lands in glades and oak-bluestem plains. Prescribed fire may be used on portions of the Hercules Glades Wilderness.

Ross McElvain of the Ava District office estimates current grazing allotments of 25,000 acres, some of which is idle. Of this, 5,000 glade acres are subject to grazing, but some may be idle. An estimated 60,000 glade acres occurs on the Ava/Cassville districts. An estimated 22,000 is currently classified as glade community, with 10,000 acres actively burned to restore and protect them. There are no resources currently available to protect the remaining 12,000 acres. There are much lesser amounts of glade acres on other districts as the LTA types suggest the underlying geology and topography is much less conducive to their development. Forest service standards provide minimum percentages of glades to manage within the White River Section of the Ozark Natural Division and further state that management emphasis should be on glades greater than 10 acres. Unfortunately, this does not take into account other much smaller glades in other LTA's for other districts harboring distinctly unique glade types and habitat needs for many plant species including *Echinacea simulata* that occurs on small glades in eastern Missouri. Igneous glade acreage on the Forest is significant on the Potosi and Fredericktown districts, which can possibly contain populations of additional Mead's milkweed.

Of special concern is what happens to glades in Wilderness areas. Because wildfire is suppressed, and prescribed burning requires approval from the Chief, most Missouri Wilderness areas are loosing their glades to cedar invasion. The last prescribed burn were conducted on Hercules Glades Wilderness was in 1989. These light burns were of limited effect primarily because constituents were then concerned about burning into woodlands. The glades continue to close in because the Forest Service cannot conduct burns hot enough to knock back the cedar trees. The only real solution is to cut them, which would likely be impossible given the lack of constituent support for doing so within the boundaries of a wilderness area.

The same plight is taking effect in Bell Mountain Wilderness. It is just a matter of time before the *Asclepias meadii* population in Bell Mountain gives way to invading *Juniperus virginiana*. A recent paper on the re-establishment of *Crotophytus collaris* on Stegall Mountain by Dr. Alan Templeton of St. Louis University showed the positive response of *Crotophytus collaris* recolonization on 26 glades on Stegall Mountain after a series of prescribed burns. However, he referenced that the historic populations on Bell Mountain have disappeared due to destruction of habitat by *Juniperus virginiana*. Burning or

mechanical removal is key, but few Forest Service staff want to propose doing so knowing that constituent organizations will vigorously oppose doing any kind of vegetative manipulation in any other Missouri wilderness are excepting Hercules Glades.

In summary:

1. Missouri glades are disappearing in original extent and coverage due to *Juniperus virginiana* invasion (and exotics such as *Lespedeza cuneata* and *Coronilla varia*).

2. Restoring and maintaining glades requires mechanical removal of *Juniperus virginiana* followed by prescribed burning. Burning alone may or will not remove all cedar.

3. Glades in Missouri wilderness areas are imperiled because wilderness standards and guidelines make it nearly impossible to manage them.

4. The federally threatened species on Bell Mountain (*Asclepias meadii*) is in peril because of cedar invasion and difficulty in taking action given the NEPA process. Marvin Bowles published on the significance and importance of maintaining this very small population because of its genetic reproductive potential to other local populations in the St. Francois Mountains.

5. Despite several past efforts to conduct prescribed burns in Hercules Glades, most fires were ineffectual in controlling *Juniperus virginiana*; thus, the glade coverage continues decreasing. Many populations of regional forester sensitive species occur in Hercules and are currently restricted to the most disturbed areas (along trails) in Hercules Glades. The cumulative effect will be the continued decline in glade coverage and habitat for glade-dependent sensitive species such as *Scutellaria bushii*, *Solidago gattingeri*, and *Matelea baldwyniana*.

REGIONAL FORESTER SENSITIVE SPECIES ASSESSMENT TABLE

POPULATION BIOLOGY AND VIABILITY

The barrens community provides habitat for at least 60 RFSS. Appropriate management of this habitat is likely to provide for viable populations of these 45 plants and 15 animals. Six of these are high priority for species assessment within the barrens and glades community conservation assessments. These are discussed in separate linked assessments. Other RFSS found in this community are also discussed briefly, as are a number of insects that may warrant RFSS status.

Mottled Duskywing (Erynnis martialis)

Cluster Fescue (Festuca paradoxa)

Yellowish Gentian (Gentiana alba)

Engelmann's Adder's-tongue (Ophioglossum engelmannii)

Prairie Parsley (Polytaenia nuttallii)

Featherbells (Stenanthium gramineum)

NOTES ON OTHER REGIONAL FORESTER SENSITIVE SPECIES PLANTS

Calamagrostis porteri ssp. *insperata* occurs in the southern portions of all three states, most often as sterile colonies of bluish grass. When it does flower, the flowers are usually sterile (NatureServe 2001). It has not yet been found on the Hoosier, but it does occur on private land about 20 miles to the east. About 80 sites are known in Missouri, most found within the last ten years (Yatskievych 1999). This grass occurs in dry, moderately open woodlands. The most serious threats to this species are forest succession due to fire suppression, clearcutting, grazing, soil compaction, recreation, and loss of habitat to agriculture (Nature Serve 2001). "Management of this species requires maintaining the open character of its habitat by using prescribed burning, selective cuttin of canopy trees and hand cutting of encroaching woody plants" (NatureServe 2001).

Agalinis skinneriana is found in open, dry, sparsely vegetated areas with little history of grazing in Missouri (NatureServe 2001). It appears to be tolerant of natural disturbances, but not to human-caused disturbances. Habitat loss and interruption of natural disturbances, including fire, are believed to be the major causes of this plants decline. Land development and inappropriately timed haying may also be detrimental.

Asclepias meadii is listed by the USDI Fish and Wildlife Service as a threatened species. Habitat loss to agriculture and lack of appropriate habitat management are the greatest threats to this species. Also related may be the loss of pollinators. Small populations are not self-compatible (NatureServe 2001). Prescribed fires on a four to five year rotation has been used as typical management in prairie areas.

Buchnera americana has been found in native-dominated old field communities on the Hoosier and Shawnee. In both cases, the fields are in the midst of barrens areas, and have been kept open through forest opening maintenance programs. It is believed that these populations are native because of nearby historic records for the species. It is more wide-spread on the Mark Twain where known populations are found in historically fire-maintained communities (NatureServe 2001). Populations of this appear to be a fire-maintained. Prescribed fire on a three to four year rotation has been effective in maintaining this plant. Individual populations are quite variable from year to year (NatureServe 2001).

Callirhoe bushii occurs in open, rocky woods and edges of barrens and glades where the usually calcareous soil is slightly deeper. Threats to this species include habitat loss and forest succession due to fire suppression (NatureServe 2001). This species may benefit from occasional disturbance, but closed canopy conditions will eliminate it.

Chamaelirium luteum has a wide ecological tolerance, inhabiting moist forests, wet savannas, and dry woods and barrens. It may do best in open woodlands (NatureServe 2001). Clearcutting and shelterwood cutting are threats to this species (NatureServe 2001).

Delphinium treleasei is endemic to open calcareous glades and barrens in the Ozark Highlands. Woody encroachment to the barrens and glades, especially *Juniperus virginiana*, due to fire suppression is the greatest threat to this species. Mowing may also be used to slow the encroachment of woody species (NatureServe 2001).

Desmodium humifusum may be a hybrid species. Between the Atlantic Coastal Plain and central Missouri (north of the Mark Twain), there is one known population on the Hoosier in a barrens area. Both presumed parent species, *D. glabellum* and *D. rotundifolium*, are present in the vicinity. It has responded favorably to prescribed fire, but is now being threatened by *Coronilla varia*.

Eupatorium album appears to be expanding its range into southern Indiana. Since it was initially reported in the late 1980's, at least five populations have been found on the Hoosier, including three in the Crawford Upland barrens area. One of the populations has expanded following a prescribed fire.

Isotria verticillata occurs on the barrens ridges in the Brown County Hills with enough frequency to not be considered as a RFSS on the Hoosier. However, it is much rarer and in a different habitat on both the Shawnee and Mark Twain National Forests. It is found in Cretaceous gravels in the Upper Gulf Coastal Plain region under essentially complete forest canopy. *Isotria medeoloides* is believed to be extirpated from Missouri.

Pycnanthemum torrei occurs in a dry-mesic barrens on the Shawnee. The greatest threats here are woody encroachment from fire suppression and competition from *Lonicera japonica*. Prescribed fire would control succession and may slow the spread of the *Lonicera* as well.

Silene regia inhabits prairies, open wools, and glades. As with most other RFSS associated with these habitats, the most serious threats are woody encroachment from lack of fire, and loss of habitat to agriculture. Occasional disturbances, such as prescribed fire and bush-hogging, would reduce competing woody vegetation. Large grazing animals may have provided the soil disturbance necessary for seedling establishment (NatureServe 2001). One of the major pollinators for this species is *Archilochus colubris*. Small populations of the plant may not be attractive enough for visitation by hummingbirds (NatureServe 2001).

Silphium trifoliatum was found at on site on the Shawnee in 1986, but has not been relocated. This species is very common in the barrens of the Crawford Upland and Escarpment. It responds favorably to fire.

Trifolium stoloniferum is listed as endangered by the USDI Fish and Wildlife Service. It is typically associated with open mesic woods, but is historically known in other

disturbed woodland situation. It may have been dependent on herds of large grazers to maintain the open understory and soil disturbance (NatureServe 2001). Fire may not have been a primary factor in maintaining populations, but it certainly did occur in the region (NatureServe 2001).

Vaccinium stamineum is known at one site on the Shawnee, but is common on the Hoosier and Mark Twain. As with most ericaceous shrubs in this habitat, prescribed fire will top-kill individuals, but, in the following years, will put on vigorous new growth, and flower and fruit profusely.

Waldsteinia fragarioides is known from one population on the Hoosier and one on the Shawnee. The Indiana site is on a barrens ridge above a creek bottom forest and has been stable since it was first reported by Deam (1940). No management has occurred at this site.

The habitat suitability index model for *Myotis sodalis* (Romme *et al*. 1995) recommend 60 to 80 percent canopy for optimal habitat. There is an open understory in this model as well. These conditions are a reasonable approximation of many barrens and woodlands. It is also worthy of note that *Dendroica cerulea* also appears to favor similar conditions, *i.e*., large canopy trees and an open understory. *Dendroica cerulea* will also forage in barrens adjacent to its preferred riparian forest habitat.

Lynx rufus is a habitat generalist occurring in the barrens and glades in the region. The most serious threat is local trapping and habitat conversion to development and agriculture (NatureServe 2001).

Aimophila aestivalis uses barrens and glades, especially those with brushy pine stands nearby in southern Missouri. Occasional fires may help to maintain the brushy component of this species habitat.

Ammodramus henslowii is an area dependent grassland bird. It requires scattered brush for perches for singing, but will also use other tall vegetation. Such areas cannot be burned annually because of this requirement. *Lanius ludovicianus* also uses similar habitat. While this species is still wide-spread, there is a trend for there to be fewer territories in a given area than in the recent past.

Amblyscirtes belli and *Calephilis muticum* are both more frequent in the eastern Ozarks than in the western Ozarks. Both species are known in the Hoosier National Forest barrens remnants in the Crawford Upland. These species are probably declining due to habitat loss from development and from woody encroachment due to fire suppression.

ADDITIONAL INSECT OF CONCERN ASSOCIATED WITH BARRENS

Recent studies on the glades and barrens of Arkansas, southern Indiana and central Kentucky have identified these habitats as having one of the most diverse assemblages of grassland-associated insects in eastern North America (Bess 1993, 1996, 1997a-b, 1998a-c, 2001b-c). Many of these species would be considered “remnant-dependent”

(following Panzer *et al*. 1995), meaning that they are only (or primarily) found in high quality remnant natural areas. The majority of the remnant-dependent (r-d) species identified to date are in the insect orders Homoptera (leafhoppers and planthoppers), Lepidoptera (butterflies, skippers and moths) and Orthoptera (grasshoppers, crickets, katydids and walkingsticks).

The range of habitats contained in the rolling topography of the region has produced a uniquely diverse flora and associated insect fauna. Species more typically found as far north as the Upper Peninsula of Michigan or west as Colorado occur here as members of the same fauna. Distribution information has been drawn from a number of sources, including Covell (1984), DeLong (1948), Forbes (1923, 1954, 1960), Mitchell (1960), Opler and Malikul (1992), Otte (1981, 1984), and Rings, *et al*. (1992). A number of species more typically associated with the dry, sandy grasslands of the southern Atlantic Coastal Plain also comprise this unique fauna. The diverse and unique insect fauna currently known to occur on glades and barrens in the study region includes:

Order Lepidoptera

Family Hesperiidae

Many skippers have specialized as larvae on Poaceae, Cyperaceae, and Fabaceae. On glades and barrens, these plant families are quite prominent and support a diverse array of skippers throughout the study region (Bess 1993, 1996, 1997a-b, 1998a-c, 2001b-c). These include *Achalarus lyciades* and *Autochton cellus*, which feed on *Desmodium* spp. and *Apios americana*, respectively. Both skippers are quite local and generally uncommon in the study area. The genus *Amblyscirtes* includes many species associated with open woodlands and barrens containing diverse grass floras. Rare or uncommon species in the study area include *A. belli* (RFSS), *A. hegon* and *A. vialis. Amblyscirtes belli* is an extremely rare species throughout its range (southeastern U. S.) and populations are typically small and highly isolated. These skippers feed on grasses in barrens and open woodland situations. Additional grass feeders associated with dry glades and barrens include *Atrytonopsis hianna, Hesperia leonardus* and *H. metea*. All three are quite uncommon in the study area and often intensely local within a given barrens complex. All of these skipper species should be considered fire-sensitive during fall and spring burns.

Families Lycaenidae, Nymphalidae, Pieridae and Riodinidae

In the family Lycaenidae, Fixenia favonius ontario *is a rare and local species associated with glade openings and open barrens complexes. The adults sun themselves on oak leaves and the males patrol openings in search of basking females. The adults nectar frequently and require a steady supply of nectar plants during their protracted flight season (May to July).* Incisalia irus *feeds as a larva on* Baptisia *spp. This species is exceedingly rare throughout its range and should probably be federally listed. Only a few scattered populations are known from the study area, primarily in Missouri and northern Arkansas. Most of these records are greater than 30 years old and may not represent currently viable populations. In the family Riodinidae, the rare and local* Calephelis muticum *(RFSS) has recently been found to occur in seep areas associated*

with glades and barrens in southern Indiana and central Kentucky (J. Bess, pers. obs.; J. Shuey, pers. comm.). Here, the larvae feed on the foliage of Cirsium altissimum. *Additional populations occur in seep and fen communities of the Missouri and Arkansas Ozarks.*

Speyeria diana *is a large attractive member of the family Nymphalidae, historically known to occur on barrens and woodland complexes throughout the southern Ohio Valley (Opler and Malikul 1992). The only recently verified populations are currently known from the southern Appalachian Highlands and the Ozark-Ouachita Mountains complex of Arkansas and Missouri (Bess 1997a-b, 1998a-c). Other notable Nymphalidae include* Cyllopsis gemma *and* Hermeuptychia soysbius. *Both feed as larvae on grasses and tend to be rare and local in woodland/barrens complexes of the region.* Euchloe olympia *is a species more typical of sand dunes along the Great Lakes and the short grass prairies of the western Great Plains. There are scattered records for this species throughout the region encompassing the study area, although few actually from within it. Like many Pieridae,* E. olympia *feeds as a larvae on wild mustards, primarily in the genus* Arabis. *It is considered extremely rare and local within the study area.*

Family Arctiidae

The Arctiidae feed as larvae on a variety of plants, favoring the plant families Asclepiadaceae, Euphorbiaceae, Fabaceae, and Poaceae. Most of the uncommon, barrens associated Arctiid moths are typically associated with sandy savannas on the southern Atlantic Coastal Plain, with outlying populations in the glades and barrens of the Ohio Valley. These include *Euerythra phasma, Grammia anna, G. figurata, G. phyllira, G. oithona*, and *Holomelina opella*. *Cycnia inopinatus* feeds as larvae on native *Asclepias*, including *hirtella*, *tuberosa, verticillata, viridiflora* and *viridis*. This moth is usually considered rare or uncommon and is very patchy in its general distribution. A similar species, *Pagara simplex*, is generally uncommon and associated with high quality barrens complexes. Previously recorded only from the southern Atlantic Coastal Plain, this moth was recently recorded from several barrens and glade complexes in Arkansas, Indiana and Kentucky (Bess 1996, 1997a-b, 1998a-c, 2001a-b).

Family Noctuidae

The large family Noctuidae contains numerous species appearing to be confined in distribution to high quality glade and barrens remnants. These include *Acronycta albarufa* which feeds as a larva on *Quercus stellata* and *Q. marilandica*. *Catocala clintoni* is monophagous on *Prunus americana* and uncommon rangewide. *Catocala consors* feeds as a larva on *Carya* spp. and prefers smaller trees in open situations. *Catocala dulciola* feeds on a variety of *Crataegus* spp. and is very rare except for a few widely scattered populations in Michigan, the Ozarks, and Virginia (Covell 1984). *Catocala gracilis* feeds on *Vaccinium* spp. and is primarily confined to the Atlantic Coastal Plain, with scattered populations around the Great Lakes and the barrens and glades of the Ohio and Mississippi valleys. *Erythroecia hebardi* feeds as a larva on *Collinsonia canadensis* in woodland/barrens complexes. It is known only from southern Ohio and Virginia.

Paectes abrostolella is a Great Plains species with disjunct populations in barrens and glades of the Ohio River Valley. *Papaipema eryngii* is another exceedingly rare species which feeds as a larva in the roots of *Eryngium yuccifolium*. This moth is known from only six populations in the world. *Papaipema polymniae* larvae feed in the stems of *Polymnia uvedalia,* and are confined to mesic slopes in woodland/barrens complexes. This moth is very rare within the study area, being known from fewer than six populations. *Schinia gloriosa* feeds as a larva on the developing seeds of *Liatris spicata* and is confined to sites where this plant abounds. *Schinia jaguarina* feeds as a larva on the developing seeds of *Orbexilum pedunculatum* and is found only where this plant is common. Both moths are quite rare and highly remnant-dependent within the study area. The rare, boreal moth *Sideridis congermana* has also been recorded from a high quality barrens complex in central Kentucky. This is a highly unusual occurrence, as the nearest populations are in high altitude areas of the central Appalachians.

The rare, southern species *Xanthopastis timais* has been recorded from a sandstone glade/barrens complex in western Kentucky and should occur as a rare, local species in the study area. Typically, this moth is found only in the everglades of southern Florida. The larval host in the wild is unknown, but may include *Agave* spp. This plant was fairly common at the Kentucky site where this species was recorded. In barrens containing hard pines, moths in the genus *Zale* can be common. An uncommon northern disjunct is *Zale duplicata,* which has been recorded from a few barrens complexes in southern Indiana and Kentucky.

Family Tortricidae

The family Tortricidae are largely tree and shrub feeders, although several genera are borers in plant stems and roots, especially prairie species. Of the tree and shrub feeders, *Ancylis semiovana* feeds as a larva only on *Ceanothus* and is often taken in conjunction with *Erynnis martialis*. *Croesia semipurpurana* and *C. curvalana* are two additional species, which are local and generally uncommon, being found primarily in high quality barrens remnants.

Of the stem and root boring species, the genus *Eucosma* contains several species apparently restricted in occurrence to high quality prairie and barrens remnants in southern Indiana and Ohio and central Kentucky. These include the *Silphium terebinthenaceum* borers (*Eucosma bipunctella* and *E. giganteana*), the *Helianthus* spp. borers (*E. fulminana, E. nandana,* and *Pelocrista womonana*), and additional prairie-associated species such as *Eucosma gracilana, E. glomerana, E. matutina, E. sombreana* and *E. wandana.*

Family Limacodidae

The Limacodidae moths are generally tree and shrub feeders. Two species are apparently quite uncommon or rare within the study area and both are apparently *Rosa* spp. feeders. *Monoleuca semifascia* is a southern Atlantic Coastal Plain species having scattered populations in glades and barrens of the Ozarks and western Ohio River Valley. *Parasa*

indetermina is reported to be local, but more common in the south. In the study area, this species is rare and local, being found only on high quality glade and barrens sites having abundant rose populations.

Families Crambidae and Pyralidae

The genus *Peoria* (family Crambidae) contains several species found primarily on the Atlantic Coast or in dry grasslands of the Great Plains. Many appear to be associated with bunch grasses (*Panicum* spp. and *Schizachyrium scoparium* in the study area). Disjunct populations of these species are currently being identified from glade and barrens complexes in the Ohio Valley and Ozark regions. These species include *Peoria longipalpella, P. floridella, P. roseotinctella*, and *P. tetradella*. Related species such as *Coenochroa illibella, C. bipunctella* and *Tampa dimediatella* also have similar distributions. All appear to be restricted to high quality remnants. The southern crimson moths (family Pyralidae) *Pyrausta tyralis* and *P. laticlavia* are additional southern Atlantic Coastal Plain species with disjunct populations in the glades and barrens of Arkansas, southern Indiana, Ohio and central Kentucky. Some more typically southern wetland species are also known to occur on glades and barrens within the study area. These include *Eoruema densella, Urola argentana, Vaxi critica* and *Xubida panalope*. All are associated with seepage areas and grass-sedge dominated portions of glade and barrens.

Order Homoptera

Family Caliscelidae

The Caliscelidae are grassland associated planthoppers that feed primarily on native grasses. The adults are large-bodied and typically wingless (rare winged-forms are known). These include *Bruchomorpha extensa* (on *Sorghastrum*), *Bruchomorpha pallidipes* (on *Schizachyrium*), *Bruchomorpha dorsata* (on *Sorghastrum*) and *Bruchomorpha jocasa* (on *Andropogon* spp. and *Sorghastrum nutans*). All appear to be remnant-dependent and are considered fire sensitive.

The Cicadellidae represent the largest single group of herbivorous insects occurring in temperate grasslands, in terms of species richness (Blocker and Reed 1976, Cherrill and Rushton 1993, Cwikla and Blocker 1981, Gardner and Usher 1989, Nagel 1979). The genus *Flexamia* is a large group of grassland-obligate leafhoppers having their center of diversity in Central North America (Bess and Hamilton 2000, Whitcomb and Hicks 1988). Species occurring in the glades and barrens of the study area include *Flexamia areolata* (on *Eragrostis spectabilis*), *F. clayi* (on *Schizachyrium*), *F. sandersi* (on *Schizachyrium*), *F. picta* (on *Aristida* spp.) and *F. reflexa* (on *Sorghastrum*). *Mesamia straminea* is a Great Plains species with disjunct populations in the barrens of central Kentucky (Bess 2001c). *Prairiana kansana* is another Great Plains species with a single disjunct population on a large barrens remnant in central Kentucky (Bess 2001c). The genus *Polyamia* is associated almost exclusively with the grass genus *Panicum*. Rare and local species occurring almost exclusively in glades and barrens of the study area include: *Polyamia alboneura, P. brevipennis, P. dilata, P. herbida, P. similaris* and *P. saxosa*

(Bess 1993, 1996, 1997a-b, 1998a-c, 2001b-c, DeLong 1948). The genus *Texananus* (as the name implies) is also primarily western, with species occurring in scattered populations throughout the Midwest and Ohio Valley regions (DeLong 1948). Species known from high quality barrens and glade complexes in and near the study area include *Texananus areolatus*, *T. excultus*, *T. rufusculus*, and *T. superbus*.

Order Orthopera

Family Acrididae

Acrididae are another large and important group of grassland herbivores. Many species occur on the glades and barrens of the study area, with some appearing to be remnant-dependent. Many of these remnant-dependent species are more typically found on the Great Plains, while another large subset appears to be endemic to the glade/barrens complexes of the region. Great Plains species occurring in the study area include *Eritettix simplex, Melanoplus keeleri luridus, Mermiria bivitatta, Pardalophora haldemani* and *Pseudopomala brachyptera*. Species which appear to be endemic to glades and barrens of the southern Appalachians/Ozark/Ouachita Mountain complex include *Melanoplus puctulatus, M. tepidus, Paratylotropidea morsei, Spharagemon saxatile* and *Trimerotropis saxatilis.* Most of these species are of conservation concern wherever they occur, with the last three being of concern on a federal level.

Familly Phasmatidae

Two notable Phasmatids occur in the study area, where they are associated with barrens complexes having a rich growth of grasses and wildflowers. These are *Diapheromera blachleyi* and *D. velii*. The two are quite similar physically, differing in that *D. velii* is southern and tends to be larger and sometimes marked with purple. The two are probably the same taxon. Both should be tracked as elements of concern wherever they occur.

POTENTIAL THREATS

Barrens are dynamic ecosystems. Geology plays a part in the distribution and character of barrens, but local events shape their existence. Both natural and anthropogenic disturbances affect the character of the barrens. Species of plants found in the open parts of the barrens are also found in the woodland matrix as depauperate individuals. These plants are waiting for an opening. A fallen tree may give these an opportunity to use the increased light in the canopy gap. Settlement reduced the effects of a number of natural processes. Timber was cut for farms, and for shipment to markets. Land clearing reduced the magnitude of stand replacing events. Open timber, prairies, and barrens became more occupied by woody vegetation, or were lost to row crops and pastures (USDA Forest Service 1999). Roads and trails disrupted the progress of fires across the landscape.

The greatest threat to the barrens ecosystem is woody encroachment. Increased woody encroachment is brought on by fire suppression and decreased intensity of grazing. Interruption of a management program can also cause problems by allowing woody

vegetation to encroach more rapidly than if no management had taken place. As barrens sites become more mesic as woody species advance, their biological diversity decreases (Ladd 1991). Quarterman (1950) documented successional patterns on limestone glades in the Nashville Basin. Similar patterns doubtlessly occur in the Shawnee Hills and Ozarks.

Accounts of the barrens in the Western Mesophytic Forest Region make note of the tall grasses in open country (see Historic Descriptions). As settlement proceeded and fire were suppressed, almost invariably the first trees to be found were the heavy seeded *Quercus* spp. and *Carya* spp. Frequent fire in earlier years kept woody plants in a condition so they were not always obvious. *Quercus* spp. and *Carya* spp. brush was present within the barrens, but was not allowed to attain tree-like character until fires were suppressed (White 1994). Much of this area is now in *Quercus stellata, Q. marilandica* and other *Quercus* spp. forest with a *Cornus florida* understory. "Forests" in the Cretaceous Hills barrens region, for another example, are dominated by 150 year-old *Quercus falcata*. Light seeded *Acer* spp. and *Fraxinus* spp. have come in more recently. Put a different way, the *Quercus* spp. and *Carya* spp. did not arrive first in the barrens because they were already present (McInteer 1946). This rapid change, as well as predominantly forest soils, suggests a short grassland occupancy (Braun 1950).

The greatest threat to many species, including *Gentiana*, *Ophioglossum*, and *Polytaenia*, appears to be loss of habitat due to woody encroachment (Chester and Wofford 1992). It may also be a factor in the population health at the Hoosier's Faucett Chapel *Stenanthium* site. In Illinois, Mohlenbrock (1959) located *O. engelmannii* in full sun on xeric limestone glades and in the shade of cedars. Also, the abundance of *O. engelmannii* in xeric forests and savannas in Missouri (Nelson 1985) indicates that the species tolerates limiting shading if edaphic conditions are not altered. However, substantial shading as a result of woody encroachment may negatively impact the species.

Natural succession in the absence of periodic disturbance is causing barrens to close in with abnormally high densities of barrens shrubs and trees, and with species not usually associated with the community. Such encroachment will cause the decline in vigor of prairie species, and may eventually lead to their extirpation and a decline in regional diversity of species and habitats. Anderson and Schwegman (1991) describe changes in vegetation with prescribed fire and interruption of the established fire regime in a Cretaceous Hills barrens. The mesic barrens at Burke Branch may be irretrievably lost to interruption of active management.

Fire suppression is the number one factor threatening the long-term survival of glade and barrens associated insect species such as *Erynnis martialis*. Many formerly extensive tracts of open barrens habitat have been allowed to succeed to closed canopy forest, greatly reducing the diversity of plant species and rendering the habitat unusable by many insects. It is probable that this reduction in floristic and insect diversity has also had a negative effect on other animal species that require these plants and insects as food sources. *Ceanothus americana* and many of *E. martialis*'s adult nectar sources are dependent upon fire for maintenance of preferred habitat and quickly disappear in its absence.

Juniperus virginiana is the most aggressive invader to open glade habitats (Martin and Crosby 1955). It has allelopathic effects that may prevent desirable plant from entering areas (Quarterman 1973). Cedars are most frequent coming from under or near established hardwoods where seeds are deposited by birds. It can be controlled by prescribed fire since it does not re-sprout (Martin and Crosby 1955). If the individuals are too large, however, there may be very little effect from burning. Harvest of cedar can increase herbaceous growth by eliminating allelopathic effects and allowing light to reach the ground. Amelon (1991) assessed the "effects of cedar harvest, prescribed fire and cattle grazing on glade productivity, nutrient cycling and hydrology." Increases in vegetation productivity resulted from both burning and harvesting treatments, concluding that both are effective tools in glade management in the White River glades. Martin and Crosby (1955) concluded that if prescribed fire is to be used to control *Juniperus virginiana* in livestock range, periods of rest are needed both before and after burning.

"Eastern red cedar creates 100% canopy cover on glades, and once it attains an age of 100 years or more, the canopy cannot be removed by fire alone because the trees suppress groundcover ladder fuels and create a carpet of flat cedar needles. At that point, many of the remaining native grasses, sedges, and herbs are suppressed to the point of falling out, and not being available for recolonization through restoration activities" (pers. comm., Paul Nelson, Mark Twain National Forest, 28 November 2001).

It has been well documented that savannas, glades and barrens burned with relative frequency in historic times (Henderson and Long 1984, Schwegman and Anderson 1984). Many of the grassland plants occurring in these communities are also "fire-dependent", meaning they require periodic fire for their long-term survival (Anderson *et al*. 1970, Arend and Scholtz 1969, Daubenmire 1968, Hulbert 1969, 1981, Knapp and Seastadt 1986, Peet *et al*. 1975, Thor and Nichols 1973, Tilman 1987, Whitford and Whitford 1978, Wright and Bailey 1982). This requires that land mangers use fire as a tool in the restoration and maintenance of native grassland vegetation. In degraded remnants of these habitat-types, prescribed burning relaxes competition from invading, non-fire adapted species, allowing fire-adapted species to proliferate and expand into newly opened areas (Anderson and Brown 1986, Crow 1988, Daubenmire 1968, Dorney and Dorney 1989, Grimm 1984, Henderson 1982, Henderson and Long 1984, Johnson 1985, Kline 1984, Schwegman and Anderson 1984, Tester 1989, White 1983, Wright and Bailey 1982). Fire also reduces canopy cover of woody species through direct mortality of living, above-ground parts. This allows more sunlight to reach the soil surface, resulting in increased photosynthetic productivity in the herbaceous flora (Dorney 1981, Lorimer 1985).

It has been often observed that without burning, barrens degrade into a forested condition relatively rapidly, as little as 10 years at one site, the only remaining mesic barrens in the Cretaceous Hills of southern Illinois (Schwegman and Anderson 1984). Many sites that had been barrens in southern Illinois are now closed forest (Anderson and Schwegman 1991, Robertson and Heikens 1994). A study in one small area in the Missouri glades showed a decline in the size of open parts of the glades from 50 percent in 1938 to only 16 percent in 1975 (Kimmel and Probasco 1980). Kimmel and Probasco (1980) used

aerial photography to document the rate at which barrens sites are closing in at sites on the Mark Twain.

With settlement, fuel loading and oak regeneration brought on with grazing may have lowered the intensity of fires. Years with intense fires tended to be the same years with drought conditions (Guyette and Cutter 1991).

Much of the decreased fire frequency has been in the last 60 years (Robertson and Heikens 1994). Robertson and Heikens (1994) found that, in southern Illinois, the greatest fire frequency was 60 to 80 years previously. It was not possible to assess fire history more than 150 years previously because centers of trees were hollow.

Prescribed burning is surrounded by controversy in some areas. Some people doubt whether fire occurred historically, or at least question the extent of burning. Whether it occurred or not, or how often, does not really make much difference. Currently, fire is the most efficient method available to treat large areas move them towards the desired future condition (Schmidt 1968). Landscape burns may consume a portion of downed woody material, a substantial portion of leaf litter, and killing some percentage of understory woody vegetation to allow sunlight to reach the forest floor (Stritch 1990). Conditions may occasionally cause stand replacement. Nitrogen volatilized by fire is quickly replaced by microbial activity. Most other nutrients are volatilized at higher temperatures, those usually not reached by most prescribed fires under normal circumstances (Martin, no date). Several years may pass before enough fuel accumulated to carry fire across some barrens areas. Other sites may be ready for the next burn in a year or two.

In barrens areas with greater canopy closure, periodic fires encourage the regeneration of oaks and hickories (NatureServe 2001). Where conditions are more open, fires will set back woody encroachment.

Summer burns may cause more damage to actively growing plants. Their recovery may be slower (Steyermark 1940). Spring burns are patchier, leaving more refugia for small animals.

Prescribed fire can bring on unexpected results. Although burned in the spring preceding the near record drought of 1988, populations of the federally threatened *Asclepias meadii* on the Shawnee flowered for the first time in five years (Stritch 1990). On the Hoosier, *Polytaenia nuttallii* appeared after a prescribed fire in 1991. By a week, it was the second known site for the species in southern Indiana.

In the past, management in barrens has featured small, species-rich locations. "Instant gratification" treatments of barrens is a good start, but eventually management needs to "connect the dots." Stritch (1990) recommended that landscape-scale prescribed fires are the most ecologically reasonable method to treat barrens areas. Barrens forbs and grasses are found throughout the woodland matrix. Fire suppression and the resulting encroachment of woody understory plants have diminished the vigor of these individuals. This condition did not allow for the dispersal of species and genetic flow between habitat

patches. Landscape scale management, especially prescribed fire, allows a mosaic of conditions to develop over an area. Fires will leave some areas unburned, some areas lightly burned, and other areas will have intense burns (Olson 1992a). Areas selected for management should be large covering entire watersheds if possible (Stritch 1990). Disturbed land should be included as buffer for higher quality sites, and should be targeted for restoration.

Wildlife populations have varied. Sauer (1927) and even Bourne (1820) noted that barrens were in decline after early settlement, including the disappearance of *Bos bison* and *Cervus elaphis canadensis* soon after settlement (Michaux 1805). *Odocoileus virginianus* was nearly eliminated, as were *Meleagris gallopavo* and *Ursus americana*. *Sciurus* spp. numbers have declined greatly in some areas. *Ectopistes migratorius*, *Conuropsis carolinensis*, and probably *Campephilus principalis* are now extinct. More than 20 species have been extirpated from the Ozarks (USDA Forest Service 1999). Over 300 species of plants and animals have been shown to be at risk in the Ozark Highlands, although not all of these are found in the barrens and glades. *Colinus virginianus* populations, on the other hand, may have increased (USDA Forest Service 1999).

Remnant-dependent grassland insects are usually (but not always) restricted in distribution because of their dependence on one or a few remnant-dependent (r-d) plant species as food sources (Brown *et al*. 1992, Delong 1948, Joern 1982, Novotny 1994a-b, 1995, Panzer *et al*. 1995, Opler and Malikul 1992, Prestidge and McNeill 1983, Scott 1986, Whitcomb *et al*. 1986, 1987a-b, 1994, Whitcomb and Hicks 1988). The availability of specific microhabitats also appears to be a major constraint for many r-d grassland insects (Blatchley 1920, Brown *et al*. 1992, Cantrall 1943, Evans 1988, Joern 1982, Kemp *et al*. 1990, Morris 1973, Otte 1981, 1984, Waloff 1980, Whitcomb *et al*. 1994). For example, many grasshopper species require, in addition to food plants, specific microhabitats in which to perform courtship displays (Otte 1984). These areas are often quite different from those where food is obtained or where oviposition occurs. Other insects such as flies, native bees and solitary wasps are important pollinators of a number of grassland plants and many are known to be highly selective in their choice of habitats (Cole 1969, Mitchell 1960). These insects require not only specific adult nectar sources, but a rich source of larval food (*e.g.* spiders, caterpillars, grasshoppers) and suitable nesting sites (*e.g.* exposed sand, rotten logs, hollow plant stems). These pollinators also face strong competition for resources from domesticated honeybees.

Unfortunately, a fairly high percentage of r-d grassland insects (*e.g.* most Homoptera and many Lepidoptera) are also considered "fire sensitive" (*i.e.*, they overwinter above-ground in dead vegetation). Their numbers are significantly reduced following a fire and some species may take two years or more to regain their pre-burn population size (Panzer, 2001 pers. comm.). Many r-d insects are also flightless or flight-restricted, making them unable to escape a local fire and limiting their ability to re-colonize recently burned habitat from unburned refugia (Waloff 1973). Other forms of grassland manipulation (e.g. grazing, mowing, nutrient enrichment) are also known to affect insect species composition and abundance (Bess 1997c, Cherrill and Rushton 1993, Morris 1973, 1981a-b, Morris and Plant 1983). These factors, coupled with the highly fragmented and degraded nature of their

habitats, makes many r-d insects species vulnerable to localized extinction resulting from catastrophic events such as fire, mowing or intense grazing. Further complicating matters, many r-d insects (and their food plants) are patchily distributed within a given grassland remnant. *Erynnis martialis* is one of these patchily distributed, fire-sensitive species.

Fire suppression can also lead to denser forests, more prone to out-breaks of pests and diseases, such as oak wilt and bark beetles (USDA Forest Service 1999).

Closely tied to the negative effects of fire suppression are the equally negative effects of poorly planned fire management. The past 250 years of fire suppression has reduced many formerly extensive barrens communities to small, isolated remnants. These remnants are often separated from one another by extensive tracts of closed canopy forest, fescue fields, or urban areas. These non-barrens environments are essentially hostile to *Erynnis martialis* and the species rarely (if ever) is found in them. Therefore, these highly isolated remnants are islands, subject to the same population emigration and immigration dynamics as those surrounded by water.

In the Midwest, over the past 25 years or so, various land management agencies have begun to appreciate the value of fire in the maintenance of these unique habitats and have implemented programs of prescribed fire management in an attempt to restore and enhance existing remnants. Until just recently, fire management had only one goal, the invigoration of herbaceous flora. This usually meant that the most floristically diverse portions of a particular remnant were burned first, often in their entirety. Many glade and barrens associated insect species overwinter in the duff and leaf litter layers, making them prone to extirpation by spring or fall fires (*i.e.*, they are "fire-sensitive"). If a particular burn encompassed an entire population of a fire-sensitive species, the extirpation of that population became a reality. This is especially true on small, highly fragmented remnants, where sources of re-colonization are widespread and separated by extensive tracts of hostile environment.

Wind and ice storms may create conditions of large and dangerous fuel accumulations. If these sites should burn under unfavorable conditions, the site may be damaged, and provide opportunities for encroachment of non-native plants.

Compared to the losses from fire suppression, agricultural activities have likely been of secondary importance in the reduction of potential habitat for glade and barrens-associated insects. Many glade and barrens sites are extremely dry, making them poor sites for the planting of crops. Those on sandstone and shale deposits also tend to be nutrient poor, further adding to the difficulty in farming. The primary use of these plant communities has been pasture production for livestock (primarily cattle and swine). Often sites were seriously overgrazed and suffered extensive erosion. Ensuing pasture "improvements" involving the use of fescue and non-native clovers further served to render many of these sites unusable by insects and many other organisms. In addition, these non-native plants often escape and move into adjacent habitat, rendering it useless as well. Grazing animals also reduce the quality of glade and barrens habitats through soil compaction and the selective removal of plant species essential to the survival of glade and barrens insects. Palmer (1914) reported that cattle had trampled a site in

Missouri and he predicted *Ophioglossum engelmannii* would soon be eliminated from this location.

Grazing rates are higher now than in the past, and herds stay in fenced areas, not moving to "greener pastures", as needed. Cattle forage is often shipped in, occasionally with noxious weeds. Over-grazing depletes nutrient reserves of the native vegetation, eventually killing it. Grazing at inappropriate seasons can encourage undesirable plants. On the other hand, light grazing can put seeds into better contact with the mineral soil improving seedling survival. Grazers are often drawn to burned areas, so fires should be large enough to avoid concentrating use (Martin and Crosby 1955). Inappropriately timed grazing and prescribed fire can reduce the amount of forage on the site (Martin and Crosby 1955). Lack of grazing when coupled with fire suppression leads to rapid woody encroachment.

Some barrens types are maintained by their inherent instability. The thin soil in shale glades is constantly moving preventing woody encroachment. Frost-heaving may have similar effects at times (NatureServe 2001). Because of their unstable soils, barrens may be susceptible to erosion caused by trails (hiking, biking, ATV, equestrian) and by over-grazing. Erosion control measures may be needed in some areas where vegetation has been removed and bare soil is exposed. Eroded areas and sites with little soil initially are more rapidly encroached upon by woody species.

One of the greatest threats to the species may be trampling, either by human activity or grazers, such as white-tailed deer, due to the thin soil and unstable substrate.

Trails of any type may provide a route of entry by invasive plants, both native and exotic. Non-native species which often invade barrens include *Coronilla varia, Rosa multiflora, Microstegium vimineum,* and *Lonicera japonica*. Prescribed fire may be useful in reducing the abundance of *Lonicera japonica* in these communities (Anderson and Schwegman 1991).

Smith (2002) believes the biggest threat to *Gentiana alba* is the loss of native vegetation to exotic cool season grasses, such as *Festuca arundinacea*. Land covered with grasses makes the invasion of woody vegetation more difficult (Barnes 1948).

Navarrete-Tindall *et al*. (in press) has suggested including *F. paradoxa* in grassland restoration plantings to increase diversity and provide wildlife food since it will begin photosynthesizing before the warm-season grasses. Rabinowitz *et al*. (1989) speculated that *F. paradoxa* may be rare due to small mammals grazing on it during spring when many of the common prairie grasses are still dormant. It also appears that the species may be more palatable than many other cool-season grasses and could play an important role in agroforestry as well as restorations (Navarrete-Tindall *et al*. in press).

Silvicultural activities (typically logging and planting of soft pines) have had mixed effects on habitat for *Erynnis martialis* and other barrens insects. Typically, glades and barrens communities occur on steep slopes, often with much exposed bedrock (*i.e.*, glades). These sites were very dry, experienced rapid runoff of surface water and

generally produced trees with stunted and twisted growth forms. Forested portions of lower slopes and valleys provide the most marketable timber, so often the dry, upper slopes have been spared or only selectively logged. In some instances this has probably enhanced existing, or created new, habitat for the *E. martialis*. Where logging projects have included larger expanses of barrens, the associated soil disturbance often leads to widespread erosion. The native vegetation is adversely affected and often replaced with weedy species (both native and non-native).

The planting of pines in many areas of former barrens has probably been the most deleterious of silvicultural activities to affect *Erynnis martialis*. Pines are typically planted in close rows that eventually shade out the herbaceous layer, rendering the site useless as habitat for most wildlife (including insects). On non-National Forest System lands, these sites are also treated with herbicides and insecticides to control "pests". Many non-target species are killed via these applications, further reducing the value of the site as wildlife habitat.

Pines also produce large amounts of dead needles that are slow to decompose. Following tree removal, these needles often remain for several years, inhibiting the growth of plants and further aiding erosion of the thin soils. Pine needles can also inhibit the infiltration of rainfall, further adding to site dryness. Overall, silviculture has likely had a deleterious effect on glades and barrens, further reducing available habitat for *Erynnis martialis* and other restricted insect species. However, in certain cases (as mentioned above), these activities may temporarily enhance existing habitat for *E. martialis* and other glade and barrens insects.

As with silviculture, roadway and utility development have likely had mixed effects on habitat for *Erynnis martialis* and other glade and barrens insects. Roadways have covered extensive areas with asphalt and crushed gravel, while also providing effective barriers to wildfires. Planting of non-native grasses and clovers along roadsides has further served to eliminate potential habitat for *E. martialis*. However, in more remote areas, where road maintenance is less thorough, roadsides sometimes contain extensive patches of native vegetation and provide habitat for uncommon glade and barrens insects (including *E. martialis*).

Utility right-of-way development (powerlines, pipelines, etc.) has had varying effects on habitat for *Erynnis martialis*. Overhead power transmission and telephone line construction is fairly unobtrusive, primarily involving the removal of trees. In discussions with butterfly collectors in the region, they often state that *E. martialis* (and other barrens-associated butterflies) can be found along powerline corridors. While true, this phenomenon only occurs on powerline rights-of-way in areas that are (or formerly were) barrens. Even so, these corridors are maintained in an open condition through the application of herbicide to trees and shrubs, often with damage to non-target vegetation (including shrubs like *Ceanothus*). Therefore, they should be viewed as providing only marginal habitat for these species.

Pipeline construction is much more intrusive, requiring the removal of rock and soil to prepare a trench for pipeline placement. Following construction, the pipeline corridors

are graded, and often planted with non-native grasses (such as fescue) and clovers. In areas of barrens or glade vegetation, conditions often do not favor the growth of these species and they are replaced (to varying degrees) by native vegetation. Given that these corridors are kept open through the application of herbicide to woody species, they can sometimes provide suitable habitat for *Erynnis martialis*. However, herbicide application to non-target vegetation such as *Ceanothus* makes these habitats of marginal quality for the long-term survival of *E. martialis* and other barrens insects.

Dumping can be an issue over the entire range of the barrens community (DeSelm 1986).

Quarrying of limestone formations is removing habitat where barrens are likely to have occurred. Known barrens have been hauled away, for example the Derby Quarry area on the Hoosier, and others have been reduced in size, such as at Barker Bluff on the Shawnee. Some species may move into the quarried area and begin development of an artificial glade community.

Although gentians in general are known to be beautiful and there has been some concern about over-collecting (Mason and Iltis 1965), there is no indication that the rarity of *G. alba* is due to over-collection.

SUMMARY OF LAND OWNERSHIP & EXISTING HABITAT PROTECTION

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES

PAST AND CURRENT CONSERVATION ACTIVITIES

RESEARCH AND MONITORING

A considerable amount of research has been done in the barrens across their range, focusing largely on the effects of fire. Fire history can be used to estimate the timing and frequency of past fires and improve understanding of current forest conditions. Frequency and size of fires appears to have been variable over the barrens region. *Juniperus virginiana* from protected parts of Missouri glades have been shown to be useful in documenting fire history (Guyette and McGinnes 1982). Guyette and McGinnes (1982) found an average of 3.2-year fire return interval before 1870, and a 22-year interval after that time in the Ava glades area of the Ozark Highlands.

Guyette and Cutter (1991) used tree cross-sections to determine the fire frequency and extent in a *Quercus stellata* "savanna" area in south-central Missouri. Large, frequent fires were most common in the 1700's. Severe fires had an interval averaging 11 years and lighter burns every 4.3 years during the period before European settlement in the Ozarks (Guyette and Cutter 1991). After 1810, the fire interval increased to 6.4 years,

but fires apparently were less intense. Because not all fires are intense enough to scar trees, the total number of fires may be greater that these estimates.

Guyette and Dey (2000) have done work determining the fire history within one 400-acre watershed on the Hoosier National Forest. One gap between fire scars in this small watershed lasted for over 125 years. However, the fire return interval after European settlement averaged 5.3 years.

Wider information is needed for fire frequency. Although several studies have been done in the Ozarks, only one has been published from southern Illinois and only preliminary work has been done in southern Indiana. Fire intensity should also be studied throughout the region.

Where fires have been suppressed and woody encroachment has proceeded for extended periods of time, restoring the fire regime and earlier conditions can be difficult.

Species richness may increase with burning, and may continue to increase for a period after fires cease (Anderson and Schwegman 1991). Species richness may not be the best measure of community health because not all species prefer the same conditions. It may be better to look at physiognomy of species groups. Lewis, *et al*. (1964), studied how plant species composition and biomass vary with differing burning dates. Legumes generally increased while there was a proportionate decrease in grasses. Hardwood sprout survival was reduced in summer and fall burns. Waldrip and Adam (1986) compared forage production on burned and unburned glades on the Ava Ranger District of the Mark Twain National Forest. Among their findings were that herbaceous vegetation decreases as woody vegetation increases, and that "Glades previously treated will quickly lose their acquired benefits if the canopy cover is allowed to reach 20 percent." Heikens, *et al.* (1994), describe the effects of fire on two different types of barrens within the Illinois Ozarks, and conclude that one burn is not enough to "significantly reduce woody cover or enhance the prairie component."

Repeated fires may reduce the importance of annual plants (Anderson and Schwegman 1991). A single burn is insufficient to cause much change, but subsequent burns are more beneficial because of greater accumulations of fine fuels. After the first two or three burns, barrens health can often be maintained with longer fire return intervals. After years of fire suppression, the first burn may be patchy, but subsequent burns are more uniform in their coverage.

Some species respond to burning by showing significant increases in populations. Legumes and composites increase. Forbs showed a 45 percent composition in recently burned areas, while they comprised only 33 percent of the flora in unburned areas. Statistically, grasses did not significantly change in abundance (Lewis *et al*. 1964). A 150 percent increase in desirable plants was noted in the Missouri Ozarks in another study (Waldrip and Adam 1986). Martin (no date) showed 500 percent increases in herbaceous production and numbers of desirable forage species.

It has been suggested that burning may be important in maintaining viable populations of *F. paradoxa* (Indiana Department of Natural Resources 2002, Olson 1999). However, in greenhouse studies, Navarret-Tindall *et al*. (in press) determined that the species may be shade tolerant in that there was no difference in biomass between plants grown in full sun and two levels of shading (55 and 80 percent). Although there was a tendency for seed production to decrease with shading, there was no statistical difference in seed production with shading. However, some studies at Tucker Prairie indicate that burning in late August increases seed production of *F. paradoxa* in comparison to spring burns or no burning (Mechlin 2001).

Fire may affect species richness on barrens, but does not normally significantly influence canopy conditions by eliminating large trees. Bender (2000) found fire reduced canopy and midstory cover. It also removed leaf litter that inhibits seedling establishment and plant growth. Taft (1999) studied fires effects in southern Illinois barrens and flatwoods. There was little effect on canopy trees, but basal area increased from top-killing of shrubs and saplings. Within healthy, well-managed barrens, it has been found that shrub density is related to fire frequency. Sites having more frequent fires generally have fewer shrubs (NatureServe 2001). There was also a significant increase in herbaceous diversity following prescribed fires.

Guyette, *et al*. (1980), used cross-sections of *Juniperus virginiana* to correlate summer temperatures and spring rainfall.

Appropriate for the Ozarks, but of only moderate benefit in the Shawnee Hills, would be studies of the effects of grazing at different times and intensities.

Baskin and Baskin (1985) review the ecology of several annual plants which are found on glades. Temperature appears to be the dominant environmental factor affecting these species.

There are several methods available to slow or stop encroachment in the barrens including prescribed fire, manual removal of target species, herbicides, and grazing. The timing and frequency of such treatments needs to be investigated across the range of the community.

Kucera and Martin (1957) found narrow ecotones between Ozark glades and forests. Following drought, native perennials of the glades were injured, and annual species became more abundant. Portions of the glades community with deeper soils support more trees. Species composition varies with bedrock parent material.

Although limestone glades have been studied extensively, there is a lack of information on specific responses of *Ophioglossum engelmannii*, *Polytaenia nuttallii*, and *Gentiana alba* to disturbance. Perhaps this is because they are not conservative species in many instances, or perhaps it is due to their being inconspicuous plants only visible during a short portion of the growing season.

Currently, there is no research available on how *Gentiana alba* responds to disturbance; however, Ladd (2000) stated that it can tolerate "moderate short-term disturbances in certain settings." No published research is available on the effects of disturbance on *Polytaenia nuttallii*; however, it appears to be a highly conservative species (Swink and Wilhelm 1994, Ladd 2000) and that it does not tolerate grazing well (Nelson 2001).

The presence of a perennating bud of *Opioglossum* below ground suggests that the species may survive minor types of disturbances if the soil/substrate is not heavily impacted.

One of the greatest needs in the barrens and glades communities is that of additional surveys for rare species, particularly insects. Surveys may determine that some of the current RFSS may not be as rare as now assumed. It is likely that species that are even rarer may be located. Such surveys would remove relatively common species from the RFSS list and add species that are in greater need of protection and management. Populations of some species have not been observed for the past two decades and basic monitoring should be established. Also, research is needed to document the effects of disturbance on these species. For example, currently there are no known monitoring programs for *Stenanthium gramineum*.

An on-going survey of barrens insects on the Hoosier National Forest has found a probable first Indiana record of *Fitchiella robertsoni*, previously known only from Ohio and Illinois prairies. Other species of note include *Flexamia reflexa*, *Chlorotettix* spp., *Schinia jaguarina*, *Lethe anthedon*, *Cyllopsis gemma*, *Zerene cesonia*, *Phoebis sennae*, *Erynnis martialis*, and *Achalarus lyciades*.

Historically, *Erynnis martialis* was distributed throughout eastern North America. Despite this broad range, individual populations were (and still are) often isolated from one another by long distances. The majority of historical records are from the Upper Midwest (primarily Michigan), northern Ozarks (Missouri), Appalachian Highlands and the New England states. Many of these historic populations are no longer extant, with the species experiencing precipitous declines in New England and Appalachian Highlands. *Erynnis martialis* is considered a species of concern (*i.e.*, rare, threatened, or endangered) throughout much of its former range.

Within the assessment area, *Erynnis martialis* was historically "common" only in the region encompassing the Mark Twain National Forest in southern Missouri. Unfortunately, very few lepidopterists (the primary source of records for this group of insects) have visited the remainder of the assessment area. Therefore, an exact understanding of long-term population trends for this species is not possible. However, given the overall degradation of the glade, barrens and prairie habitats used by this species, it is assumed that *Erynnis martialis* has undergone a steady population decline here as well.

Effective and repeatable monitoring protocols are necessary to track changes in species composition, habitat condition and the effects of management (Ladd and Heumann 1994). Vegetation provides only a portion of the biodiversity of the landscape, and

healthy ecosystems have a diversity of other species as well. Among these species are conservative types that are adapted to very specific habitat conditions. Managing for a diverse landscape is likely to provide suitable conditions for these species. Many RFSS fall into this category.

There are six known extant populations and one known extirpated site for *Festuca paradoxa* in Indiana. Although *F. paradoxa* has been extirpated from a number of locations in Missouri, it remains in approximately 40 counties. The majority of the sites are in the unglaciated portion of the state, which is probably a result of the northern portion being heavily impacted by agricultural practices.

Seven extirpated populations of *Gentiana alba* have been documented in Indiana. However, because of its widespread nature, populations of this species is not being tracked in Illinois or Missouri.

Olson (1999) suggested that the Hoosier National Forest population of *Ophioglossum engelmannii* may have declined due to fire suppression and subsequent woody encroachment.

It appears that at least in some areas populations of *Polytaenia nuttallii* are declining. Yatskievych (2002) indicates that in over 30 counties in Missouri populations have been extirpated in the last 40 years. Specific information regarding population size and species vigor is not available since the species is not monitored by the Missouri Department of Conservation.

Chester and Wofford (1992) reported the decline of *P. nuttallii* in Tennessee. Within less than one decade, they observed the loss of over 50 percent of a large population (200 individuals to less than 100). At a second location the species was lost at the original site. In both situations they attributed the decline of the species to woody encroachment as a result of lack of fire (Chester and Wofford 1992).

In Indiana, several populations of *Polytaenia* have been extirpated since the early 1900s. The only population that has been monitored indicates an increase in number of stems (from 3 to 7) and a slight increase in vigor; however, since this data is limited to only two growing seasons it is not a good indicator of the population trend. Olson (1999) stated that the species is at high risk on the Hoosier National Forest and that the population may be declining.

Radford *et al*. (1968) noted that *Stenanthium* normally is found is small colonies in North Carolina. Ladd (2000) stated that all of the Missouri populations he observed were also small. Apparently, it has been extirpated from nine counties in Missouri. Yatskievych (2001) suggested *Stenanthium* should have a listing of at least S4 indicating that the species is secure and has many occurrences in Missouri.

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APPENDICES

APPENDIX I: SCIENTIFIC NAMES OF PLANTS AND ANIMALS MENTIONED IN TEXT.

Latin Name	Common Name
LICHENS (Esslinger 1997)	
Caloplaca saxicola	
Cladina spp.	
Cladina subtenuis	
Cladonia spp.	
Cladonia caroliniana	
Cladonia cristatella	British soldier lichen
Cladonia furcata	Reindeer moss (lichen)
Cladonia mateocytha	
Cladonia polycarpoides	
Cladonia squamosa	
Cladonia strepsilis	
Flavoparmelia spp.	
Flavoparmelia baltimorensis	
Flavoparmelia caperata	
Lecanora muralis	
Placidium lachneum	
Placynthium nigrum	
Pleopsidium chlorphanum	
Psora russellii	
Punctelia spp.	
Punctelia hypoleucites	Shield lichen
Punctelia rudecta	
Xanthoparmelia spp.	
NON-VASCULAR PLANTS (Redfearn 1998)	
Dicranum condensatum	Barrens moss
Dicranum scoparium	Wind-swept moss
Grimmia laevigata	Black moss
Hedwigia ciliata	
Leucobryum glaucum	Pincushion moss
Polytrichum spp.	
Polytrichum juniperinum	
Polytrichum ohiense	Hair-cap moss
FERNS (Gleason and Cronquist 1991)	
Botrychium spp.	
Cheilanthes lanosa	Wooly lip-fern
Cheilanthes feei	Slender lip-fern
Isoetes melanopoda	Black-footed quillwort
Ophioglossum engelmannii	Engelmann's adder's-tongue fern
Ophioglossum vulgatum	Adder's-tongue fern
Pellaea atropurpurea	Purple cliffbrake
Pteridium aquilinum	Bracken fern
Selaginella rupestris	Rock spikemoss
MONOCOTS (Gleason and Cronquist 1991)	
Agave spp.	Agave
Agave virginica	False aloe
Agrostis elliottiana	Awned bent grass

Latin Name	Common Name
Agrostis hyemalis	Tickle-grass
Agrostis perennans	Autumn bent-grass
Allium canadense	Wild onion
Allium cernuum	Nodding wild onion
Allium stellatum	Starry onion
Amianthum spp.	Fly-poison
Andropogon spp.	Bluestem
Andropogon elliottii	Elliott's broomsedge
Andropogon gerardii	Big bluestem
Andropogon ternarius	Silver broomsedge
Andropogon virginicus	Virginia broosmsedge
Aristida spp.	Three-awn grass
Aristida purpurascens	Arrowfeather
Arundinaria gigantea	Giant cane
Bouteloua curtipendula	Side-oats gramma
Brachyelytrum erectum	False brome
Bromus pubescens	Woodland brome
Calamagrostis porteri insperata	Ofer Hollow reed-grass
Camassia scilloides	Wild hyacinth
Carex albicans	Close-covered sedge
Carex caroliniana	Carolina sedge
Carex complanata	Downy sedge
Carex flaccosperma	Glaucous sedge
Carex meadii	Mead's sedge
Carex picta	Painted sedge
Carex retroflexa	Reflexed sedge
Carex umbellata	Umbelled sedge
Chamaelirium luteum	Devil's bit
Chasmanthium latifolium	Wood oats
Cypripedium candidum	White lady-slipper
Danthonia spicata	Poverty oats
Eleocharis tenuis	Slender spike-rush
Elymus spp.	Wild rye-grass
Elymus virginicus	Virginia wild-rye
Eragrostis spp.	Love-grass
Eragrostis capillaris	Lace-grass
Eragrostis spectabilis	Purple love-grass
Festuca arundinacea	Tall fescue
Festuca paradoxa	Cluster fescue
Hexalectris spicata	Crested coralroot
Hypoxis hirsute	Yellow star-grass
Isotria medeoloides	Small whorled pogonia
Isotria verticillata	Whorled pogonia
Juncus tenuis tenuis	Path rush
Koehleria pyramidata	June-grass
Melanthium spp.	Bunchflower
Melica mutica (but see Yatskeivich 1999)	Two-flowered melic-grass
Microstegium vimineum	Stilt grass
Nothoscordum bivalve	False garlic
Panicum spp.	Panic-grass
Panicum boscii	Bosc's panic-grass
Panicum dichotomum	Forked panic-grass
Panicum lanuginosum	Panic-grass

Latin Name	Common Name
Panicum lanuginosum fasciculatum	Panic-grass
Panicum latifolium	Wide-leaved panic-grass
Panicum linearifolium	Long-leaved panic-grass
Panicum (Dichanthelium) ravenelii	Ravenel's witchgrass
Panicum virgatum	Switch-grass
Schizachyrium scoparium	Little bluestem
Scleria oligantha	Few-flowered nutsedge
Scleria pauciflora	Small-flowered nutsedge
Sisyrhichium albidum	Blue-eyed grass
Smilax spp.	Greenbriars, briers
Smilax bona-nox	Catbriar
Smilax glauca	Glaucous greenbriar
Smilax rotundifolia	Round-leaved greenbriar
Sorghastrum nutans	Indian grass
Spiranthes cernua	Nodding ladies-tresses
Sporobolus heterolepis	Prairie dropseed
Sporobolus neglectus	Bald grass
Sporobolus vaginiflorus	Poverty grass
Stenanthium gramineum	Featherbells
Stipa spartea	Porcupine grass
Tradescantia ohiensis	Ohio spiderwort
Tradescantia virginiana	Virginia spiderwort
Tridens flavus	Purpletop
Tripsacum dactyloides	Eastern gamma grass
Veratrum spp.	False hellebore
Vulpia octoflora	Six-weeks fescue
Zigadenus spp.	Death-camus
DICOTS (Gleason and Cronquist 1991)	
Acalypha gracilens	Three-seeded mercury
Acer spp.	Maple
Acer saccharum	Sugar Maple
Agalinis auriculata	Eared false-foxglove
Agalinis gattingeri	Round-stemmed false-foxglove
Agalinis skinneriana	Purple false-foxglove
Agalinis tenuifolia	Slender foxglove
Ambrosia artemisiifolia	Common ragweed
Ambrosia bidentata	Two-toothed ragweed
Amelanchier arborea	Shadbush
Amorpha canescens	Leadplant
Amphicarpaea bracteata	Hog-peanut
Antennaria plantaginifolia	Common pussytoes
Apios americana	Ground-nut
Apocynum androsaemifolium	Spreading dogbane
Apocynum cannabinum	dogbane
Arabis spp.	Rock-cress
Arabis laevigata	Smooth rockcress
Arenaria patula	Sandwort
Asclepias spp.	Milkweeds
Asclepias amplexicaulis	Sand milkweed
Asclepias hirtella	Tall green milkweed
Asclepias meadii	Mead's milkweed
Asclepias purpurascens	Purple milkweed
Asclepias tuberosa	Butterfly-weed

Latin Name	Common Name
Asclepias variegata	White milkweed
Asclepias verticillata	Horsetail milkweed
Asclepias viridiflora	Green milkweed
Asclepias viridis	Green-flowered milkweed
Aster spp.	Asters
Aster drummondii	Hairy heart-leaved aster
Aster dumosus strictior	Long-stalked aster
Aster ericoides	Heath aster
Aster laevis	Smooth aster
Aster linariifolius	Stiff aster
Aster patens	Clasping aster
Aster sericeus	Western silky aster
Aster solidagineus	Narrow-leaved white-top aster
Aster undulatus	Clasping heart-leaved aster
Astragalus distortus	Ozark milk-vetch
Baptisia spp.	Wild indigo
Baptisia bracteata	White wild indigo
Baptisia lactea	Milky wild indigo
Buchnera americana	Bluehearts
Bumelia lycioides	Southern buckthorn
Cacalia atriplicifolia	Pale Indian plantain
Callirhoe bushii	Bush's poppy-mallow
Carya spp.	Hickory
Carya glabra	Pignut hickory
Carya ovalis	Sweet pignut hickory
Carya ovata	Shagbark hickory, scalybark
Carya texana	Black hickory
Carya tomentosa	Mockernut hickory, Barren hickory
Cassia fasciculata	Partridge pea
Castanea pumila ozarkensis	Ozark chinquapin
Castilleja purpurea	Purple paintbrush
Ceanothus americanus	New Jersey tea
Ceanothus herbaceus	Redroot
Celtis tenuifolia	Dwarf hackberry
Cercis canadensis	Redbud
Chamaelirium luteum	Blazing-star
Chrysanthemum leucanthemum	Ox-eye daisy
Cimicifuga racemosa	Black snakeroot
Cirsium altissimum	Tall thistle
Cladrastis lutea	Yellowwood
Clitoria mariana	Butterfly-pea
Collinsonia Canadensis	Northern horse-balm
Coreopsis lanceolata	Longstalk tickseed
Coreopsis major	Forest tickseed
Coreopsis palmata	Finger tickseed
Coreopsis tripteris	Tall tickseed
Coronilla varia	Crown vetch
Cornus spp.	Dogwood
Cornus florida	Flowering dogwood
Corylus americana	American hazelnut
Cotinus obovatus	Smoketree
Crataegus spp.	Hawthorns
Crataegus berberifolia	Green hawthorn

Latin Name	Common Name
Croton monanthogynus	Prairie-tea
Crotonopsis elliptica	Elliptic-leaved rushfoil
Crotonopsis linearis	Narrow-leaved rushfoil
Cunila origanoides	Dittany
Dalea candida	White prairie-clover
Dalea purpurea	Purple prairie-clover
Dasistoma macrophylla	Mullein foxglove
Delphinium carolinianum	Carolina larkspur
Delphinium treleasei	Trelease's larkspur
Desmodium spp.	Tick-trefoils
Desmodium glabellum	Smooth tick-trefoil
Desmodium humifusum	Trailing tick-trefoil
Desmodium nudiflorum	Naked tick-trefoil
Desmodium paniculatum	Panicled tick-trefoil
Desmodium rotundifolium	Round-leaved tick-trefoil
Diodia teres	Buttonweed
Diospyros virginiana	Persimmon
Dodecatheon meadia	Common shooting-star
Echinacea pallida	Prairie coneflower
Echinacea paradoxa paradoxa	Yellow coneflower
Echinacea purpurea	Purple coneflower
Echinacea simulata	Wavyleaf purple coneflower
Erigeron strigosus	Daisy fleabane
Eryngium yuccifolium	Rattlesnake-master
Eupatorium album	White thoroughwort
Eupatorium altissimum	Tall boneset
Eupatorium rugosum	White snakeroot
Euphorbia corollata	Flowering spurge
Fagus grandifolia	American beech
Fragaria virginiana	Virginia strawberry
Frasera caroliniensis	American columbo
Fraxinus spp.	Ash
Fraxinus americana	White ash
Gaylussacia baccata	Black huckleberry
Gentiana alba	Yellowish gentian
Gentiana andrewsii	Bottle gentian
Gentiana X*curtisii*	
Gentiana puberulenta	Prairie gentian
Gentiana X*pallidocyanae*	
Grindelia squarrosa	Curly-top gumweed
Hedyotis nigricans	Narrow-leaved bluets
Helianthus spp.	Sunflowers
Helianthus angustifolius	Narrow-leaved sunflower
Helianthus divaricatus	Woodland sunflower
Helianthus hirsutus	Hairy sunflower
Helianthus mollis	Downy sunflower
Helianthus rigida	Stiff sunflower
Helianthus silphioides	Silphium sunflower
Heliotropium tenellum	Slender heliotrope
Heuchera richardsonii	Prairie alumroot
Hieraceum gronovii	Orange hawkweed
Hypericum frondosum	St.John's-wort
Hypericum gentianoides	Pineweed

Latin Name	Common Name
Hypericum hypericoides	St. Andrew's-cross
Hypericum prolificum	Shrubby St.John's-wort
Isanthus brachiatus	False pennyroyal
Kalmia latifolia	Mountain laurel
Krigia biflora	Two-flowered Cynthia
Kuhnia eupatorioides	False boneset
Lathyrus frondosus	Forest-pea
Lechea mucronata	Pinweed
Lespedeza spp.	Bush-clovers
Lespedeza cuneata	Sericea bush-clover
Lespedeza hirta	Hairy bush-clover
Lespedeza intermedia	Intermediate bush-clover
Lespedeza procumbens	Trailing bush-clover
Lespedeza repens	Creeping bush-clover
Lespedeza violacea	Violet bush-clover
Lespedeza virginica	Slender bush-clover
Lesquerella filiformis	Missouri bladder-pod
Liatris spp.	Blazing-stars
Liatris aspera	Rough blazing-star
Liatris cylindracea	Cylindrical blazing-star
Liatris spicata	Dense blazing-star
Liatris squarrosa	Squarrose blazing-star
Liatris squarrulosa	Southern blazing-star
Liriodendron tulipifera	Yellow poplar
Lithospermum canescens	Hoary puccoon
Lonicera flava	Yellow honeysuckle
Lonicera japonica	Japanese honeysuckle
Lysimachia quadrifolia	Four-leaved loosestrife
Matelea baldwiniana	Baldwin's milkvine
Melilotus alba	White sweet-clover
Monarda spp.	Bergamont
Monarda fistulosa	Wild bergamont
Monarda russeliana	Woodland bergamont
Nyssa sylvatica	Black gum
Oenothera fruticosa	Southern sundrops
Oenothera missouriensis	Missouri evening primrose
Opuntia humifusa	Prickly-pear
Orbexilum pedunculatum	Scurf-pea
Ostrya virginiana	Ironwood
Oxydendrum arboreum	Sourwood
Palafoxia callosa	Palafoxia
Parthenium integrifolium	Feverfew
Parthenocissus quinquefolium	Virginia creeper
Penstemon digitalis	Tall white beard-tongue
Penstemon tubaeflorus	Tube beard-tongue
Phlox bifida	Cleft phlox
Phlox divaricata	Sweet William
Phlox pilosa	Downy phlox
Phryma leptostachya	Lopseed
Phyllanthus polygonoides	Phyllanthus
Physotegia virginiana	Obedient-plant
Platanus occidentalis	Sycamore, sicamore
Polygala incarnata	Pink milkwort

Latin Name	Common Name
Polygala sanguinea	Blood milkwort
Polymnia uvedalia	Yellow leaf-cup
Polytaenia nuttallii	Prairie parsley
Polytaenia texana	Southern prairie parsley
Porteranthus stipulatus	Indian physic
Potentilla spp.	Cinquefoils
Potentilla simplex	Common cinquefoil
Prunella vulgaris	Self-heal
Prunus americana	Plum
Prunus munsoniana	Goose plum
Prunus serotina	Wild black cherry
Psoralidium tenuiflorum	Gray scurf-pea
Pycnanthemum spp.	Mountain mints
Pycnanthemum albescens	White-leaved mountain mint
Pycnanthemum torrei	Torrey mountain mint
Pyrus ioensis	Prairie crabapple
Quercus spp.	Oak
Quercus alba	White oak
Quercus coccinea	Scarlet oak
Quercus falcata	Southern red oak, bitter oak, Spanish oak
Quercus imbricaria	Shingle oak, laurel oak
Quercus marilandica	Blackjack oak, blackjack
Quercus muehlenbergii	Chinquapin oak
Quercus prinus	Rock chestnut oak
Quercus shumardii	Shumard's oak
Quercus stellata	Post oak
Quercus velutina	Black oak
Ratibida pinnata	Gray-headed coneflower
Rhamnus caroliniana	Carolina buckthorn
Rhododendron prinophyllum	Rosebus azalea
Rhus spp.	Sumac, sumach, sumack
Rhus aromatica	Fragrant sumac
Rhus copallinum	Shining sumac
Rhus glabra	Smooth sumac
Rosa spp.	Rose
Rosa carolina	Pasture rose
Rosa multiflora	Multiflora rose
Rosa setigera	Prairie rose
Rubus flagellaris	Northern dewberry
Rudbeckia fulgida speciosa	Orange coneflower
Rudbeckia fulgida sullivantii	Sullivant's Coneflower
Rudbeckia hirta	Black-eyed Susan
Rudbeckia missouriensis	Missouri coneflower
Ruellia humilis	Wild petunia
Sabatia angularis	Common marsh-pink
Sabatia brachiata	Narrow-leaf pink
Salix spp.	Willow
Sassafras albidum	Sassafras
Scutellaria bushii	Bush's skullcap
Scutellaria nervosa	Veined skullcap
Scutellaria parvula parvula	Small skullcap
Scutellaria spp.	skullcap
Silene regia	Royal catchfly

Latin Name	Common Name
Silphium integrifolium	Rosinweed
Silphium laciniatum	Compass-plant
Silphium pinnatifidum	Pinnatifid Prairie-dock
Silphium terebinthinaceum	Prairie dock
Silphium trifoliatum	Whorled rosinweed
Solidago spp.	Goldenrods
Solidago bicolor	Silver-rod
Solidago drummondii	Drummond's goldenrod
Solidago erecta	Erect goldenrod
Solidago gattingerii	Gattinger's goldenrod
Solidago juncea	Early goldenrod
Solidago nemoralis	Gray goldenrod
Solidago odora	Aromatic goldenrod
Solidago rigida	Stiff goldenrod
Solidago ulmifolia	Elm-leaved goldenrod
Strophostyles umbellata	Wild bean
Stylosanthes biflora	Pencil-flower
Symphoricarpos orbiculatus	Coralberry, buckbrush
Talinum parviflorum	Prairie fame-flower
Tephrosia virginiana	Goat's-rue
Thaspium barbinode	Bearded meadow-parsnip
Thaspium trifoliatum	Smooth meadow-parsnip
Toxicodendron radicans	Poison ivy
Tridens flavus	purpletop
Trifolium reflexum	Buffalo clover
Trifolium stoloniferum	Running buffalo clover
Triodanus perfoliata	Venus' looking-glass
Ulmus spp.	Elm
Ulmus alata	Winged elm
Ulmus rubra	Slippery elm
Vaccinium spp.	Blueberry
Vaccinium arboreum	Farkleberry
Vaccinium pallidum	Low-bush blueberry
Vaccinium stamineum	Deerberry
Valerianella ozarkana	Ozark corn-salad
Verbena canadensis	Rose vervain
Verbesina spp.	Wingstem
Verbesina helianthoides	Yellow crownbeard
Verbesina virginica	White wingstem
Veronicastrum virginicum	Culver's-root
Viburnum rufidulum	Rusty nannyberry, southern black haw
Viola palmata	Wood violet
Viola pedata	Bird's-foot violet
Viola sagittata	Arrowhead violet
Vitis spp.	Grape vine
Vitis aestivalis	Summer grape
Vitis cinerea	Winter grape
Waldsteinia fragarioides	Barren strawberry
Zanthoxylum americanum	Prickly ash
Zizia aptera	Heart-leaved golden-alexanders
Zizia aurea	Common golden-alexanders
CONIFERS (Gleason and Cronquist 1991)	
Juniperus virginiana	Eastern redcedar, cedar

Latin Name	Common Name
Pinus echinata	Shortleaf pine, pine

Latin Name	Common Name
MAMMALS (Whitaker 2000)	
Bos bison	Bison
Blarina carolinensis	Short-tailed shrew
Canis latrans	Coyote
Canis lupus	Gray wolf
Cervus elaphus canadensis	Elk
Felis concolor cougar	Eastern cougar, panther
Lasiurus borealis	Eastern red bat
Lynx rufus	Bobcat, wildcat
Marmota monax	woodchuck
Mephitis mephitis	Striped skunk, Pole-cat
Microtus ochrogaster	Prairie vole
Mustella vison	Mink
Myotis austroriparius	Southeastern myotis
Myotis septentrionalis	Northern myotis
Myotis sodalis	Indiana bat
Nycticeius humeralis	Evening bat
Odocoileus virginianus	White-tailed deer
Peromyscus leucopus	White-footed mouse
Pipistrellus subflavus	Eastern pipistrelle
Procyon lotor	Raccoon
Sciurus spp.	Squirrel
Sciurus niger	Eastern fox squirrel
Sylvilagus floridanus	Rabbit, cottontail
Ursus americana	Bear
Vulpes vulpes fulva	Red fox
BIRDS (American Ornithologists Union 1998)	
Aimophila aestivalis	Bachman's Sparrow
Ammodramus henslowii	Henslow's Sparrow
Baeolophus bicolor	Tufted Titmouse
Campephilus principalis	Ivory-billed Woodpecker
Colaptes auritus	Common Flicker
Colinus virginianus	Northern Bobwhite
Contopus virens	Eastern Wood-Pewee
Conuropsis carolinensis	Carolina Parakeet
Cyanocitta cristata	Blue Jay
Dendroica cerulea	Cerulean Warbler
Dendroica discolor	Prairie Warbler
Dendroica dominica	Yellow-throated Warbler
Ectopistes migratorius	Passenger Pigeon
Geococcyx californianus	Greater Roadrunner
Icteria virens	Yellow-breasted Chat
Icterus spurius	Orchard Oriole
Lanius ludovicianus	Loggerhead Shrike
Melanerpes carolinus	Red-bellied Woodpecker
Melanerpes erythrocephalus	Red-headed Woodpecker
Meleagris galopavo	Wild Turkey
Mniotilta varia	Black-and-white Warbler

Latin Name	Common Name
Passerina cyanea	Indigo Bunting
Picoides pubescens	Downy Woodpecker
Piranga rubra	Summer Tanager
Poecile carolinensis	Carolina Chickadee
Polioptila caerulea	Blue-gray Gnatcatcher
Sayornis phoebe	Eastern Phoebe
Sialia sialis	Eastern Bluebird
Spizella pusilla	Field Sparrow
Tympanuchus cupido	Greater Prairie-Chicken
Vermivora pinus	Blue-winged Warbler
Vireo griseus	White-eyed Vireo
REPTILES (Conant and Collins 1998)	
Coluber constrictor	Black racer
Crotalus horridus	Timber rattlesnake
Crotaphytus collaris	Collared lizard
Elaphe obsolete	Black rat snake
Eumeces fasciatus	Five-lined skink
Heterodon platyrhinos	Eastern hog-nosed snake
Scelopurus undulatus hyacinthinus	Eastern Fence lizard
Scincella laterale	Ground skink
Terrepene carolina triunguis	Three-toed box turtle
Virginia valeriae elegans	Smooth earth snake
AMPHIBIANS (Conant and Collins 1998)	
Ambystoma annulatum	Ringed salamander
Ambystoma opacum	Marbled salamander
Bufo americanus	American toad
Notophthalmus viridescens louisianensis	Central newt
INSECTS (Borror and White 1970)	
Achalarus lyciades	Hoary-edge
Acronycta albarufa	Albarufan dagger moth
Allonemobius fasciatus	
Amblyscirtes belli	Bell's roadside skipper
Amblyscirtes hegon	Pepper-and-salt skipper
Amblyscirtes vialis	Roadside skipper
Ancylis semiovana	A tortricid moth
Atrytonopsis hianna	Dusted skipper
Autochton cellus	Golden skipper
Bruchomorpha dorsata	A planthopper
Bruchomorpha extensa	A planthopper
Bruchomorpha jocasa	A planthopper
Bruchomorpha pallidipes	A planthopper
Calephelis mutica	Swamp metalmark
Catocala clintoni	Clinton's underwing moth
Catocala consors	Consort
Catocala dulciola	Dulciola underwing moth
Catocala gracilis	Blueberry underwing moth
Ceuthophilus maculatus	Camel cricket
Chlorotettix spp.	A leafhopper
Coenochroa bipunctella	A moth
Coenochroa illibella	A moth
Conocephalus nemoralis	Meadow grasshopper
Croesia curvalana	Huckleberry leaf-tier
Croesia semipurpurana	Oak leaf-tier

Latin Name	Common Name
Cycnia inopinatus	Unexpected tiger moth
Cyllopsis gemma	Gemmed satyr
Cyrtacanthacridinae	Spur-throated grasshoppers
Diapheromera blachleyi	A walkingstick
Diapheromera velii	A walkingstick
Eoruema densella	A moth
Eritettix simplex	A grasshopper
Erynnis juvenalis	Juvenal's duskywing
Erynnis martialis	Mottled duskywing
Erythroecia hebardi	A moth
Euchloe olympia	Olympia marblewing
Eucosma bipunctella	Prairie-dock borer moth
Eucosma fulminana	Sunflower borer moth
Eucosma giganteana	Prairie-dock borer moth
Eucosma gracilana	A tortricid moth
Eucosma glomerana	A tortricid moth
Eucosma matutina	A tortricid moth
Eucosma nandana	Sunflower borer moth
Eucosma sombreana	A tortricid moth
Eucosma wandana	A tortricid moth
Euerythra phasma	Specter
Fixenia favonius ontario	Northern hairstreak
Flexamia areolata	Lovegrass leafhopper
Flexamia clayi	A leafhopper
Flexamia picta	A leafhopper
Flexamia reflexa	A leafhopper
Flexamia sandersi	A leafhopper
Grammia anna	Anna'stiger moth
Grammia figutata	Figured tiger moth
Grammia phyllira	Southern tiger moth
Grammia oithona	Oithona's tiger moth
Gryllus pensylvanicus	Field cricket
Hesperia leonardus	Leonard's skipper
Hesperia metea	Cobweb skipper
Hermeuptychia soysbius	Carolina satyr
Holomelina opella	Opella's tiger moth
Incisalia irus	Frosted elfin
Junonia coenia	Common buckeye
Lethe anthedon	Northern pearly-eye
Melanoplus spp.	Spur-throated grasshoppers
Melanoplus keeleri luridus	Spur-throated grasshopper
Melanoplus punctulatus	A grasshopper
Melanoplus tepidus	A grasshopper
Mermiria bivitatta	A grasshopper
Mesamia straminea	Downy sunflower hopper
Monoleuca semifascia	Zig-zag slug moth
Neoconocephalus spp.	Cone-headed grasshopper
Nicrophorus americanus	American burying beetle
Oecanthus spp.	Tree crickets
Orchelimum sylvaticum	
Paectes abrostolella	A moth
Pagara simplex	A tiger moth
Papaipema eryngii	Rattlesnake-master borer moth

Latin Name	Common Name
Papaipema polymniae	Cup-plant borer moth
Paratylotropidea morsei	A grasshopper
Parasa indetermina	A slug moth
Pardalophora haldemani	A grasshopper
Pelocrista womonana	A leafroller moth
Peoria spp.	Grass moths
Peoria floridella	A grass moth
Peoria longipalpella	A grass moth
Peoria roseotinctella	A grass moth
Peoria tetradella	A grass moth
Phoebis sennae	Cloudless sulphur
Polyamia alboneura	A leafhopper
Polyamia brevipennis	A leafhopper
Polyamia dilata	A leafhopper
Polyamia herbida	A leafhopper
Polyamia saxosa	A leafhopper
Polyamia similaris	A leafhopper
Prairiana kansana	A leafhopper
Psuedopomala brachyptera	A grasshopper
Pyrausta laticlavia	Southern crimson moth
Pyrausta tyralis	Southern crimson moth
Pyristia lisa	Little sulphur
Schinia gloriosa	Blazingstar flower moth
Schinia jaguarina	A moth
Sideridis congermana	Boreal moth
Speyeria cybele	Great spangled fritillary
Speyeris diana	Diana fritillary
Spharagemon saxatile	A grasshopper
Tampa dimediatella	A moth
Texananus areolatus	A leafhopper
Texananus excultus	A leafhopper
Texananus rufusculus	A leafhopper
Texananus superbus	A leafhopper
Trimerotropis saxatilis	A grasshopper
Urola argentana	A moth
Vaxi critica	A moth
Xanthopastis timais	Spanish moth
Xubida panalope	A moth
Zale duplicata	A moth
Zerene cesonia	Dogface sulphur
OTHER INVERTEBRATES	
Dugesiella hentzi	Tarantula

APPENDIX II: COMPARISONS OF HERITAGE PROGRAMS, ECS, AND TNC ASSOCIATIONS

Hoosier National Forest

Heritage Program Natural Community	Ecological Classification System						
	Brown County Hills (222Em)		Crawford Uplands (222De, 222Df)				
	ELTP10	ELTP20	ELTP10	ELTP12	ELTP20	ELTP22	ELTP23
Dry upland forest	*5022*	*5022*	*2425, 5022*	*2149, 2391*	*2425, 5022*	*2149*	
Sandstone barrens			*2425*	*4062*			
Siltstone barrens	*5022*						
Limestone barrens							*2149, 2391, 5131*

2149 – Quercus stellata-Quercus marilandica-Quercus velutina-Carya texana/Schizachyrium scoparium woodland
2391 – Quercus stellata-Quercus marilandica/Schizachyrium scoparium wooded herbaceous vegetation
2425 – Quercus marilandica/Vaccinium arboreum/Danthonia spicata scrub woodland
4062 – Quercus marilandica-Juniiperus virginiana/Schiachyrium scoparium-Hypericum gentianoides wooded herbaceous vegetation
5022 – Quercus prinus/Smilax spp. Forest
5131 – Quercus muhlenbergii-Juniperus virginiana/Schiachyrium scoparium-Manfreda virginica wooded herbaceous vegetation

Shawnee National Forest

Heritage Program Natural Community	Illinois Ozarks (222A)	Cretaceous Hills (222C)	Shawnee Hills (222D)
Forest			
Xeric upland forest	*2401, 5022*		*2391, 2425, 5022*
Dry upland forest	*2150, 2401, 5022*	*4127*	*2150, 2391, 2425, 5022*
Prairie			
Loess hill prairie	*5131*		*5131*
Savanna			
Dry barren	*2149*	*2149*	*2149, 2391*
Dry-mesic barren		*4217*	
Mesic barren		*4217*	
Primary			
Sandstone glade			*4062*
Limestone glade	*5131*		*5131*
Shale glade	*2428*		

2149 – Quercus stellata-Quercus marilandica-Quercus velutina-Carya texana/Schizachyrium scoparium woodland
2150 – Quercus alba-Quercus stellata-Quercus velutina/Schizachyrium scoparium woodland
2391 – Quercus stellata-Quercus marilandica/Schizachyrium scoparium wooded herbaceous vegetation
2401 – Pinus echinata-Quercus velutina-Quercus stellata/Vaccinium spp. forest
2425 – Quercus marilandica/Vaccinium arboreum/Danthonia spicata scrub woodland
2428 – Quercus marilandica-(Juniperus virginiana)/Schizachyrium scoparium-Danthonia spicata wooded herbaceous vegetation
4062 – Quercus marilandica-Juniiperus virginiana/Schiachyrium scoparium-Hypericum gentianoides wooded herbaceous vegetation
4217 – Quercus stellata-Quercus alba-(Quercus falcata)/Schizachyrium scoparium woodland
5022 – Quercus prinus/Smilax spp. Forest
5131 – Quercus muhlenbergii-Juniperus virginiana/Schiachyrium scoparium-Manfreda virginica wooded herbaceous vegetation

Mark Twain National Forest

	Ecological Classification System											
	8		10	12		14	19	21		22	26	27
Heritage Program Natural Community	**Xeric chert forest**	**Dry savanna**	**Xeric chert forest**	**Xeric chert forest**	**Dry savanna**	**Xeric chert forest**	**Glade savanna**	**Dolomite glade**	**Limestone glade**	**Xeric limestone forest**	**Igneous glade**	**Xeric igneous forest**
FOREST												
Xeric limestone forest		*7833*					*5131*	*7833*	*5131*	*5131, 7489*		
Xeric chert forest	*2150, 2400, 2401, 7489*	*2393, 2394*	*2150, 2393, 2400, 2401, 7489*	*2150, 2393, 2400, 2401, 7489*	*2393, 2394*	*2150, 2400, 2401, 7489*				*7489*		
Xeric sandstone forest		*2150, 2391, 2393, 2394, 2400, 2401, 2425, 7489*			*2150, 2391, 2393, 2394, 2400, 2401*		*2150*					
Xeric igneous forest											*5203*	*2150, 2393, 2400, 2401, 2425, 5203*
SAVANNA												
Dry-mesic savanna		*2391, 2394*			*2391, 2394*							
Limestone savanna		*7833*			*7833*			*7833*	*7833*			

	Ecological Classification System											
	8		10	12		14	19	21		22	26	27
Heritage Program Natural Community	**Xeric chert forest**	**Dry savanna**	**Xeric chert forest**	**Xeric chert forest**	**Dry savanna**	**Xeric chert forest**	**Glade savanna**	**Dolomite glade**	**Limestone glade**	**Xeric limestone forest**	**Igneous glade**	**Xeric igneous forest**
Chert savanna	*2150*	*2149, 2393, 2394*	*2150*	*2150*	*214, 2393, 2394*	*2150*						
Sandstone savanna		*2149, 2150, 2391, 2393, 2394*			*2150, 2391, 2393, 2394*		*2150*					*2402*
Igneous savanna		*2393*			*3293*						*5203*	*2149, 2150, 2393, 2402, 5203*
PRAIRIE												
Dry chert prairie												
PRIMARY												
Limestone glade		*7833*			*7833*		*5131*	*7833*	*5131, 7833*	*5131*		
Dolomite glade		*7833*			*7833*			*7833*	*7833*			
Chert glade												
Sandstone glade		*2309, 4062*			*2309, 4062*		*2309, 4062*					*2402, 4062*
Shale glade							*2428*	*2428*	*2428*			
Igneous glade											*2243, 5203*	*2402, 5203*

2149 – Quercus stellata-Quercus marilandica-Quercus velutina-Carya texana/Schizachyrium scoparium woodland
2150 – Quercus alba-Quercus stellata-Quercus velutina/Schizachyrium scoparium woodland
2243 – Schizachyrium scoparium-Sorghastrum nutans-Corepsis lanceolata-Croton willdenowii wooded herbaceous vegetation
2309 – sandstone talus interior highlands sparse vegetation
2391 – Quercus stellata-Quercus marilandica/Schizachyrium scoparium wooded herbaceous vegetation

2393 – Pinus echinata-Quercus stellata-Quercus marilandica/Schizachyrium scoparium woodland
2394 – Pinus echinata-Quercus alba/Schizachyrium scoparium woodland
2400 – Pinus echinata/Vaccinium (arboreum, pallidum, stamineum) forest
2401 – Pinus echinata-Quercus velutina-Quercus stellata/Vaccinium spp. Forest
2402 – Pinus echinata/rock outcrop interior highland woodland
2425 – Quercus marilandica/Vaccinium arboreum/Danthonia spicata scrub woodland
2428 – Quercus marilandica-(Juniperus virginiana)/Schizachyrium scoparium-Danthonia spicata wooded herbaceous vegetation
4062 – Quercus marilandica-Juniiperus virginiana/Schiachyrium scoparium-Hypericum gentianoides wooded herbaceous vegetation
5131 – Quercus muhlenbergii-Juniperus virginiana/Schiachyrium scoparium-Manfreda virginica wooded herbaceous vegetation
5203 – igneous talus Ozark sparse vegetation
7489 – Pinus echinata-Quercus (alba, rubra)/Vaccinium (arboreum, pallidum)/Schizachyrium scoparium-Chasmanthium sessiliflorum-Solidago ulmifolia forest
7833 – Juniperus ashei/Cotinus obovatus/Carex eburnea-Rudbeckia missouriensis woodland

APPENDIX III: ECOLOGICAL SUB-REGIONS HAVING BARRENS AND GLADES.

As part of the effort to reduce biases in interpretation of natural communities, a hierarchical framework of natural regions is being developed (Keys *et al*. 1995). Among parameters being used to define these are geology, soils, topography, and vegetation. Within the framework, several eco-regional subsections occur in the area which encompasses the Hoosier, Shawnee, and Mark Twain National Forests. Those having the barrens community are briefly discussed below.

OZARK HIGHLANDS SECTION (222A) includes most of the uplands in southern Missouri, the northern quarter of Arkansas, and also extends into southeast Kansas, northeast Oklahoma, and extreme southwest Illinois. Nearly all of the Mark Twain is in the Ozarks, as is a modest portion of the Shawnee.

St. Francis Knobs and Basins (222Aa) are underlain by Precambrian igneous and Cambrian sedimentary rocks. There are prominent knobs of rounded, smooth-sided igneous mountains and hills; intervening smooth-floored basins on limestone and sandstone; and tracts of dissected topography typical of the surrounding areas. Local relief may be as much as 1,000 feet. Presettlement vegetation was a mixture of forests, open woodlands, glades, and small prairies. Potential vegetation includes little bluestem acidic glade, post oak-blackjack oak woodland, and black oak-scarlet oak forest.

Central Plateau (222Ab) is underlain by Ordovician cherty dolomites and sandstones. This is the least dissected part of the Ozarks. Lack of surface water and droughty soils are characteristic. Presettlement vegetation was mostly savanna or grassy woodland, and prairie. Potential vegetation includes little bluestem-Indian grass prairie, post oak-blackjack oak woodland, and black oak-scarlet oak forest.

Osage River Hills (222Ac) is underlain by Ordovician cherty dolomites and sandstones. Steep slopes, narrow ridges, and narrow valley bottoms dominate. Presettlement vegetation was deciduous forest and savanna. Potential vegetation includes post oak-blackjack oak woodland, black oak-white oak woodland, and white oak forest.

Gasconade River Hills (222Ad) is underlain by Ordovician cherty dolomites and sandstones. There are local karst features. Steep slopes, narrow ridges, and narrow valley bottoms dominate. Presettlement vegetation was a mixed (oak and pine) forest and savanna. Potential vegetation includes shortleaf pine-oak woodland, black oak-white oak woodland, and white oak forest.

Meramec River Hills (222Ae) is underlain by Cambrian and Ordovician cherty dolomites. There are local karst features. Steep slopes, narrow ridges, and narrow valley bottoms dominate. Presettlement vegetation was a mixed oak and pine forest and some savanna. Potential vegetation includes shortleaf pine-oak woodland, black oak-white oak woodland, and white oak forest.

Current River Hills (222Af) is underlain by Cambrian and Ordovician cherty dolomites and sandstones. There are local karst features. Steep slopes, narrow ridges, and narrow

valley bottoms dominate. Presettlement vegetation was a mixed forest oak and pine, and savanna. Potential vegetation includes shortleaf pine-oak woodland, black oak-scarlet oak woodland, and white oak forest.

White River Hills (222Ag) is underlain by Ordovician cherty dolomites. There are local karst features. Steep slopes, narrow ridges, and narrow valley bottoms prevail. Relief is up to 600 feet. Presettlement vegetation was a mosaic of oak and oak-pine forest and woodland, interspersed with extensive dolomite glade/savanna complexes. Potential vegetation includes little bluestem-sideoats grama alkaline glade, post oak-blackjack oak woodland, and white oak-black oak forest.

Inner Ozark Border (222Aj) is underlain by Ordovician cherty dolomites. Local relief ranges from 150 to 300 feet. Slopes are moderate, and bedrock exposures are common along larger streams. Loess mantles many ridges. Presettlement vegetation included oak woodland, extensive dolomite glade/savanna complexes, and small prairies. Potential vegetation includes little bluestem-sideoats grama alkaline glade, post oak-blackjack oak woodland, and white oak-black oak forest.

Outer Ozark Border (222Ak) is underlain by Paleozoic sedimentary rocks. Relief in this area is between 200 and 350 feet. Slopes are steep, and bedrock exposures are common. Loess mantles the uplands of the entire subsection. Presettlement vegetation included oak forest, savanna, glades, and prairies. Potential vegetation includes white oak-black oak woodland, white oak forest, and sugar maple-oak forest.

Black River Ozark Border (222Al) is underlain by Ordovician sandstones and cherty dolomites. There are moderately dissected hills with local relief of up to 300 feet. Presettlement vegetation was post oak flatwoods on loess covered divides, and mixed oak and pine woodlands on more dissected areas. Potential vegetation includes shortleaf pine-oak woodland, post oak-blackjack oak woodland, and oak-sweetgum forest.

Springfield Plain (222Am) is underlain by Mississippian limestone, some very cherty. There is well developed karst in several places. Relief is generally less than 150 feet. Presettlement vegetation was mostly prairie with timber along stream courses and in the more dissected border regions. Potential vegetation includes big bluestem-Indian grass prairie, little bluestem-Indian grass prairie, and post oak-blackjack oak woodland.

Illinois Ozarks (222Aq) is underlain by Devonian and Mississippian cherty limestones. Hills are deeply dissected with up to 500 feet of local relief. Presettlement vegetation was mostly white oak, black oak, and hickories. Potential vegetation includes white oak-black oak forest, shortleaf pine-oak forest, little bluestem-sideoats grama glade, and beech-sugar maple forest.

UPPER GULF COASTAL PLAIN SECTION (222C) extends from western Tennessee through western Kentucky to extreme southern Illinois. Barrens occur in the Cretaceous Hills on the Shawnee.

Cretaceous Hills (222Ca) is underlain by Mississippian limestones, and Cretaceous and Tertiary clay, sand, and gravel. Topography is primarily low knobs and ridges, with less

than 100 feet of local relief. Presettlement vegetation was extensive barrens dominated by warm-season grasses and oak brush. Potential vegetation includes white oak-red oak forest, southern red oak-mixed oak forest, post oak-mixed oak barrens.

INTERIOR LOW PLATEAU, SHAWNEE HILLS SECTION (222D) extends across southern Illinois, through central Kentucky, and southwestern Indiana. Most of the Shawnee and Hoosier are in the Shawnee Hills.

Crawford Uplands (222De) is underlain by Mississippian and Pennsylvanian sandstone and shale. Topography is well dissected with some broad ridges. Local relief approaches 200 feet in some areas. Presettlement vegetation was dominated by white oak and beech. Potential vegetation includes white oak-red oak forest and beech-sugar maple forest.

Crawford Escarpment (222Df) is underlain by Mississippian sandstones, shales, and limestones. Topography is moderately dissected. Local relief is about 150 feet. The presettlement forest was dominated by beech and white oak. Potential vegetation includes white oak-red oak forest and beech-sugar maple forest.

Greater Shawnee Hills (222Dh) is underlain by Pennsylvanian sandstones. Topography is well dissected with some broad ridges. Local relief approaches 300 feet in some areas. Presettlement vegetation included a variety of oaks, hickories, sugar maple and beech. Potential vegetation includes white oak-red oak forest, post oak-blackjack oak forest, and blackjack oak-redcedar glades.

Lesser Shawnee Hills (222Di) is underlain by Mississippian sandstones, limestones, and shales. Topography is moderately dissected. Local relief is about 200 feet. The presettlement forest was dominated by beech, black oak, and white oak. Potential vegetation includes white oak-red oak forest, post oak-blackjack oak forest, and blackjack oak-redcedar glades.

INTERIOR LOW PLATEAU, HIGHLAND RIM SECTION (222E) is centered in central Tennessee, reaching its southern limit in northern Alabama, covering much of south-central Kentucky, and extending a peninsula into south-central Indiana. About a third of the Hoosier is on the Highland Rim.

Mitchell Karst Plain (222Ek) is underlain by Paleozoic carbonates. Topography is relatively flat, but karst feature are abundant. Presettlement vegetation included large tracts of treeless barrens. Where trees were present, they included beech, sugar maple, and white oak. Potential vegetation includes white oak-red oak forest, little bluestem-sideoats gramma glade, and beech-sugar maple forest.

Brown County Hills (222Em) is underlain by Paleozoic shales and siltstones. Topography is deeply dissected with narrow ridges, steep slopes, and narrow valleys. Local relief is about 150 feet. Presettlement vegetation was dominated by white oak, beech, and black oak. Potential vegetation includes upland oak-hickory forest, beech-sugar maple forest, and chestnut oak-mixed oak forest.

TABLES

Table 1a. Regional Forester Sensitive Species that may be found in barrens: Plants.

Common Name	Latin Name	Hoosier	Mark Twain	Shawnee
FERNS				
Engelmann's adder's-tongue fern	***Ophioglossum engelmannii***	**R**	**+**	**+**
MONOCOTS				
Ofer Hollow reed-grass	*Calamagrostis porteri insperata*		R	R
Blazing-star	*Chamaelirium luteum*			R
Cluster fescue	***Festuca paradoxa***	**R**	**+**	**R**
Crested coralroot	*Hexalectris spicata*		+	R
Small whorled pogonia	*Isotria medeoloides*		X	
Whorled pogonia	*Isotria verticillata*	+	R	R
Ravenel's witchgrass	*Panicum* (*Dichanthelium*) *ravenelii*		+	R
Featherbells	***Stenanthium gramineum***	**R**	**+**	**R**
DICOTS				
Eared false-foxglove	*Agalinis auriculata*		R	
Purple false-foxglove	*Agalinis skinneriana*		R	
Mead's milkweed	*Asclepias meadii*		LT	LT
Tradescant aster	*Aster dumosus strictior*		R	+
Bluehearts	*Buchnera americana*	*	+	R
Bush's poppy-mallow	*Callirhoe bushii*		R	
Ozark chinquapin	*Castanea pumila ozarkensis*		R	
Yellowwood	*Cladrastis lutea*		+	R
Trelease's larkspur	*Delphinium treleasei*		R	
Trailing tick-trefoil	*Desmodium humifusum*	R		
Yellow coneflower	*Echinacea paradoxa paradoxa*		R	
Wavyleaf coneflower	*Echinacea simulata*		R	R
White thoroughwort	*Eupatorium album*	R		
Yellowish gentian	***Gentiana alba***	**R**	**+**	**R**
Silphium sunflower	*Helianthus silphioides*		+	R
Baldwin's milkvine	*Matelea baldwiniana*		R	
Yellow honeysuckle	*Lonicera flava*		R	
Phyllanthus	*Phyllanthus polygonoides*		R	
Pink milkwort	*Polygala incarnata*		+	R
Prairie parsley	***Polytaenia nuttallii***	**R**	**+**	**+**
White-leaved mountain mint	*Pycnanthemum albescens*		+	R
Torrey mountain mint	*Pycnanthemum torrei*			R
Orange coneflower	*Rudbeckia fulgida speciosa*		R	
Sullivant's Coneflower	*Rudbeckia fulgida sullivantii*			R
Narrow-leaf pink	*Sabatia brachiata*		R	
Bush's skullcap	*Scutellaria bushii*		R	
Small skullcap	*Scutellaria parvula parvula*	R	+	+
Royal catchfly	*Silene regia*		R	
Prairie-dock	*Silphium pinnatifidum*			R
Whorled rosinweed	*Silphium trifoliatum*	+		R
Gattinger's goldenrod	*Solidago gattingerii*		R	
Buffalo clover	*Trifolium reflexum*		+	R

Running buffalo clover	*Trifolium stoloniferum*		LE	
Deerberry	*Vaccinium stamineum*	+	+	R
Ozark corn-salad	*Valerianella ozarkana*		R	
Barren strawberry	*Waldsteinia fragarioides*	R	R	R

Table 1b. Regional Forester Sensitive Species which may be found in barrens: Animals.

Common Name	Latin Name	*Hoosier*	*Mark Twain*	*Shawnee*
MAMMALS				
Gray wolf	Canis lupus	X	X	X
Eastern cougar	Felis concolor cougar	X	X	X
Bobcat	Lynx rufus	R	+	+
Southeastern myotis	*Myotis austroriparius*	X		R
Indiana bat	*Myotis sodalis*	LE	LE	LE
Evening bat	*Nycticeius humeralis*	R	+	+
BIRDS				
Bachman's Sparrow	*Aimophila aestivalis*	X	R	X
Henslow's Sparrow	*Ammodramus henslowii*	R	R	R
Cerulean Warbler	*Dendroica cerulea*	R	R	R
Loggerhead Shrike	*Lanius ludovicianus*	R	R	R
REPTILES				
Timber rattlesnake	*Crotalus horridus*	R	+	R
INSECTS				
Bell's roadside skipper	*Amblyscirtes belli*	R	+	
Swamp metalmark	*Calephelis mutica*	R	+	
Mottled duskywing	***Erynnis martialis***	**R**	**+**	
American burying beetle	*Nicrophorus americanus*	X	X	

R – Regional Forester Sensitive Species
X – extirpated from this Forest
+ - occurs on this Forest but not listed as RFSS
* - recently discovered on Forest but not yet listed as RFSS
LE – federally listed as endangered species
LT – federally listed as threatened species
BOLD – priority species for conservation assessment

Table 2. Ecoregions, subsections, and substrates of barrens: total number of sites and acres; number of NFS sites and acres (based on state heritage program data). Additional areas are recognized by each Forest and state, but are not included in these acreage totals.

Ecoregion	Gravel	Sandstone/ siltstone	Shale	Limestone/ Calcareous shale	Dolomite	Chert	Igneous	Loess
Ozark Highlands								
St.Francis Knobs and Basins		1; 10 ac. None NFS			1; 13 ac. None NFS		36; 2988 ac. 14; 1691 ac.	
Central Plateau					13; 180 ac. 3; 81	7; 845 ac. None NFS		
Osage River Hills		4; 420 ac. None NFS		2; 44 ac. None NFS	55; 861 ac. None NFS	19; 2403 ac. None NFS		
Gasconade River Hills		3; 25 ac. 2; 19 ac.			2; 72 ac. 1; 11 ac.	2; 157 ac. None NFS		
Meramec River Hills		2; 8 ac. None NFS			16; 212 ac. None NFS	7; 416 ac. None NFS		
Current River Hills					36; 335 ac. 8; 55 ac.		8; 326 ac. None NFS	
White River Hills				9; 95 ac. 3; 5 ac.	34; 927 ac. 18; 411 a.	2; 1342 ac. None NFS		
Inner Ozark Border		7; 37 ac. None NFS			31; 1955 ac. None NFS			
Outer Ozark Border		11; 32 ac. None NFS		6; 75 ac. None NFS	4; 62 ac. None NFS	1; 4 ac. None NFS		
Black River Ozark Border					1; 3 ac. None NFS			
Springfield Plain		4; 61 ac. None NFS		9; 52 ac. None NFS	2; 10 ac. None NFS	17; 85 ac. None NFS		
Illinois Ozarks			2; 5 ac. None NFS	2; 11 ac. 1; 9 ac.		3; 28 ac. 1; 10 ac.		
Upper Gulf Coastal Plain								
Cretaceous Hills	8; 70 ac. All NFS							
Ecoregion	**Gravel**	**Sandstone/**	**Shale**	**Limestone/**	**Dolomite**	**Chert**	**Igneous**	**Loess**

		siltstone		**Calcareous shale**				
Shawnee Hills								
Crawford Upland		6; 22 ac. 2; 3 ac.		10; 61 ac. All NFS				
Crawford Escarpment				10; 84 ac. None NFS				
Greater Shawnee Hills		19;281 ac 11; 217 ac.		4; 6 ac. All NFS				1; 19 ac. All NFS
Lesser Shawnee Hills		14 ac. None NFS		16; 61 ac. 4; 28 ac.				
Highland Rim								
Mitchell Karst Plain		2; 12 ac. None NFS		16; 55 ac. None NFS		5; 75 ac None NFS		
Brown County Hills		5; 15 ac. 2; 7 ac.						

Table 3. Dominant species of barrens on various substrates in ecological subsections.

St. Francis Knobs and Basins	
Igneous barrens	*Quercus stellata--Quercus alba--Quercus marilandica*/*Agrostis elliottiana*
Igneous glade	*Schizachyrium scoparium--Danthonia spicata*/*Quercus velutina--Carya ovata*
Dolomite glade	*Schizachyrium scoparium--Panicum virgatum*/*Quercus stellata*
Central Plateau	
Dolomite barrens	*Quercus stellata--Quercus marilandica--Quercus velutina*
Dolomite glade	Schizachyrium scoparium--Panicum virgatum--Bouteloua curtipendula/Quercus stellata--Quercus marilandica
Gasconade River Hills	
Sandstone barrens	*Quercus marilandica--Quercus stellata--Quercus alba*/*Cladonia* spp.
Dolomite glade	*Schizachyrium scoparium--Sorghastrum nutans*/*Quercus stellata*
Dolomite barrens	*Quercus stellata*/ *Schizachyrium scoparium--Sorghastrum nutans*
Meramec River Hills	
Dolomite barrens	Quercus stellata--Q. velutina/Andropogon gerardii--Schizachyrium scoparium
Current River Hills	
Dolomite barrens	*Sorghastrum nutans--Andropogon gerardii/Pinus echinata--Quercus coccinea--Q. marilandica--Q. stellata*
Igneous barrens	Schizachyrium scoparium--Andropogon gerardii--Danthonia spicata/Quercus stellata--Pinus echinata--Q. marilandica
White River Hills	
Dolomite glade	*Schizachyrium scoparium--Panicum virgatum--Bouteloua curtipendula*
Dolomite barrens	*Quercus stellata*
Outer Ozark Border	
Sandstone barrens	Schizachyrium scoparium--Andropogon ternarius/Pinus echinata
Illinois Ozarks	
Limestone barrens	*Quercus muehlenbergii--Quercus stellata--Juniperus virginiana*/*Bouteloua curtipendula*
Chert barrens	*Quercus stellata*/*Vaccinium arboreum*/*Flavoparmelia* spp.
Gravel barrens	Quercus marilandica--Pinus echinata/Vaccinium arboreum

Cretaceous Hills

Gravel barrens	Quercus velutina--Q. falcata/Cladina spp./Danthonia spicata--Schizachyrium scoparium

Crawford Uplands

Sandstone barrens	*Quercus alba*/*Panicum dichotomum--Danthonia spicata*
Sandstone barrens	*Quercus prinus*/*Smilax rotundifolia*
Limestone barrens	*Quercus stellata*/*Sorghastrum nutans--Andropogon gerardii*
Sandstone glade	*Quercus prinus*/*Vaccinium arboreum*/*Cladonia* spp.

Crawford Escarpment

Limestone barrens	Quercus stellata/Schizachyrium scoparium--Sorghastrum nutans

Greater Shawnee Hills

Loess barrens	*Schizachyrium scoparium--Andropogon gerardii*
Sandstone barrens	*Quercus marilandica*/*Schizachyrium scoparium--Aristida purpurascens--Sorghastrum nutans*
Sandstone barrens	*Quercus prinus*/*Vaccinium arboreum*/*Schizachyrium scoparium*
Sandstone barrens	*Quercus stellata--Quercus alba*/*Danthonia spicata*
Limestone barrens	Quercus muehlenbergii/Andropogon gerardii

Lesser Shawnee Hills

Limestone glade	*Sorghastrum nutans--Bouteloua curtipendula--Schizachyrium scoparium*
Sandstone barrens	Quercus muehlenbergii--Quercus alba--Quercus stellata/Rhus aromatica

Mitchell Karst Plain

Limestone barrens	*Quercus stellata*/*Andropogon gerardii*

Brown County Hills

Siltstone barrens	*Quercus prinus*/*Vaccinium pallidum--Smilax rotundifolia*/*Carex picta--Danthonia spicata*

Table 4. Management area designations of barrens communities on the Hoosier.

	Management Area*	Acres**	Subsection	Substrate
Harding Flats	8.2	782	Crawford Upland	limestone
Clover Lick	8.2	1,658	Crawford Upland	limestone/sandstone
Buzzard Roost	8.2	454	Crawford Upland	limestone
Rockhouse Hollow	8.2	201	Crawford Upland	limestone/sandstone
Boone Creek	8.2	700	Crawford Upland	limestone/sandstone
Carnes Mill	8.2	280	Crawford Upland	sandstone
Plaster Creek	8.2	568	Crawford Upland	sandstone
Faucett Chapel	8.2	89	Crawford Escarpment	limestone
Browning Hill	8.2	Possible	Brown County Hills	siltstone
Charles C. Deam Wilderness	5.1	Possible	Brown County Hills	siltstone
Fork Ridge	2.8	25	Brown County Hills	siltstone
Kurtz Hill	2.8	10	Brown County Hills	siltstone

* **Management Area 8.2** on the Hoosier designates special areas that include unique or unusual ecological, botanical, zoological, geological, scenic, historic, prehistoric, and other areas that merit special recognition and management. Management of these areas will emphasize the protection, perpetuation, or restoration of their special features and values. Vegetation management will occur only to accomplish the purpose of special area designation and to meet the needs of Federal endangered, threatened, and sensitive species.

** acres in management area is not necessarily limited to barrens community

Table 5. Management area designations of barrens communities on the Shawnee.

	Management Area*	Acres**	Subsection	Substrate
Atwood Ridge	8.2	955	Illinois Ozarks	gravel
Barker Bluff	8.2	60	Lesser Shawnee Hills	limestone
Bell Smith Springs	8.2	1,260	Greater Shawnee Hills	sandstone
Burke Branch	8.2	300	Cretaceous Hills	sand
Caney Branch Barrens	5.1	48	Greater Shawnee Hills	sandstone
Cave Hill	8.2	465	Greater Shawnee Hills	sandstone/loess
Cedar Bluff	8.2	285	Greater Shawnee Hills	sandstone
Copperous Branch	8.2	26	Lesser Shawnee Hills	limestone
Cretaceous Hills	8.2	200	Cretaceous Hills	gravel/loess
Dean Cemetery East	8.2	20	Cretaceous Hills	gravel/loess
Dennison Hollow	8.2	315	Greater Shawnee Hills	sandstone
Dog Creek	8.2	74	Cretaceous Hills	gravel/loess
Double Branch Hole	8.2	85	Greater Shawnee Hills	sandstone
Draper's Bluff	8.2	334	Greater Shawnee Hills	sandstone
Garden of the Gods	5.1	95	Greater Shawnee Hills	sandstone
Gyp Williams Hollow	8.2	320	Greater Shawnee Hills	sandstone/loess
Horse Cave Area	8.2	33	Greater Shawnee Hills	sandstone
Jackson Hollow	8.2	289	Greater Shawnee Hills	sandstone
Keeling Hill South	8.2	45	Lesser Shawnee Hills	limestone
Kickasola Cemetery	8.2	36	Cretaceous Hills	gravel/loess
Klondike Springs			Cretaceous Hills	gravel/loess
Larue Pine Hills/ Otter Pond	8.2	2,811	Illinois Ozarks	limestone/chert
Leisure City Barrens	9.2	4	Lesser Shawnee Hills	limestone
Little Grand Canyon /Horseshoe Bluff	8.2	1,023	Greater Shawnee Hills	sandstone
Lusk Creek Canyon	9.2	253	Greater Shawnee Hills	sandstone
Millstone Bluff	8.3	85	Lesser Shawnee Hills	limestone
Odum Tract	8.2	50	Greater Shawnee Hills	sandstone
Opossum Trot Trail	8.2	45	Illinois Ozarks	limestone/loess
Ozark Hill Prairie	9.3	535	Illinois Ozarks	limestone/loess
Panther Hollow	8.2	180	Greater Shawnee Hills	sandstone
Pine Hollow	8.2	90	Greater Shawnee Hills	sandstone
Pleasant Valley Limestone Barrens	8.2	4	Lesser Shawnee Hills	limestone
Poco Cemetery East	8.2	34	Cretaceous Hills	gravel/loess
Poco Cemetery North	8.2	22	Cretaceous Hills	gravel/loess
Pounds Hollow	8.2	197	Greater Shawnee Hills	sandstone
Russell Cemetery Barrens	8.2	18	Greater Shawnee Hills	sandstone
Simpson Township Barrens	8.2	65	Lesser Shawnee Hills	limestone
Stoneface	8.2	175	Greater Shawnee Hills	sandstone/loess
Trigg Tower Sandstone Barrens	8.2	197	Lesser Shawnee Hills	sandstone
Whoopie Cat Mountain	8.2	48	Lesser Shawnee Hills	limestone
Wolf Creek Area	8.2	495	Illinois Ozarks	gravel

Table 6. Management area designations of barrens communities on the Mark Twain.

	Management Area*	Acres**	Subsection	Substrate
AA Glade	3.4	8	Current River Hills	dolomite
Bald Hill Glade	8.1	55	Central Plateau	dolomite
Beaver Creek Hollow	6.3	2	White River Hills	limestone
Bell Mountain	5.1	321	St. Francis Knobs and Basins	igneous
Bell Mountain	5.1	7	St. Francis Knobs and Basins	igneous
Bell Mountain	5.1	106	St. Francis Knobs and Basins	igneous
Boundary Line Glade		23	White River Hills	dolomite
Braddock Glade		5	White River Hills	dolomite
Brown Mountain	6.1	192	St. Francis Knobs and Basins	igneous
Buffalo Branch Glades		8	Central Plateau	dolomite
Butler Hollow Glades	8.1	35	White River Hills	dolomite
Cedar Creek Glades		6	White River Hills	dolomite
Cedar Mountain		25	St. Francis Knobs and Basins	igneous
Cottoner Mountain		23	St. Francis Knobs and Basins	igneous
Crane Hollow Glade		6	White River Hills	dolomite
Devil's Backbone Glade	5.1	3	Current River Hills	dolomite
Eleven Point River	8.1	8	Current River Hills	dolomite
Haden Bald		18	White River Hills	dolomite
Hercules Glade	5.1	51	White River Hills	dolomite
Irish – White's Creek	8.1	4	Current River Hills	dolomite
Johnson Mountain	6.3	222	St. Francis Knobs and Basins	igneous
Kaintuck Hollow		6	Gasconade River Hills	limestone
Ketcherside Mountain		228	St. Francis Knobs and Basins	igneous
Kinnard Glade		8	Current River Hills	dolomite
Lee Hollow Glades		15	Current River Hills	dolomite
Little Matthews Mountain		100	St. Francis Knobs and Basins	igneous
Lower Rock Creek		65	St. Francis Knobs and Basins	igneous
Marlow Mountain		32	St. Francis Knobs and Basins	igneous
McAdoo Creek Glades		50	White River Hills	dolomite
McClurg Glades		30	White River Hills	dolomite
Medley Hollow	8.1	8	Current River Hills	dolomite
Midco Glade	6.3	1	Current River Hills	dolomite
Mill Creek Glade		11	Gasconade River Hills	dolomite
MO-AR State Line		41	White River Hills	dolomite
Otter Creek Glade		38	White River Hills	dolomite
Patterson Mountain	6.3	334	St. Francis Knobs and Basins	igneous
Pine Hollow Glades		2	White River Hills	limestone
Pine Hollow Ridge		1	White River Hills	limestone
Piney Creek	5.1	18	White River Hills	dolomite
Piney Creek	5.1	8	White River Hills	dolomite
Piney Creek	5.1	11	White River Hills	dolomite
Roaring River		8	White River Hills	dolomite
Rock Creek Glade	6.3	28	White River Hills	dolomite
Smith Hollow Glades		29	White River Hills	dolomite
Solomon Hollow Glade		13	Gasconade River Hills	sandstone
South Ance Creek Glade		6	White River Hills	dolomite
Twisted Oak Glades		18	Central Plateau	dolomite
Van East Mountain	6.1	21	St. Francis Knobs and Basins	igneous
Van East Mountain	6.1	15	St. Francis Knobs and Basins	igneous