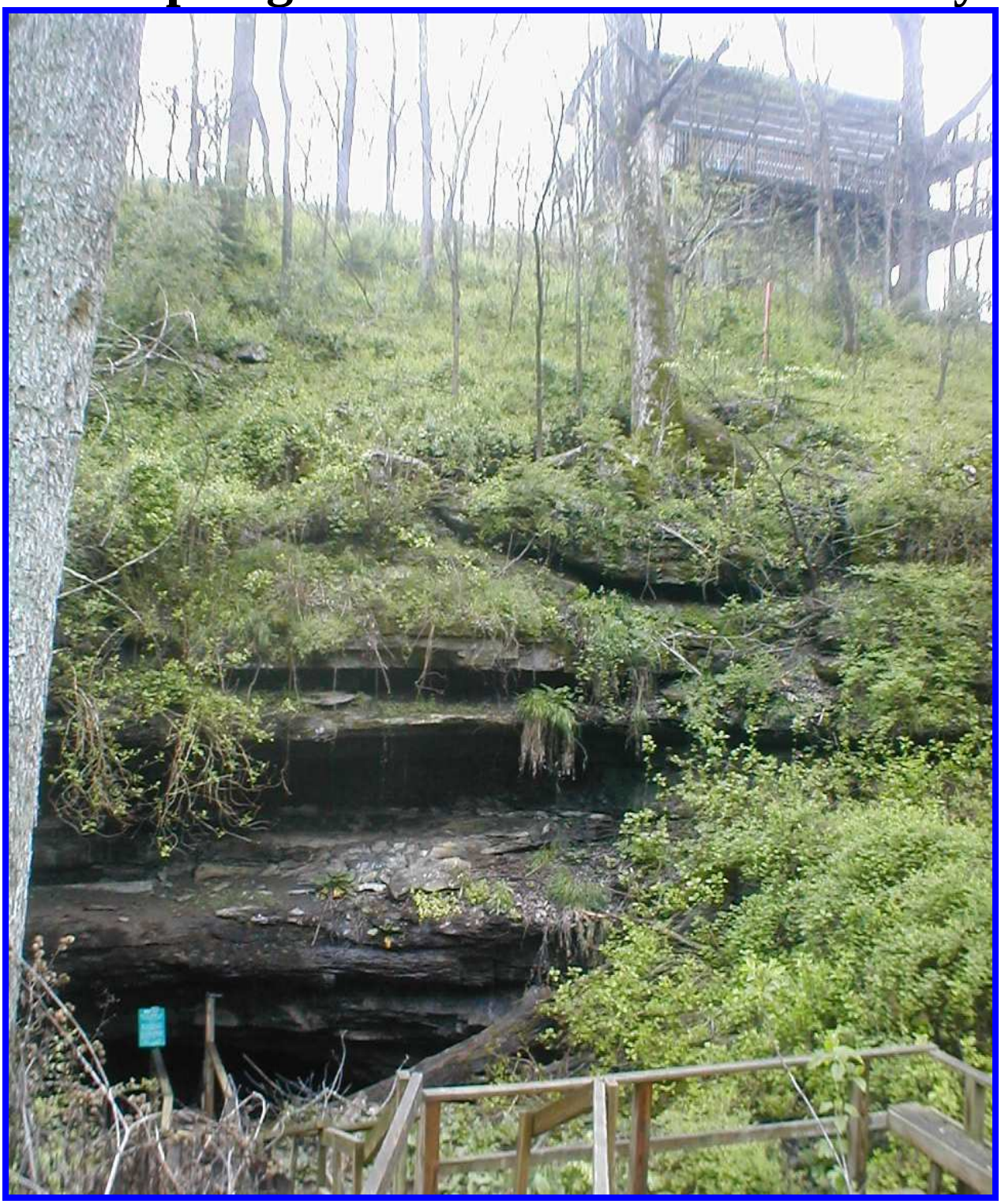
Cave Spring Cavern: Botanical Inventory



Julian Campbell & Associates

Cave Spring Cavern Educational Reserve: Botanical Inventory

(near Smiths Grove, Warren County)

Prepared for Western Kentucky University and the Kentucky Heritage Land Conservation Fund

Final Report, July 2009

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[Cover photo shows older bitternut hickory to left and younger woods above cave below house]

Introduction

Cave Spring Cavern (also known as Crump Cave) is in northeastern Warren County, about a mile northeast of downtown Smiths Grove. It is a well known cave that has been studied and enjoyed by residents and visitors for many decades. Its position in the transition between watersheds of the main stem of Green River and its tributary, the Barren River, has provided much interest for hydrology, subterranean ecology and associated environmental issues. The recent acquisition of its entrance by Western Kentucky University will aid in protection of ecological conditions and rare animals within the cave. The tract of land around the entrance covers about two acres, including most of the wooded sinkhole with the cave, plus some fringing uplands with more open grassy vegetation and fencerows.

The following botanical report on this site is based largely on four trips between April and July, 2009. In addition, previous biological information from this region has been reviewed. Included with this report are lists of species (mostly in appendices), together with provisional maps of the site and its context, bigger trees and other features.

Site Context: geology, soil and regional significance

Cave Spring Cavern lies within the Pennyrhile Karst Plain section of the Mississippian Plateaus (Figure 1). This region comprises the relatively flat or gently rolling land between the Green River Hills to the southeast and the Shawnee Hills to the northwest. It lies mostly on limestones of Upper Mississippian age: in the lower member of the Girkin Formation (which is also known as a part of the Golconda Formation). This whole karst plain is drained mostly by the Green River and the Cumberland River. The Smiths Grove area itself is drained by the Barren River, which is a major tributary of the Green.

The Pennyrhile Karst Plain varies in subtle ways due to geological patterns, various degrees of soil development, topography and drainage, above and below ground. The STATSGO mapping of NRCS, as interpreted here (Figure 1), distinguishes four variants as soil-associations. Together with information from the more detailed soil surveys of Warren County (Barton et al. 1981) and adjacent counties, these four variants can be outlined as follows. Typical soil classes and series are listed (with some older names after "/" marks); series mapped extensively in the Smiths Grove area or nearby in similar topography are indicated in **bold**.

(a) Relatively pure and mostly well-drained limestone soils, with loess caps: mostly paleudalfs (**Pembroke**, **Crider**) and locally fragiudalfs (Nicholson). Karst is locally intense. NRCS (Barton et al. 1981; and STATSGO) mapped the "Pembroke-Crider-(Nicholson)" association to the west of Smiths Grove, covering much of western Warren Co. and southern portions of Logan, Todd and Christian Counties.

(b) More cherty, well-drained limestone soils, with loess caps: mostly paleudalfs (**Hammack**, **Baxter**, **Crider**) and locally hapludalfs (Fredonia). Karst is locally intense. NRCS mapped "Hammack-Baxter-(Crider)" associations across much of the Smiths Grove area in eastern Warren Co. and a little in adjacent Edmonson Co. Further east, NRCS mapped the "Baxter-

Crider-Fredonia" association across much of northern Barren and southern Hart Counties where the land is slightly more hilly, with more frequent rocky soils (Fredonia). Barton et al. (1981) indicated that a "Hammack-Baxter" association was relatively distinct in Warren Co. and limited to about 7000 acres around Oakland and Smiths Grove. Local farmers often consider that this is the best farmland within the county—or even within the whole karst plain region (J. Blubaugh, pers. comm.). The Baxter soil series tends to be more acid than less cherty soils (a). However, Hammack is the only upland soil series in the county reported to have generally "high natural fertility" as opposed to "moderate" or "low" (Barton et al. 1981). Early settlers attributed this local fertility to regular roosts of passenger pigeons in the woodlands of this area; see notes below under Land Use History.

(c) Somewhat damper cherty limestone soils, with loess caps but more deeply weathered and with extensive fragipans in places: paleudalfs (**Baxter**), paleudults (**Mountview**), fragiudalfs (Nicholson) and fragiudults (**Dickson**). Karst is generally less intense. NRCS mapped the "Baxter-Mountview-Dickson" association extensively across most of the southeastern side of the Pennyrile Karst Plain in Kentucky.

(d) Less well-drained depressions or high terraces, generally with deeply weathered/cherty soils but overlain by loess or local alluvium: mostly fluvaquents (Melvin), fragiudalfs (Nicholson, Lawrence), fragiudults (Dickson), paleudalfs (Crider, Baxter). Karst is generally not developed, with broad depresssions instead filled by slowly draining sediments and surrounding fragipans. NRCS mapped several local soil associations with these series across the Pennyrile Karst Plain, especially on the southeastern side.

More locally, there are also distinct soil-associations in small areas on more dissected topography within the karst plain, especially outlying knobs, and along drains or around sinks. These include areas with more hapludalfs (Fredonia, Caneyville), which predominate to the north and west on outlying knobs and in foothills of the Shawnee Hills. Larger floodplains can be mapped as azonal features, mostly with eutrochrepts (Nolin) and fluvaquents (Newark).

Before settlement, vegetation on the karst plain was mostly grassland or open woodland. An extensive review of historical references to these “barrens” was provided by Campbell (1999); see Appendix Four. This vegetation has largely disappeared, but small remnants or native vegetation and more conservative species can still be found at scattered sites.

The Barren River watershed has been considered for a major concentration of effort to protect, conserve and restore aquatic systems, together with selected subterranean and terrestrial sites. A Conservation Reserve Enhancement Program of NRCS and partners has been extended in recent years from the Green River watershed into the Barren River watershed. Attention to such interests is, to some extent, also aided by the central location of Bowling Green within this watershed, together with programs of Western Kentucky University. However, the highly disturbed and fragmented nature of the Barren River watershed, as well as extensive farming or development of the land, provide severe challenges for “nature conservation” as classically conceived. The karst plain section of the Barren River watershed includes some relatively well-preserved stream corridors, with strips of woods and some caves of special interest: along the

main stem, also lower Brush Creek, lower Trammel Fork and Drakes Creek. There are also some scattered wetlands with considerable significance, including various wooded or open marshy types.

Cave Springs Cave itself is a rather isolated natural feature within this landscape, but it is significant due to its use by endangered bat species (Indiana bat, Gray bat), the cave crayfish (*Orconectes pellucidus*) and no doubt other rare invertebrates. The woods around the cave have been highly disturbed but there are some large trees, and several somewhat conservative woodland plants, as documented below. About two miles to the east and to the west, there are some low hills with more woodland, and further exploration of the Smiths Grove neighborhood might be warranted to see if a local program for conservation and related education could integrate some of these features.

Rare or conservative plant species that are known to still exist in (or adjacent to) the karst plain section of the Barren River include Eggert's sunflower (*Helianthus eggertii*) and Ozark least trillium (*T. ozarkanum*), which are both globally rare (G3 more or less). The flora of Warren County was originally studied in detail by Sadie Price (1893). There has been much further documentation in recent decades thanks to Kenneth Nicely, together with his students and successors at the herbarium of Western Kentucky University, now under the expert management of Robert Neidlinger and direction of Dr. Larry Alice.

Figure 1 (next two pages). Barren River watershed, showing location of site in relation to (a) Landtype Associations (LTAs) and (b) overall land use.

The legend for (a) is as follows.


K1. N. Shaley Karst Plain Transition
K11. Eastern Karst Plain
K12. Eastern Karst Plain (wet)
K2. Northern Karst Plain
K3. Nolin Karst Plain
K4. Slumped-sand Karst Plain
K5a. Dissected Calcareous Plain (cherty uplands)
K5b. Calcareous Hills
K5b. Calcareous Hills (gentler)
K5c. Dissected Calcareous Plain (cherty hills)
K5d. High Terrace/Calcareous Plain
K5e. W Pennyrile Cherty Hills
K6a. Pennyrile Karst Plain (damper cherty)
K6b. Pennyrile Karst Plain (cherty)
K6c. Pennyrile Karst Plain (loessic)
K7a. Pennyrile Karst Plain (pure)
K7b. Pennyrile Karst Plain (some chert)
K7c. Pennyrile Karst Plain (cherty)
K7d. Pennyrile Karst Plain (shaley)
K8a. Pennyrile Karst Plain (damp)
K8b. Pennyrile Karst Plain Wetlands
L1. Dripping Springs Hills (dissected)
L1b. Dripping Springs Ravines
L1c. Dripping Springs Hills (dissected calcareous)
L2. Dripping Springs Hills (loessic)
L2c. Dripping Springs Hills (calcareous)
L3. Slumped-sand Ridge
L4. Slumped-sand Ridge
L5. Dissected Sandy Calcareous Plain
L6. Damp Sandy Calcareous Plain
L7. Dissected Sandy Plain
L8. Damp Sandy Plain
M1a. Loessic Sandstone Ravines
M1b. Loessic Sandstone Hills
M2. Loess-covered Sandstone Uplands
M3. Loess-covered Sandstone Uplands
M4. Loess-covered Sandstone Uplands
M5a. Tradewater River Bottomlands (ponded)
M5b. Tradewater River Wetlands
M5c. Outer Shawnee Hills Bottomlands
M6a. Inner Shawnee Hills Bottomlands (ponded)
M6b. Inner Shawnee Hills Wetlands
M6d. Outer Shawnee Hills Wetlands
M6e. Central Green River Valley
M7a. Deep Loessic Sandstone Uplands
M7b. Deep Loessic Sandstone Hills
M8a. Deep Loess Rolling Uplands
M8b. Deep Loess Hills
M8c. Deep Loess Terraces
M9. Mined Shawnee Hills
S1. C Tennessee Basin (rocky)
S2. C Tennessee Basin (cherty transition)
S2b. C Tennessee Basin (cherty escarpment foothills)
Y1. Bottomland in Shawnee Hills
Y3. Lower Cumberland River Bottomland
Y5. Central Cumberland River Bottomland
Z. Water

Barren River Watershed LTAs: showing location of Cave Springs Cavern; see previous page for color-coding of LTAs.

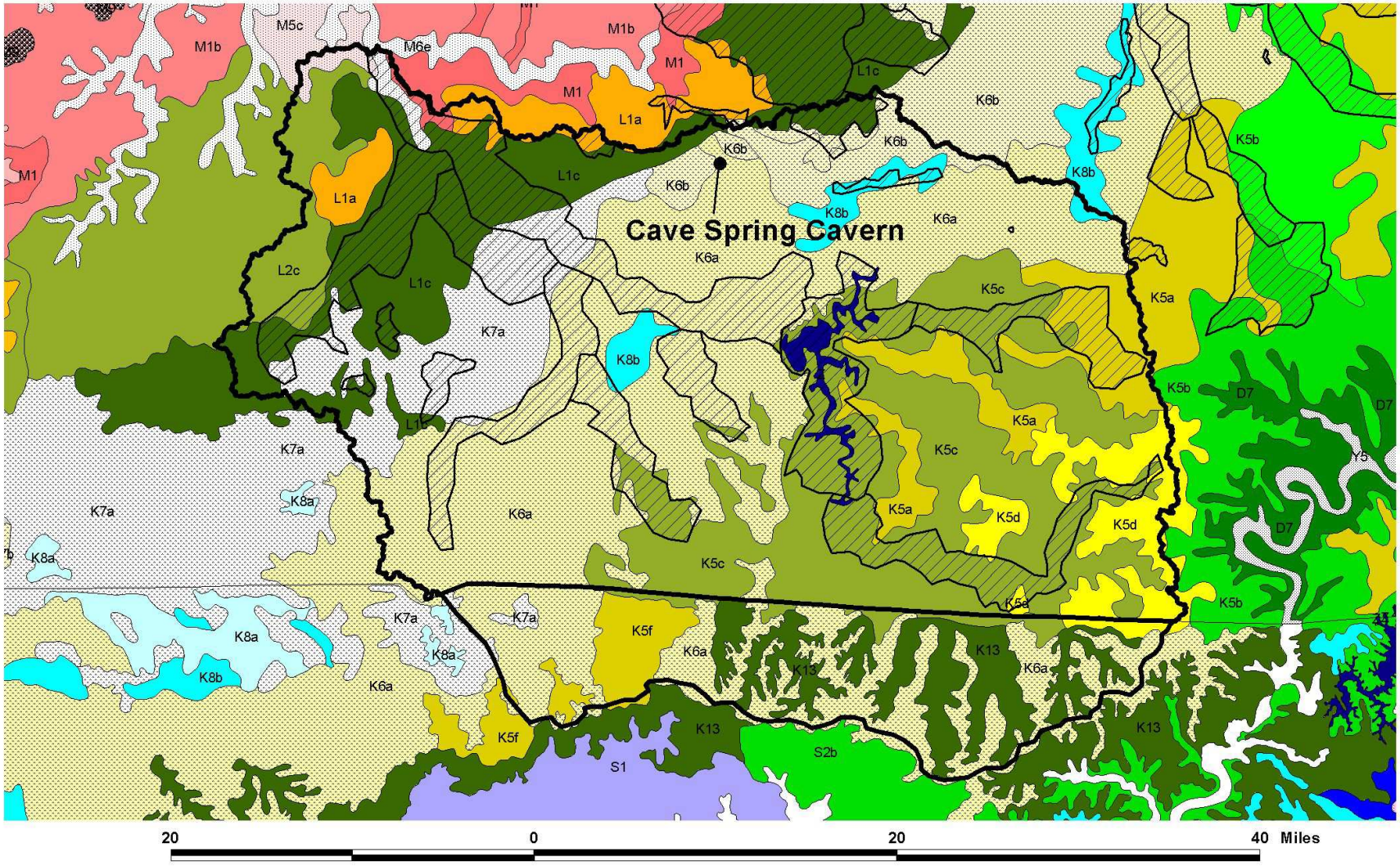


Figure 1a. See legend on previous page.

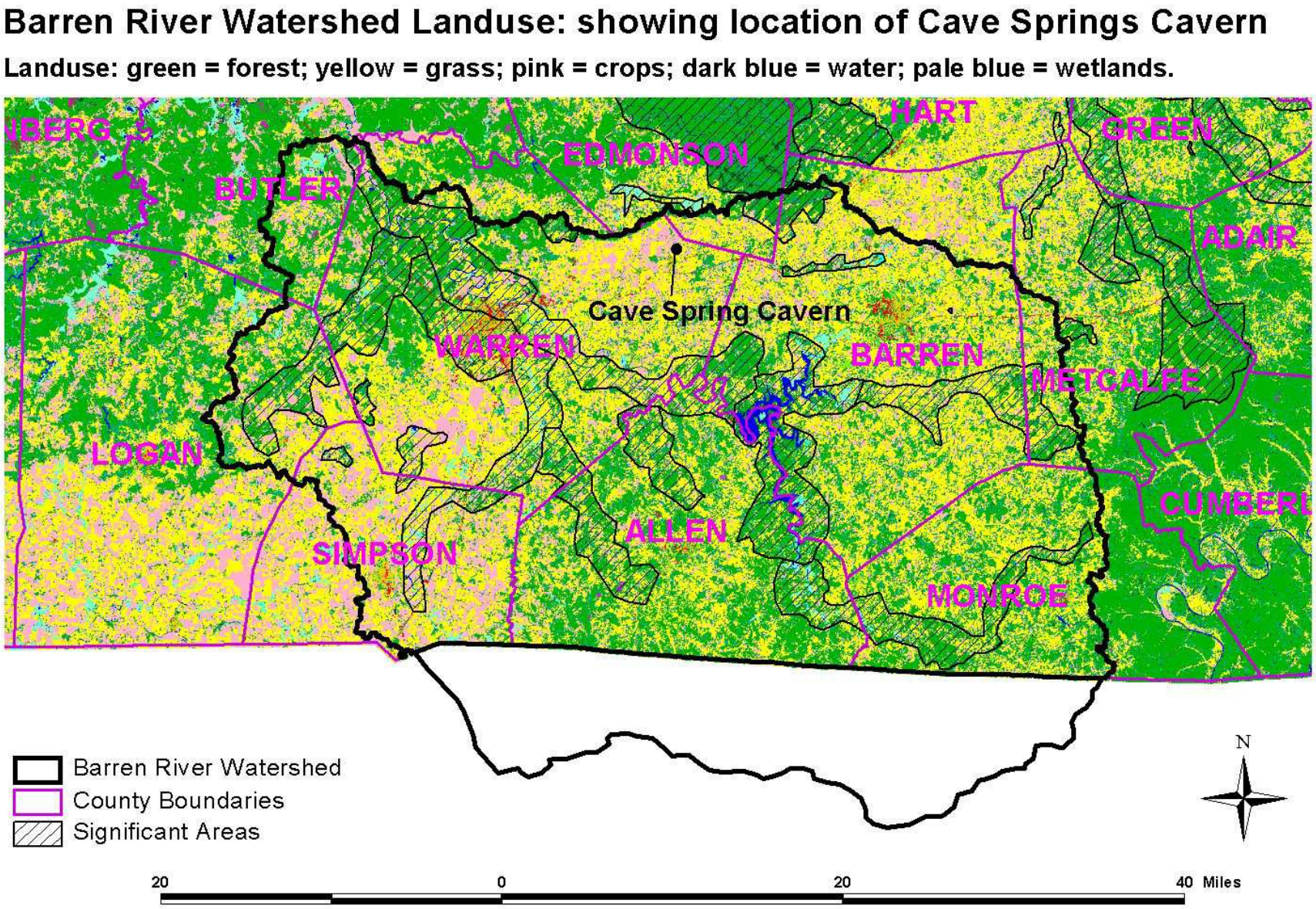


Figure 1b. Barren River watershed in relation to aerial photograph (DOQQ from Ky. Office of GIS).

Smiths Grove Neighborhood: showing location of Cave Spring Cavern and other potential natural areas (wooded knobs and sinkholes)

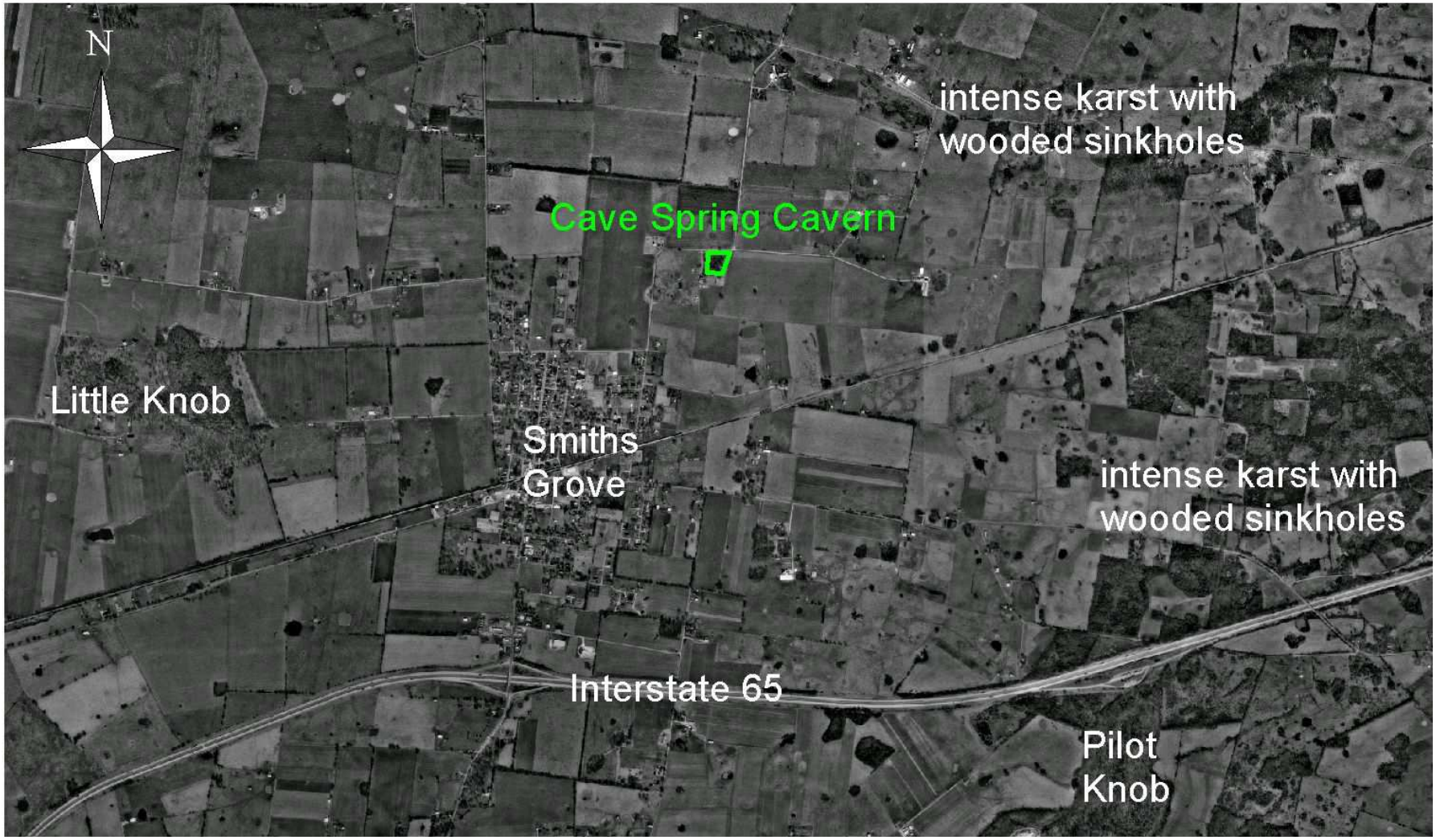


Figure 2. Cave Springs Cavern: close-up on 2006 image of FSA (from Ky. Office of GIS).

Figure 3a. Aerial view of Cave Springs from 2006 image of FSA. The house on southwest side dates from 1857. It is home to the seller of the two acre tract sold to Western Kentucky University. There are three buildings along the northern rim of the sinkhole; the one clearly visible at center plus another to the west are retained by the farm, which rents for for bed-and-breakfast. The farm was settled about 1810 by Jacob Wright Jr. (1774-1857), who married Miriam Helm. The east-west road to north is the Smiths Grove-Rocky Hill Road; the northern road from the intersection at northeast corner is as the Upper Smiths Grove Road.

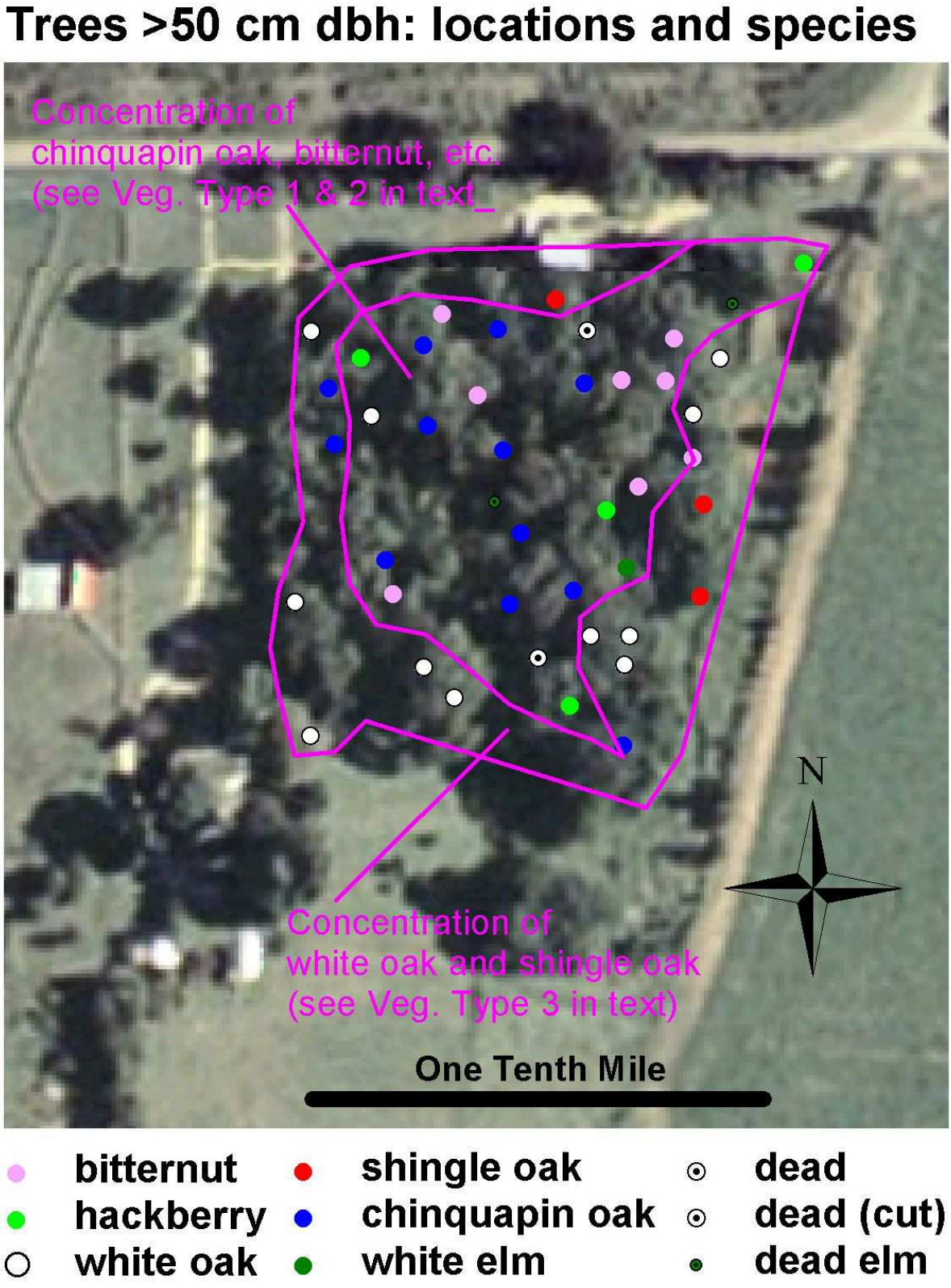


Figure 3b. Distribution of bigger trees in sinkhole.

Land Use History

Groves within the Barrens. Historical information about the “barrens” of the whole Pennyrile Karst Plain, plus extensions into adjacent regions, is included in Appendix Four, which is largely taken from Campbell (1999). Although largely covered with grassland, short shrubland (with sumacs, hazel, dwarf willow and plums), or open grassy woodland (usually with much post oak and blackjack oak), the karst plain did have isolated areas with more shady woods. Such groves occurred in the following three general contexts.

(1) Damper depressions, sinkholes and drains. Although subhydric, hydric or aquatic conditions are locally extensive on the karst plain, historical records suggest that open marshy vegetation predominated on these sites, rather than swampy forest. Nevertheless, there were locally extensive patches of relatively mesic woods around deeper sinks, or strips of woods along drains, covering up to about 3000 acres in a few cases. Two of the most prominent "groves" on the karst plain were noted by Gorin (1929, p. 2), and more details of these sites and others were provided by Gardiner (1940, p. 178-179). Gardiner noted: "The timber in these groves consisted largely of the finest quality of Ash, Sugar Tree, Scaly Bark Hickory, Black and White Walnut, Yellow Poplar and other valuable varieties, while along the lower lands those varieties were mixed with considerable Elm, Beech, and Hackberry and some Sycamore, and the land was nearly all of the very finest quality. These groves were entirely surrounded by the "barrens," thus giving to the early settlers the advantage of free and abundant pasturage from the start."

(2) Small knobs, with relatively xeric rocky oak woods and cedar-glades on drier sites (especially S/SW-facing aspects) and locally more mesic woodland on moister sites (especially N/NE-facing aspects). These features were widely scattered across the plain, but concentrated in transitions to adjacent regions (see 3 below). Gardiner noted (following quote under 1 above): "There were also smaller, but considerable, groves of the same sort of timber on land equally as good on the north slopes of knobs in that region, among which were... the Pilot Knob near Lafayette [NE Warren Co.]... and other knobs [mostly SW Hart Co.] between the L.& N. Railroad and the Edmonson County line." Much of the Smiths Grove and Oakland area appears to have had woods of this type (Allen 1899, Cole 1941).

(3) Transitions to—or mixtures with—adjacent regions that were more wooded.
(3a) Transitions to the Shawnee Hills, in the form of the Dripping Springs Escarpment, are generally abrupt, and this was probably reflected in the vegetation. The isolated knobs (as noted above under 2) are locally more frequent towards this escarpment.
(3b) Transitions to the "Cumberland or Green River Hills" on the south or east side of the karst plain may have been more gradual, in general, including an extensive zone of open blackjack or post-oak woodland near the Tennessee state line. More shady parts of this southeastern transition, at the time of settlement, may be reflected in some place names: Summersville (N Green Co., Ky.); Shady Grove (N Metcalfe Co.); Summer Shade (S Metcalfe Co., Ky.); Oak Grove and Sugar Grove (NE Sumner Co., Tenn.); Oakdale (E Robertson Co., Tenn.).

Original vegetation in the Smiths Grove area deserves further historical research, using old land surveys and other local sources. Smiths Grove appears to have been named after woods that existed especially on Little Knob (to the west), also on Pilot Knob (to the east), and perhaps

around adjacent sinkholes to the north of Pilot Knob. The Cave Spring area itself could have contained a northern outlier of this grove (or grove-cluster). Such interpretation has been supported by local historians, especially Allen (1899) and associated material in the Smiths Grove Public Library. Allen's notes on the Smiths Grove area included the following statements [with comments on this author in brackets]:
(a) "Around the knobs and at the sink of the creeks on the east were some groves of timber, such as the oak and a few sugar maple, walnut and poplar."
(b) "THE WILD PIGEON ROOST. Some things I remember about it; it was located in the grove of timber around Smith's Grove knob [perhaps = Little Knob], and extended out several miles... The pigeon roost covered hundreds of acres of scrubby timber and millions of birds would roost there in good mast years..."
(c) "Around the base of the little knob was a beautiful grove of trees and this was made a settlement—date unknown except that it seemed to be before the county was organized [1796]... This was part of the Wild pigeon Roost (which we shall take up later). It seemed to be a common expression to say "Lets go down to Smiths Grove and shoot pigeons.""
(d) "A sugar camp was once worked on the east side of the long knob [probably Pilot Knob] as late as 1844. A nice grove of sugar maples grew luxuriously there, and there were large poplars, walnut trees, black haws and pawpaws. The soil is black and rich and very productive..." [This account goes on to include details of the Crump or Wright Cave.]

In historical notes on the "Oakland Country"—to the south of Smiths Grove—Cole (1941) added further details.
(e) "The Big Sink on the farm formerly owned by the late W.R. Allen, is about one-fourth of a mile long, about one hundred feet deep and contains twelve acres. There is an underground stream in this sink that rises in the sink to a depth of fifty or sixty feet when we have excessive rains. Until it was cleared up trees and wild flowers grew in this sink that are usually found only on the banks of streams..."
(f) "The road that was opened up when the Henry Cowle's farm was sold goes through a section of country known as the pigeon roost. [They] roosted in the young timber that was then growing up."

Timber after Settlement. After settlement, the original "barrens" were largely replaced by farmland, and the remaining wilder lands became generally more densely wooded, as the frequency of fires was reduced. Barton (1919) provided the first comprehensive survey of forest resources across the state, based on data collected ca. 1900-1915. His data for Warren Co. and some nearby counties are presented in Appendix Two; Simpson Co. provides a benchmark as the county with by far the highest proportion of karst plain (over 90% of its area). Only 23% of Warren Co. was reportedly forested at that time; ca. 20% seems to have been typical for the karst plain (as in Simpson Co. with 19%). The timber volume per acre in Warren Co. was relatively low for the region, with ca. 1100 board feet per acre; similar numbers were reported in adjacent counties to the south, across the karst plain (Simpson and Allen). It appears that this central section of the karst plain around Warren Co. had been more intensively disturbed, settled and cleared, compared to sections further east and west. To some extent, this pattern may have resulted from more extensive grassland even before settlement. Possibly soils were relatively productive in some sections, as around Smiths Grove (see below). In addition, rapid settlement and clearance may have been enhanced by the Barren River; presumably logs were rafted out.

The most common timber type reported by Barton (1919) for Warren Co. was "black oak," with 60%; most of this was probably black oak (*Q. velutina*), southern red oak (*Q. falcata*), blackjack oak (*Q. marilandica*), and perhaps shingle oak (*Q. imbricaria*). Dominance of the black oak group was typical of woods on the karst plain during this period; Simpson Co. had 55% reported. Across the whole state, Barton's data indicated that "black oak" was most abundant in western regions, especially in or near the karst plains (Figure 4a). It seems likely that succession from more open, fire-maintained, grassy conditions allowed these generally mid-successional oaks to become abundant in those young woods that remained a century after settlement.

The "white oak" group (especially *Quercus alba*) remained dominant in older woods across most other regions of the state, except where intensive logging had occurred during early settlement (and in the unusually eutrophic central Bluegrass). But "white oaks" formed only 9.5% of the timber in Warren Co. according to Barton's data; most of these trees were probably white oak, post oak (*Q. stellata*) and perhaps chinquapin oak (*Q. muhlenbergii*). Post oak was not consistently separated in Barton's report, but it may still have been the most common white oak on the karst plain; 15% was reported for Simpson Co. Across the whole state, post oak was clearly concentrated in western regions, especially in eastern and western sections of the karst plain (Figure 4b).

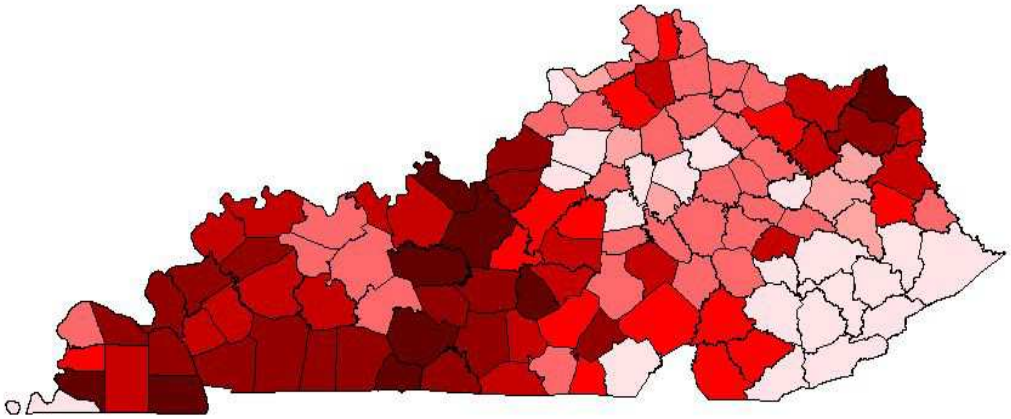
Other common timber types reported by Barton for Warren Co. were beech (11.5%), [tulip] poplar (4.7%), hickories (3.5%), gums [black & sweet] (3.8%) and maples [sugar & red] (3%). Remaining minor types each comprised no more than 1-2%. Using data from Simpson Co. as a guide, it is likely that hickories (8.3%) and maples (4.1%) were relatively common on the karst plain, compared to gums (2.6%), beech (1.9%) and poplar (0.3%).

Among minor species, the distribution of red cedar has special interest, since it appears to have increased progressively after settlement. Virtually no cedar was recorded in early 19th century land surveys of the karst plain or adjacent hills (e.g. those summarized in Appendix 4A), but it was present in small areas on xeric hillsides (as noted in accounts of Appendix 4B). In Barton's (1919) data, however, there was a remarkable band of cedar in counties along the northern side of the karst plain: comprising ca. 0.25-2.5% of timber in Logan, Warren, Edmonson, Grayson, Hardin, Meade and Bullitt (Figure 4c). Presumably this cedar was concentrated on drier slopes in the Dripping Springs and on outlying knobs. Elsewhere in the state, cedar was not specifically reported by Barton in any other counties, except for a disjunct eastern band from the "Eastern Karst Plain" (around Clinton Co.) north to the Kentucky River Palisades (Figure 4c).

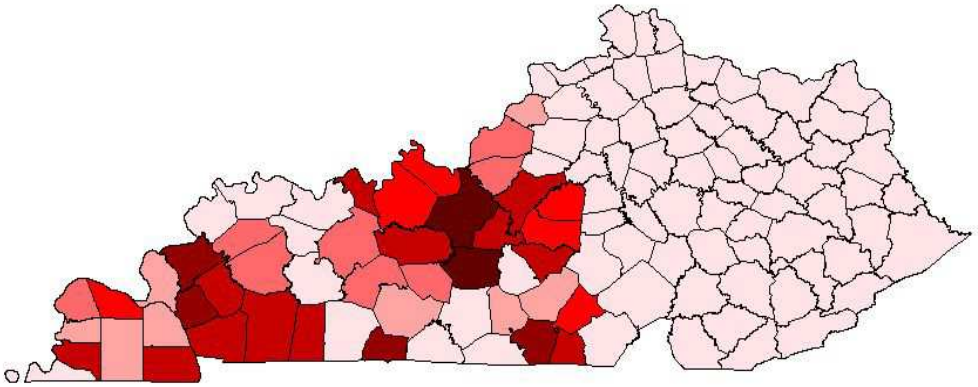
It seems likely that these two concentrations of cedar in Kentucky were associated with an original (presettlement) pattern of moderate disturbance, involving a balance of fire frequency (probably reducing cedar on the karst plain) versus browsing intensity (probably favoring cedar on some included knobs and adjacent hills). It is also possible that larger herbivores enhanced this pattern when they sought refuge in cedar woods on rocky hillsides while the karst plain burned, or while native people hunted. There may have been long-distance migrations by bison (and extinct megafauna during earlier times), seeking shelter and forage during hard winters within the cedar woods and canebrakes of central Kentucky and Tennessee.

Figure 4. Concentrations of timber types in counties of Kentucky ca. 1900-1915, based on percentages of total timber for each county in data on Barton (1919).

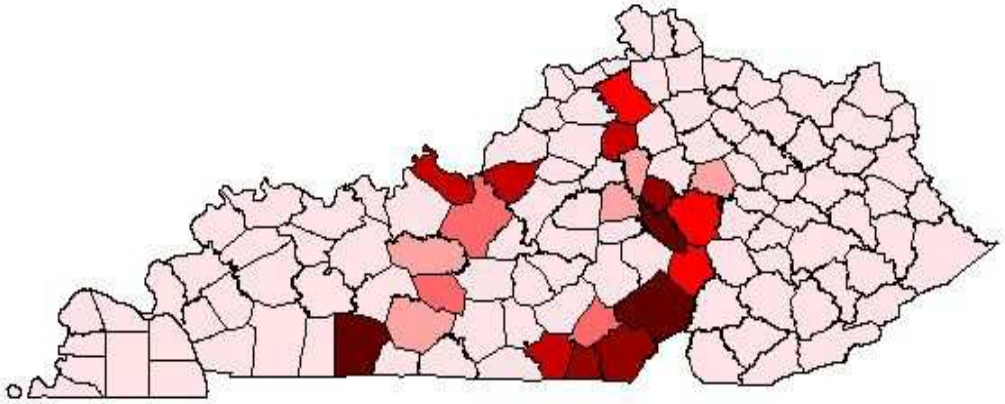
(a) Black & red oak group. Darkest red = 50-60%; palest red = 10-15%; pale blue = 2-10%.



(b) Post oak. Darkest red = 20-30% reported; palest red = 0.6-1.2% reported. Pale blue = not reported; however, post oak was not consistently separated from other "white oak" species.



(c) Red cedar. Darkest red = 2-3% reported; palest red = 0.2-0.3% reported. Pale blue = not reported.



Agricultural Prosperity. The Smiths Grove area, including Cave Springs, has been much influenced by various disturbances and plantings during the past 200-250 years. In addition to general removal of native grassland and woodland, several alien species have invaded due to accident or purpose. In addition to alien weeds, several ornamental aliens exist here. The sinkhole is just 100-200 yards from the front yard of the old Cave Springs farm house, and must have been generally used for enjoyment of residents and visitors since the time of first settlement.

Smiths Grove seems to have reached a cultural zenith about 1880-1900, when there were glowing accounts, such as the following.

Anonymus ["W.E.A., M.D."] (1885): "Smith's Grove is beautifully situated on the Louisville and Nashville Railroad, 15 miles north of Bowling Green, in the best portion of Warren County. You may talk to [of?] Lexington and its bluegrass surroundings, (said to be the garden spot of Kentucky), but it dwindles into insignificance when exhibited in contrast with Smith's Grove and its surroundings... You may look from this point West and Northwest and your view is only bounded by the Green River Knobs from five to seven miles distant, and from those knobs floats as pure air as that, that floated across the sinless plains of Eden [Figure 5a]. And the intervening country consists of thousands of acres of as fine land as any in the State. The country east of Smith's Grove is all that one could desire, extending away to Beaver Creek, distant about seven miles, including the fine farm of Dr. Allen."

Greene (1898): "This delightful little town is situated in the midst of one of the most fertile sections of Warren County, fourteen miles east of Bowling Green, on the line of the Louisville and Nashville Railroad. It is in the midst of natural groves and surrounded by a beautiful, almost level country in a high state of cultivation. The farms and farm houses indicate wealth and prosperity, and the many churches and school houses that dot the landscape bear testimony to the moral and educational progress of the people. The population of the town is about six hundred. It has a natural drainage. An exceedingly orderly state of society exists, making it a pleasant place of residence. The business of the place is almost enitrely local, but it is such a large and productive section of country surrounding it, that the volume is very considerable."

Such accounts, coupled with modern soil surveys, indicate that the deep well drained fertile soils of this area allowed a particularly intense agricultural prosperity during the 19th century. The locally high fertility was attributed by some early residents to the effects of passenger pigeons, which roosted here during fall and winter. Allen's description (1899; see also, McIntire & Blakeman 1847; Appendix 4B) included the following statements: "The roost covered from eight to ten thousand acres or more. As the flocks of hundreds and thousands of birds would come in of evenings from the beech and oak forest of Green, Barren and Cumberland rivers and their tributaries, they would circle around and often light in the tree tops, seeming to rest from their long flight of ten, fifty, and as far as one hundred miles... The droppings from these millions of birds covered the ground and was an inch deep in places. That accounts for the deep rich soil of the Smith's Grove country... The pigeon roost covered hundreds of acres of scrubby timber and millions of birds would roost there in good mast years..."

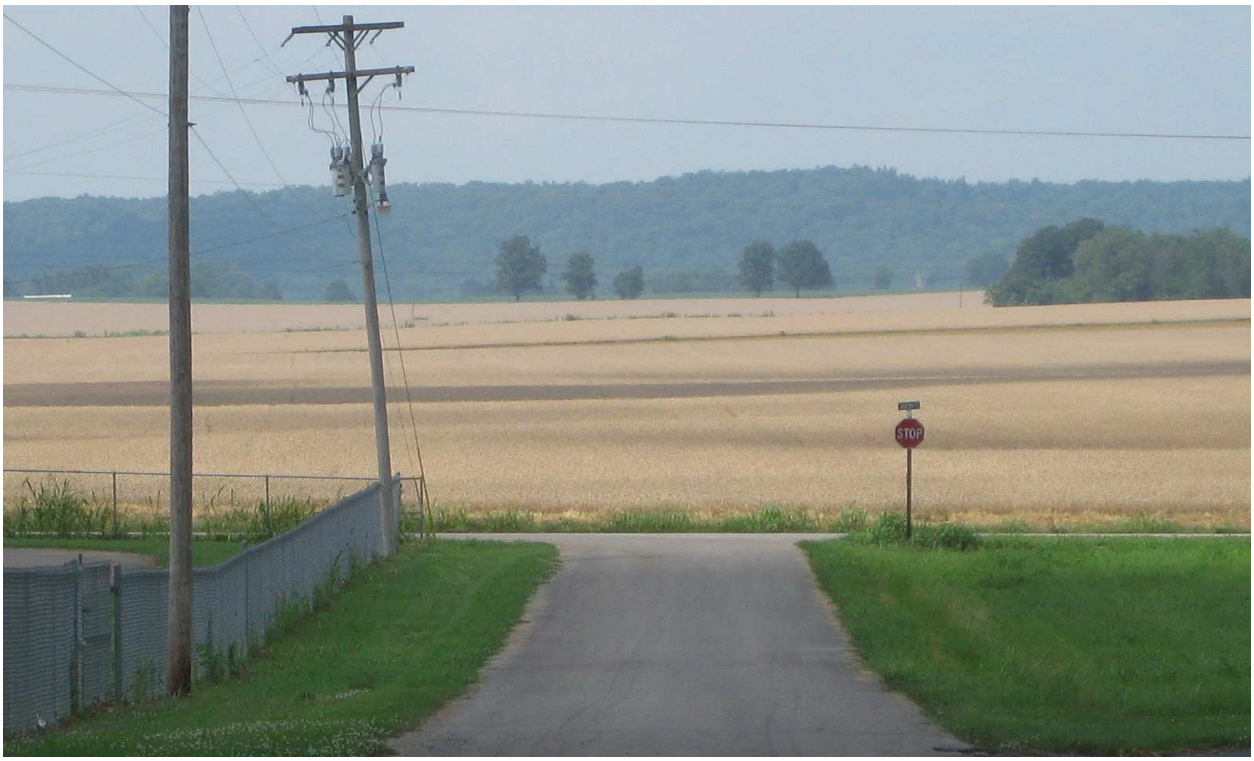


Figure 5a. "The Sinless Plains of Eden"; looking north from Smiths Grove across large wheat fields on the karst plain towards the Dripping Springs Hills, about three miles away.


Figure 5b. Dr. Hilary Lambert next to large black oak (ca. 150 cm dbh) in the grove of a dozen post oaks (70-100 cm dbh) behind the North Warren Elementary School in Smiths Grove.

Cave Springs Farm. The Cave Springs farm was settled about 1810 by Jacob Wright Jr. (1774-1857), who married Miriam Helm. The present house was built in 1857-58 (Figure 5c).

A grand-daughter of Jacob Wright was Mrs. James R. Kirby, born Miriam Elmina Royalty in 1853 (Jan 19). At the age of 96, in 1949 (Jan 23), she recalled some events in her life for the Park City Daily News: "When she was about 16, Mrs. Kirby's family returned [from Glasgow] to Smiths Grove to reside where her grandfather, Jacob Wright, had settled many years before on some 300 or 400 acres, purchased from the government. This property is now known as the Crump place, and a large cave on the farm, called Crump's cave, was once known as Kirby's cave."

Her father-in-law was David Kirby, Jr. (born 1829), whose life was outlined in M.E. Kirby, Sr. (1954): "In January 1864, he moved to where he now resides [perhaps in 1880s] near Smiths Grove, and located on 216 acres, all of which is in a high state of cultivation, well improved, and with fine residence and good substantial barn and outbuildings. Mr. Kirby, by good management, has succeeded in accumulating a handsome fortune, owning nine farms, containing in all, 1,531 acres, mostly in the vicinity of Smiths Grove, perhaps the richest and best lands in Warren County. He lost several negroes by the war. He is a member of the Grange. He cast his first presidential vote for General Taylor in 1848. Since the war he has been a Democrat, and has never missed a presidential vote."

Figure 5c. The Cave Springs farmhouse, dating from 1857, which is about 500 feet southwest of the cave; old white oaks and other trees remain in the yard, which grades into the gentler sinkhole slopes on this side. The 17 acre estate is on the National Register of Historic Places.

Outline of Habitat Types

The woods around the cave are isolated and disturbed, and do not allow an easy assessment of their origins or their potential for native biodiversity. However, they can be generally assigned to a "submesic" type, as outlined below. One can also speculate that a more mesic variant (with more maple) was originally much more extensive in more protected areas of the Smiths Grove area, and that a more open or disturbed variant (with more oak) existed on less protected areas, especially on drier or more frequently burned sites. The distribution of larger trees in the sinkhole suggests at least two original woodland variants (Figure 3b).

After the vegetation type's general name below, there are lists of the 'JC' codes used here (for Geographic Information System), plus the closest matches to 'KN' types of Kentucky's Natural Heritage Program (see website of Ky. State Nature Preserves website), and 'NV' types of the National Vegetation Classification (see website of NatureServe). See Appendix Five for more details of species composition in this and other types in the region.

1. Submesic woods: the general condition within the sinkhole.
[JC 07.E/D.2*; none in KN but see notes below; none in NV but see notes below]
The word "submesic" is used here in a broad sense to indicate conditions intermediate between (a) more mesic woods on relatively protected sites, and (b) more recently disturbed, stressed or open woods. The most common trees in the sinkhole, in terms of numbers, include cherry (*Prunus serotina*), hackberry (*Celtis occidentalis*), and walnut (*Juglans nigra*). Maple (*Acer saccharum* perhaps introgressed with *A. nigrum*) and bitternut (*Carya cordiformis*) are locally frequent; and elms are scattered (*Ulmus americana*). Oaks are not abundant in numbers, but they include most of the larger trees, ca. (7) 8-14 dm dbh: white oak (*Quercus alba*), shingle oak (*Q. imbricaria*) and chinquapin oak (*Q. muhlenbergii*). Only a few moderately large trees, ca. 7-8 dm dbh, belong to other species: bitternut, hackberry and elm.

On the steeper slopes and in the bottom of the sinkhole (Figure 3b), the larger trees are mostly chinquapin oak (mostly 6-8 dm) and bitternut hickory (mostly 4-5 dm dbh), plus a few hackberries and elms (7-9 dm). This zone could have included truly mesophytic forest before settlement, as discussed below (under 2). On the upper slopes of the sinkhole, especially gentler slopes to the south, the larger trees are mostly white oak (mostly 8-12 dm dbh), plus a few shingle oaks (7-10 dm dbh). This zone with white oaks could have been transitional to a more open oak woods type before settlement, as discussed below.

In the shrub layer, there are few native species, but buckbush (*Symphoricarpus orbiculatus*) is locally abundant, and large mounds of hydrangea (*H. arborescens*) occur along the low gullies. A few stems of pawpaw occur near the large bitternut on the southwest side of the cave. Unfortunately, alien shrubs and vines are also locally common to abundant: especially *Rosa multiflora* and *Lonicera japonica*, plus scattered *Ligustrum* spp. (especially *sinense*).

On the ground, aliens are more abundant than native in several areas, especially during the spring, with much "Star-of-Bethlehem" (*Ornithogalum umbellatum*) and *Veronica hederifolia*. Other locally frequent aliens include *Duschesnea indica*, *Hemerocallis fulva*, *Lamium purpureum* and *Narcissus* sp. Some weedy native species are locally frequent to

abundant: including *Chaerophyllum* (cf. *tainturei*), *Dentaria laciniata, Erigeron philadelphicus, Eupatorium rugosum, Galium aparine, Geum vernum* and *Viola papilionacea*. A few native species typical of deeper mesic woods also form large patches: mayapple (*Podophyllum peltatum*), Solomon's Seal (*Polygonatum biflorum*), greater sessile trillium (*T. cuneatum*) and smooth yellow violet (*Viola pensylvanica*). Smaller patches of wild ginger (*Asarum canadense*) and rich wood tick-trefoil (*Desmodium glutinosum*) occur on the steeper slope, and one small plant of the wood-fern (*Dryopteris* cf. *marginalis*) was discovered along the gully to northeast of the cave. More shade-tolerant native grasses are few and infrequent, except for the common wild rye (*Elymus virginicus* var. *virginicus*). The alien Japanese grass, *Microstegium vimineum,* occurs in a few patches, and could well increase further.

Similar woods exist within Mammoth Cave and nearby, especially on toe-slopes and bottoms within sinkholes, as documented by Campbell 1999 (see Appendix Five below). A "disturbed/seral phase" was outlined in that report, named *Juglans nigra-Prunus serotina-*(*Celtis occidentalis, Ulmus americana/rubra*). Similar woods are also extensive in the Bluegrass region, and historical records indicate that, with older trees, they were typical in much of that region at the time of settlement (Campbell 1989). Although widespread on moist fertile soils in east-central states, this type of woods has been somewhat neglected in classifications, probably because it is usually so fragmented, disturbed and invaded by aliens. However, a continual disturbance regime was probably part of its ecology even before settlement; local or occasional intense browsing, or burning, may have interrupted succession towards deeper woods with maples. The Ky. State Nature Preserves Commission recognizes only a special, historically interpreted variant of this type: "Bluegrass mesophytic cane forest" (with much *Juglans nigra, Aesculus glabra* and *Arundinaria gigantea*). NatureServe includes this KSNPC type within alliance 232 as CEGL 4437, and they have outlined some similar types in this alliance or the southern alliance 214: CEGL 4741 on rockier sites in KY, TN, ?AL; CEGL 4794 in OK; CEGL 7180 in FL, ?GA and ?AL; see also flooded variants in their alliance 957, and western variants with *Juglans major* in their alliance 1912. In most cases, these types are considered globally imperilled (more or less G2).

2. **More mesic woods**: as may have existed before settlement.
[JC 05.E.1/2; KN calcareous mesophytic forest, and see notes below; NV cf. association 4411]
A type characterized by frequent *Acer saccharum/nigrum* and *Carya cordiformis* may have existed widely in more protected areas on richer soils here and elsewhere in the Smiths Grove area. Such woods would have harbored the herbs of deeper woods (as noted under 1). Campbell (1999) outlined this type for the Mammoth Cave area: named *Acer saccharum* (or *nigrum*)-*Carya cordiformis* forest. This type might have been a relatively stable "climax" on the most fertile, well-drained river bottoms and sinkhole bottoms, but intense farming and ungulate browsing has generally removed it or greatly modified it. A small protected area exists at the base of Cedar Sink in the National Park. Based on that site and more diffuse data, other trees may include *Liriodendron, Quercus muhlenbergii* and *Ulmus rubra* (perhaps *Aesculus glabra, Tilia americana*). Shrubby species include *Asimina* and *Lindera*. Ground vegetation includes *Athyrium pycnocarpon, Cinna arundinacea, Microstegium vimineum, Eupatorium rugosum, Festuca subverticillata (obtusa), Monarda* sp. (the undescribed mid-western variant of *clinopodia*), *Pilea pumila, Polygonum virginianum, Solidago flexicaulis, Tradescantia subaspera, Verbesina alternifolia,* etc.

Woods dominated by sugar maples (*Acer saccharum, nigrum* or *barbatum*) plus much bitternut (*Carya cordiformis*), but little or no oak (*Quercus*), occur widely in east-central states on deep moist fertile soils, but they are usually in small patches or highly disturbed. The Ky. State Nature Preserves Commission does not specify a type like this, but their description of "calcareous mesophytic forest" tends to include it; there are also affinities with their "deep soil mesophytic forest" and (on alluvial terraces) with their "floodplain ridge/terrace forest". NatureServe does include such types, in either their upland alliance 251 (as association/CEGL 4411, etc.) or their lowland alliance 302 (as association/CEGL 5035, etc.). These types are mostly considered globally imperiled (G1 or G2).

3. **More open oak woods**: as may have existed before settlement.
[JC 10.D/E.1**, 11.D/E.3; KN cf. calcareous subxeric forest; NV cf. association 5018/3876].
A woodland type—or complex of types—with abundant oaks probably occurred widely in the Smiths Grove area, including transitions to more open woodlandd and grassland that was frequently burned. Woods around the fringe of the sinkhole may have been locally dominated by white oak (*Quercus alba*), as noted above under "submesic woods." However, on much of the more level uplands, post oak (*Q. stellata*) was probably more abundant. Half a mile to the southwest, behind the school in Smiths Grove, there is a significant grove of old trees with post oaks, ca. (70) 80-90 (100) cm dbh, plus a huge black oak (*Q. velutina*) ca. 150 cm dbh (Figure 5b).

Similar oak woods probably occurred within Mammoth Cave National Park, but usually on rockier soils than found around Cave Springs. Campbell (1999) described old field forest in the park dominated by red cedar, on karst valley floors (less often on broad ridges) with much limestone or calcareous shale, but sometimes mixed with slumped sandy material. These sites are presumed to have originally supported an oak woodland type, perhaps open in places. Similar woods may have occurred widely on the karst plain before conversion to grassland by fires of human origin. More mature areas in old field succession at the park have relatively frequent *Q. alba, Q. falcata, Q. stellata, Q. imbricaria* and *Q. velutina,* plus several *Carya* spp. The local abundance of *Q. imbricaria* in old field succession may warrant further investigation—on moderately base-rich, relatively gentle upland slopes, there may have been a presettlement oak type with much *Q. imbricaria*, where frequent fires kept the *Juniperus* at low levels. Such woods (JC 10.D.1) would have been typical of relatively deep soils, where occasional or local browsing or burning probably enhanced the oak component. On rockier, subxeric sites (with types 10.D.3 or 11.D.3, etc.), the flora would have been similar and such woods in the park area currently tend to be more mature, but drier conditions rather than disturbance may maintain the oaks, which include locally frequent *Q. muhlenbergii* and *Q. shumardii*.

In the successional cedar woods of karst valleys within the park (Campbell 1999), frequent trees in addition to the oaks currently include *Juglans nigra, Liriodendron tulipifera, Ulmus alata, Pinus virginiana* (perhaps in sandy transitions), etc. Common shrubby species include *Cornus florida, Corylus americana, Symphoricarpos orbiculatus,* etc. Much of the ground is bare, but relatively frequent or locally abundant species (often near trails and gullies) include *Agrimonia pubescens, Amphicarpaea bracteata, Bromus pubescens, Circaea canadensis, Eupatorium rugosum* (locally dominant), *Galium triflorum, Hackelia virginiana, Leersia virginica, Lonicera japonica, Lycopodium digitatum, Microstegium vimineum, Parthenocissus quinquefolius, Poa*

sylvestris, Polygonum virginianum, Polystichum acrostichoides, Rhus radicans, Salvia lyrata, etc. Similar vegetation could well occur on abandoned uplands around Cave Springs Cavern, if farming ceased.

Woods on upper slopes of the the Cave Springs sinkhole could be treated as various transitions or mixtures between submesic woods (as outlined above) and the oak woods that probably surrounded the site before settlement. The more mature woods envisaged here could be included in the broad definition of "calcareous subxeric forest" by Ky. State Nature Preserves Commission, with transitions to their "calcareous mesophytic" type. NatureServe has outlined several similar types, mostly with much *Q. alba* and *Q. falcata*, as in their forest alliance 241 (such as associations 5018 and 4068) and their open woodland alliance 613 (such as associations 2150 and 3722); see also alliance 612 with *Q. velutina* further north (6434). On rockier soils, there is also affinity with their alliance 1912 (including association 3876, which has much *Q. imbricaria*). Assessment of global status is difficult, but more calcareous variants may be considered somewhat imperiled.

4. **Grassland**: with aliens currently prevalent, but perhaps restorable to a native type.
[JC 10.D/E.1/3***; KN tallgrass prairie; NV cf. alliance 1213]
The strip of open ground on the eastern side of the sinkhole is dominated by aliens, including cheat (*Bromus* cf. *japonicus*), orchard grass (*Dactylis glomerata*), fescue (*Festuca arundinacea*) and bluegrass (*Poa pratensis*). There are no clear remnants of the original native grassland; native species present here are widely distributed, more or less "weedy" species, such as *Andropogon virginicus, Carex aggregata, Solidago altissima, Tridens flavus* and *Vernonia gigantea*. Much of the soil has been disturbed: some is scraped down an exposed cherty condition; some has been bulldozed into a small pond.

Based on scattered diffuse observations within Mammoth Cave National Park or nearby, Campbell (1999) outlined the type of grassland that probably existed on relatively deep calcareous soils of the karst valleys, and, by extension, on the adjacent karst plain. This grassland could be classified in the *Andropogon gerardii*-(*Sorghastrum nutans*) group; perhaps as a base-rich variant with much *Tridens flavus*. It probably occurred in areas that were open due to a long history of burning and browsing. Taller grasses are now virtually all replaced by *Tridens flavus, Andropogon virginicus, Panicum clandestinum* and *Poa pratensis* (especially ssp. "angustifolia") in more disturbed old fields and brushy regrowth. In karst valleys (with some sandy slump/wash in places) and on the karst plain, there are a few remnants of native grassland and there is much old field vegetation where various degrees of "nativeness" exists. However, due to farming on the one hand, and forest regrowth (especially *Juniperus virginiana*) on the other, these sites have small size and low quality. Typical associates, at least in open woodland phases, may have included *Cassia marilandica* (?), *Cirsium altissimum, C. discolor**, *Desmodium ciliare**, *Panicum (Dichanthelium) clandestinum, Elymus glabriflorus var. australis, Erianthus alopecurioides, Hieracium gronovii**, *Houstonia lanceolata**, *Panicum (Dichanthelium) lanuginosum, Polymnia uvedalia* (?), *Pycnanthemum pycnanthemoides, Sabatia angularis, Silphium trifoliatum, Solidago graminifolia, Thalictrum revolutum, Tridens flavus, Verbesina helianthoides**, *V. virginica*, etc. State-rare species may have included *Baptisia alba, Echinacea purpurea, Helianthus eggertii** (in sandy transitions), *Liatris squarrulosa**, *Silene regia** (in Nolin River drainage), *Tripsacum dactyloides* (damp sites), etc. [*Asterisked species may be typical of more subxeric-tending variants.]

Such tallgrass prairie can be classified in the *Andropogon gerardii*-(*Sorghastrum nutans*) alliance (1192) of NatureServe, with most affinity to their associations (CEGLs) 2203 (the glaciated midwestern type), 2204 (the unglaciated Ozarkian type), 4677 (the more Appalachian type on acid/sandy soils), 6039 (the Virginian Ridge & Valley type) and 7931 (the Tennesseean Ridge & Valley type). There should also be comparisons with the "Black Belt" prairies of Mississippi and Alabama and similar southeastern prairies, where taller grasses and forbs (especially *Silphium* spp.) are locally dominant. Such vegetation is sometimes misclassified in just a little bluestem type; NatureServe places the Black Belt prairie all in alliance 1198 (4664; see also 4020, 4025, 4027, 4757). Drier or more disturbed remnants of the Big Barrens in Kentucky are much more extensive than true remnants of tallgrass dominated by big bluestem, and they clearly belong in the little bluestem alliance 1198 (as type 7805 or, at more disturbed sites, 7707). However, the immediate surroundings of Smiths Grove are assumed to have been mostly tallgrass. Further analysis and discussion of big versus little bluestem ecology is beyond the scope of this report, as are the former shrubby variants of the Big Barrens, fascinating though they may have been.

Without a more detailed analysis of floristic and ecological differences, the precise classification of the Big Barrens in Kentucky and Tennessee remains somewhat uncertain. Baskin et al. (1991) have emphasized the relatively low diversity of these grasslands, compared to the more ancient prairies further west. The "barrens" here appear to have originated mostly due to increases in burning by native people during the past few thousand years. However, it is likely that smaller areas on more rocky soils, more hydric soils, and more intensively browsed sites (perhaps including the original "Bowling Green"), had supported relatively open grassy conditions before the human influences. Moreover, there are a few grassland plants taxa that appear centered in the barrens region of south-central Kentucky and central Tennessee—and may have originated in this region. These include *Helianthus eggertii*, *Silphium pinnatifidum*, *Echinacea simulata* and perhaps *Onosmodium molle* (ssp. *molle* if it is truly distinct from ssp. *hispidissimum*).

Figure 6. Banks with *Hydrangea arborescens* in gullies leading down to cave.

Figure 7a. Old chinquapin oak in bottom of sinkhole; dbh ca. 7 dm.

Figure 7b. Old bitternut hickory in bottom of sinkhole; dbh is ca. 9 dm. This tree appears to have died during April-June 2009.

Figure 7. Old hackberry on slope of sinkhole; dbh is ca. 8 dm.

Figure 8. Relatively large walnut in bottom of sinkhole; dbh is ca. 5 dm. *Veronica hederifolia* is dominant on ground.

Figure 9. Large white oak on south edge of sinkhole; dbh is ca. 12 dm.

Figure 10. Eastern lower slope with young woods of cherry, hackberry, maple, etc. Although native perennials are locally abundant, aliens are also (especially *Ornithogalum* and *Veronica*).

Figure 11. Ground vegetation with trillium on side slopes with more oak litter; note Star-of-Bethlehem (*Ornithogalum*) is still locally abundant, but perhaps more smothered by the litter.

Annotated List of Flowering Plants & Ferns

Attached as Appendix 3a is the list of vascular plants discovered on the Cave Spring tract in 2009. Nomenclature is generally "old-fashioned", with broad genus concepts, largely following Fernald's (1950) "Gray's Manual" and Wilson & Francis (2004). For recent changes coming into modern usage, see Jones' (2005) guide to the Kentucky Flora.

About 145 species of vascular plant were discovered at this site. It is likely that more can be found, especially aliens and other weeds in the fringes of the tracts, along field margins and fencerows. About 985 species are known from Warren Co. as a whole (Appendix 3b).

The flora in general is depauperate but typical for submesic woods on the Pennyrile Karst Plain. Most species are widely distributed in east-central states on moist fertile soils. Less common species with more notable local occurrences are *Clematis* cf. *versicolor* (one stem on steeper slope above the cave) and *Trillium cuneatum* (several beds on gentler slopes). Native species typical of more acid soils (such as leached cherty, gravelly or sandy) are completely lacking: for example, *Athyrium asplenioides*; *Pinus virginiana*; Ericaceae; *Chimaphila maculata, Geranium maculatum, Goodyera repens, Houstonia caerulea, Mitchella repens, Tipularia discolor*. Several species typical of base-rich fertile soils are also absent, though some are known from nearby in the county: for example, *Asclepias quadrifolia, Carex jamesii, Chaerophyllum procumbens, Corydalis flavula, Dentaria diphylla, Elymus macgregorii, Erythronium albidum, Hydrophyllum* spp.*, Jeffersonia diphylla, Laportea canadensis, Melica mutica, Pachysandra procumbens, Phacelia* spp., *Polygala latifolia, Uvularia grandiflora*. It is likely that past woodland clearance and other disturbances have led to local extinctions, and that reinvasion from refugia a few miles away has been slow or impossible.

Native grassland species are poorly represented at this site, but they were probably common within a few hundred meters before settlement, as detailed in notes under habitat types and rare species. Only common weedy natives were found in the old fields and fencerows around the sinkhole: e.g. *Carex aggregata, Solidago altissima, Vernonia gigantea*.

Alien species make up about a third of the flora, reflecting the disturbed condition of the woods and the surrounding open lands. The alien proportion across the region is less: a fifth to a quarter (Appendix 3b; Jones 2006).

Figure 12a. Large sessile trillium (*Trillium cuneatum)*, or "sweet betsy" (although it smells like wet dog); locally common in the sinkhole. This occurs on uplands east of the Mississippi Rv. and mostly south of the Ohio Rv.; in Kentucky, it is virtually absent north of a line from Bowling Green to Somerset. Photo by Thomas G. Barnes, Univ. of Ky. (from http://plants.usda.gov).

Figure 12b. *Clematis versicolor*: one non-flowering shoot was found at Cave Springs Cavern. Photo by JC; from roadside near entrance to land of Western Ky. Univ. in Hart Co.

Figure 13. East slope with beds of trillium, solomon's seal and mayapple.

Figure 14. Patches of larkspur (*Dephinium tricorne*) among mayapple.

Figure 14. Base of large elm with yellow violets (*Viola pensylvanica*) and morel.

Figure 15. Small patch of woodland buttercup (*Ranunculus hispidus*) found among mayapples.

Figure 16. Patches of yellow stemmed-violets (*Viola pensylvanica*) are locally extensive.

Figure 17. Smooth blue stemless violet (*Viola papilionacea*) and a locally common albino form.

Rare Plant Species

No rare plant species monitored for protection by the Ky. State Nature Preserves Commission have been found on or near this tract. No species are even marginally rare ("watch list" or S3S4 in Natural Heritage system). There are, however, a few plants with local interest for potential protection, propagation and recovery. The occurrences of *Clematis versicolor* and *Trillium cuneatum* are notable, since this site is close to the northern edge of their ranges.

Listed rare species that might be most expected in this neighborhood, or that may have occurred before settlement would include the following. Rare species known from calcareous sections of Warren Co. or Barren Co. but typical of more xeric or hydric habitats are excluded from this list. In highly weathered cherty or sandy soils with lower fertility, other species could be added as well, but natural soils of the Smiths Grove neighborhood generally appear to have had relatively high base-status or fertility. All soils are mapped as alfisols, although they are mostly cherty variants (Barton et al. 1981). Species typical of full sun are indicated by double asterisks (**); those typical of edges or thin woods are indicated by single asterisks (*).

**Apios priceana* (Price's potato bean)
**Astragalus canadensis* (Milk-vetch)
Carya carolinae-septentrionalis (Southern shagbark hickory)
***Castilleja coccinea* (Indian paint-brush)
***Dalea purpurea* (Purple prairie-clover)
***Eurybia hemispherica = Aster h.* (Southern prairie aster)
***Gentiana puberulenta* (Prairie gentian)
**Hasteola suaveolens = Cacalia s.* (Hastate-leaved Indian-plantain)
***Helianthemum bicknellii* (Plains frostweed)
**Helianthus eggertii* (Eggert's Sunflower)
***Lespedeza capitata* (Round-headed bush-clover)
**Lilium michiganense* (mid-western wood-lily);
perhaps confused/intergrading with *L. superbum*.
***Onosmodium hispidissimum* (mid-western gromwell);
perhaps confused/intergrading with *O. molle*.
**Perideridia americana* (Eastern Yampah)
**Prenanthes crepidinea* (Giant wood-lettuce)
***Silene regia* (Royal catchfly)
***Silphium pinnatifidum* (Pinnatifid prairie-dock);
perhaps confused/mixed with *S. terebinthinaceum.*
***Symphyotrichum priceae = Aster p.* (Price's aster)
**Trifolium reflexum* (Buffalo clover)
Trillium ozarkanum (Ozark Trillium)

Additional rare or conservative species that probably occurred in this neighborhood before settlement may have included **Asclepias purpurascens, *Cirsium altissimum, *Desmodium cuspidatum,**Desmodium sessilifolium, **Echinacea purpurea, **Eryngium yuccifolium, **Helianthus angustrifolius, **Helianthus mollis, *Hexalectris spicata, **Liatris squarrosa,** Liatris squarrulosa, **Oligoneuron rigidum* (= *Solidago r.*), **Panicum virgatum, **Parthenium integrifolium, *Ranunculus fascicularis, *Solidago speciosa, Synandra hispidula, *Tragia cordata, **Tripsacum dactyloides,* and ***Veronicastrum virginicum.*

Figure 18. Ozark trillium (*T. ozarkanum* or *T. pusillum* var. *ozarkanum*). Rare throughout its range, this species occurs mostly in the Ozark and Ouachita region (AR, MO, OK), plus a few sites in KY and TN. Two sites are known in Warren Co. on wooded slopes near the Barren River a few miles south of Smiths Grove. It typically grows on moderately acid, cherty limestone soils in mesic to subxeric, thin oak-hickory woods, thickets or edges (often with *Carex pennsylvanica*); see reports of state heritage programs. There are some suggestions that it might prosper locally in open grassy areas, perhaps with fires in the fall; Short (1836) noted unspecified trilliums in the "barrens" (see Appendix Four). Ozark trillium should be propagated for recovery; drier sites with oak litter at Cave Springs might be suitable.
Photo from www.naturalheritage.org.

Figure 19. Eggert's sunflower (*Helianthus eggertii*); an uncommon species around the barrens.

Figure 20. Pinnatifid prairie-dock (*Silphium pinnatifidum*); still common in some barrens remnants; photos by Dennis D. Horn and Paul Sommers (from http://tenn.bio.utk.edu/vascular).

Invasive Alien Plants

The following species are significant problems within the woods at this site; excluding the many alien species that are largely restricted to the currently maintained fields on the uplands. Some species are not detailed here, since they are not especially common and they may decline in later succession, but they may deserve action: e.g. perhaps common bedstraw (*Galium aparine*; which may be native); a few bush-honeysuckles (*Lonicera maackii*); and a few white mulberries (*Morus alba*) in the outer edges and fencerows. Other problematic species expected in the neighborhood include purple winter-creeper (*Euonymus fortunei*).

Duchesnea indica (False strawberry): locally frequent.

Euonymus alatus (burning bush): scattered in low numbers.

Hemerocallis fulva (Day-lily): locally common in one patch on southeast slope.

Lamium purpureum (Red dead-nettle): locally frequent.

Ligustrum sinense (Chinese privet): locally frequent; the European privet is also present.

Lonicera japonica (Japanese Honeysuckle): this is locally abundant, especially in thin woods and near edges. It will probably decline in deeper shade after several decades.

Microstegium vimineum (Japanese grass): few patches on disturbed ground.

Narcissus cf. *pseudonarcissus* (Daffodil): local, with one patch on south slope.

Ornithogalum umbellatum (Star-of-Bethlehem): this is widespread and abundant.

Perilla frutescens (Beaf-steak plant): locally frequent, especially on or near trails.

Rosa multiflora (Multiflora Rose): several patches occur in the woods and edges. It may not be a long-term threat since it fades out in a few decades of succession to woods.

Stellaria media (Common Chickweed): this is locally frequent, especially on bared ground along trails or in the upper transitions to fields, but also at some sites within the sinkhole. It will probably continue to be a local problem.

Veronica hederifolia (Ivy-leaved speedwell): widespread and abundant.

These alien species can mostly be placed in the four broadly-defined functional groups.

(a) Low winter-green herbs: annuals or stolonifers (*Duchesnea, Lamium, Stellaria, Veronica*; *Glechoma hederacea* is also expected).

(b) Summer annuals (*Perilla*, *Microstegium*).

(c) Lilioids from bulbs or rhizomes (*Hemerocallis, Narcissus, Ornithogalum*); these are all horticultural escapes or persistors.

(d) Shrubs or vines (*Euonymus, Ligustrum, Lonicera, Rosa*).

Most of the lilioids and shrubs/vines may be reduced or even eliminated by appropriate control. However, the *Ornithogalum* is likely to be difficult to reduce because of its short window for herbicide application and the potential for collateral damage to natives. The low winter-greens, and especially the summer annuals, will also be difficult to confront. They tend to be pervasive with much seed-bank and they are highly mixed up with natives. It may be worth experimenting with various unconventional disturbance regimes, e.g., confining goats or sheep to plots for measuring effects.

Figure 21. Ivy-leaved veronica (*V. hederifolia*), a winter annual that is abundant in the woods at Cave Springs (photo from http://www.floraimages.co.uk).

Figure 22. Star-of-Bethlehem (*Ornithogalum umbellatum*), a lilioid perennial abundant in the woods at Cave Springs. Photo by Kunsiri C. Siripun (from http://tenn.bio.utk.edu/vascular).

Figure 23. European privet (*Ligustrum vulgare*); this is mixed with Chinese privet in the Cave Springs area; photo from Univ. of Georgia (UGA5142064 at (http://www.invasive.org).

Summary and Recommendations

A biological survey of the Cave Spring tract was conducted during 2009, focusing on the vascular plants. Maps of the area were based on field work and various available images or data layers. Descriptive notes are provided for the vegetation types. Notes are provided on potential rare species for recovery in the area, and on invasive aliens that present significant problems for restoration.

This tract is part of the Barren River watershed, a general focus of attention for conservation by Western Kentucky University, The Nature Conservancy and associated agencies. In addition to remnants of aquatic communities in the river system, special habitats in this watershed include the less disturbed stream corridors, cliff-lines and caves, extensively wooded ravine slopes, and adjacent uplands with remnants of native grassland. Rare species include the globally imperiled mussels, fishes and other aquatic species. Several plants with regional or local rarity are also present, especially in remnants from the formerly extensive grasslands and open woodlands of the karst plain.

The Cave Spring tract itself includes no state-listed rare plant species, and there are problems due to invasive alien species. However, the woods form a generally "submesic" type that is probably descended from vegetation that formerly occurred around sinks and drains in the "Smiths Grove" area before settlement. Such vegetation may now be considered globally imperiled. Several large trees (with dbh up to ca. 11-15 dm) are present, most notable the oaks (white, chinquapin and shingle). The site presents considerable opportunities for educational displays and small-scale restoration experiments.

Management issues for the Cave Spring tract include the following.

(a) **Trail System**. There is a need to redesign this carefully for public and professional access. The existing wooden steps and rails are old to dangerous in places, and it may be more suitable ecologically for bare ground or rock to be used. The trail could be integrated with designed plantings, displays and benches. Herbicides should generally ***not*** be used for maintenance.

(b) **Invasive Alien Plants**. The more approachable problems are the woody aliens, especially *Lonicera japonica* and *Rosa multiflora*. Special techniques will probably be required for the Star-of-Bethlehem (*Ornithogalum*) and the low winter-green herbs (especially *Veronica hederifolia*). Small-scale experiments on these aliens would have value for research and education.

(c) **Recovery of Woodland Species**. Although there are no obvious needs for protection and recovery of uncommon or rare species at the site, there is considerable long-term interest in recovering species that probably would have occurred here before settlement. In the woods, such species include some that are common elsewhere in the region (see notes above under "Annotated List"), and a few that are rare to endangered (see notes above under "Rare Plant Species"). Selected wild flowers and native grasses in the woods could be propagated eventually for local use in restoration and native horticulture: especially attractive uncommon species like *Clematis versicolor* and *Trillium cuneatum*.

(d) **Recovery of Shrubland and Grassland Species**. The open grassy areas on the uplands, especially on the east side, could be used for cultivation and demonstration of native shrubs and grassland species typical of deeper (submesic) soils. The area could even be maintained with prescribed fire at 1-3 year intervals. See notes above for suggested species (especially under "Rare Plant Species")

(e) **Further Research & Education**. A popular, strong, broad-based, integrated program of great regional significance could be developed with general relevance for conserved lands on the karst plain of the Barren River watershed.

Large white oak on southwest side of sinkhole; blown down in June 2009

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Mysterious experiment being conducted in the ground vegetation at Cave Springs; April 2009

Appendix One. General characteristics of soil series, plus general interpreted relationships with topography and presettlement vegetation.

Most data come from the Warren County Soil Survey (Barton et al. 1981); additional soil series to be expected are in square brackets, with data from adjacent county surveys.

Explanation of format for data on soils.

First line. Soil class, with abbreviations as follows: a = alfic; c = cumulic; d = dystric; f = fluventic; h = humic; l = lithic; m = mollic; q = aquic; t = typic; v = vertic. At right margin typical pH of topsoil (ca. 0-8 inches) is coded as follows: A = 4.5-5; B = 5.1-5.5; C = 5.6-6; D = 6.1-6.5; E = 6.6-7.3. Note: in most cases pH is less in lower horizons by 0-1 units.

Second line. Name of soil series, with abbreviations for typical texture (excluding eroded clayey phases on steeper slopes) as follows: csl = cherty silt loam; fsl = fine sandy loam; l = loam; sc = silty clay; scl = silty clay loam; sl = silt loam; ssl = shaly silt loam; rl = rocky loam (or complex mixture).

Third line. Typical slope in percent; followed by typical depth to bedrock in feet. At right margin, general drainage class is coded as follows: 1 = very poorly drained; 2 = poorly drained; 3 = somewhat poorly drained; 4 = moderately well-drained; 5 = well-drained; 6 = somewhat excessively drained; 7 = excessively drained.

Fourth line. Parent material, with abbreviations as follows: >> = thick loess mantle; > = thin or patchy loess mantle; As = acid shale; Ch = cherty limestone; Cs = calcareous shale; Li = limestone (arg = argillaceous); Sa = sandstone; Sh = shale (undifferentiated); bot = bottomland (with generally fresh alluvium); col = colluvium; dep = depression alluvium (tending to sla); pon = ponded alluvium (tending to sla); res = residuum; sla = slack-water deposits (with fine-textured alluvium on bottomlands, terraces or locally uplands); ter = terrace (with generally weathered alluvium).

Following page: upper chart shows soils derived from calcareous parent material in region; lower chart shows overlaid vegetation, as interpreted for conditions before settlement. Shaded cells are predominant soil series in soil associations; * soil series Mountview and Dickson are mapped extensively by STATSGO but not in Barton et al. (1981).

See explanation on previous page: upper = soil data; lower = interpreted vegetation.

SOILS	MORE HILLY LANDSCAPES IN GENERAL all well-drained		INTERMEDIATE LANDSCAPES IN GENERAL mostly deep soils		LESS HILLY LANDSCAPES IN GENERAL less well-drained
UPLANDS mostly steeper slopes, some excess drainage	ld-Eutrochrept E [Dandridge ssl] 6-50; 1-2.5 6 LiCs res	t-Hapludalf C Caneyville rl 2-35; 2-3 5 LiShSa res	t-Hapludalf C Fredonia sl 2-12; 2-3 5 Li res		
UPLANDS mostly gentler slopes, mostly well drained	a-Hapludult E [Westmorel. ssl] 6-50; 1-2.5 6 LiCs res	m-Paleudalf C Pembroke sl 2-12; 5+ 5 >Li res	t-Paleudalf C Crider sl 2-12; 6+ 5 >Li res	g-Hapludalf B [Epley sl] 2-12; 4-10 5 >>Cs res/ter	v-Hapludalf C [Colbert scl] 2-12; 3-7 4 Li(arg)
UPLANDS mostly gentler slopes/flats; some poorly drained	m-Hapludalf C [Renox sl] 6-12; 4-8 5 ChShSa col/ter	t-Paleudalf B Baxter csl 6-12; 5-8 5 Ch res	g-Paleudalf C Hammack sl 2-6; 5+ 5 >>Ch res	t-Paleudult B [Mountview sl*] 2-12; 5-? 5 >>LiCh res/ter	g-Fragiudult B [Dickson sl*] 2-6; 5-? 4 >>LiChSi res
HIGH TERRACE mostly old alluvium	a-Hapludult D [Humphreys csl] 2-12; 5-12 5 ChShSa ter/col	u-Hapludalf C Elk sl 2-6; 5-20 5 LiShSa ter	t-Fragiudalf C Nicholson sl 0-6; 5+ 4 >Li res/ter	a-Fragiudalf B Lawrence sl 0-2; 5-6 3 Li+ res/ter	t-Fragiaqualf B Robertsville sl 0-2; 5+ 2 Li+ ter (col)
BOTTOMLAND mostly fresh alluvium: higher, formerly wooded	t-Udifluvent D [Robinsonville fsl] 0-3; 4-10 5 LiSaSh bot	df-Eutrochrept D Nolin sl 0-2; 5-12? 5 LiShSa+ bot	fa-Eutrochrept D Lindside sl 0-2; 5+ 4 Li+ bot	a-Fluvaquent D Newark sl 0-2; 5+ 3 Li+ bot	t-Fluvaquent E Melvin sl 0-2; 5+ 2 Li+ bot/dep
BOTTOMLAND mostly fresh alluvium: lower, formerly marshy		t-Hapludoll D [Huntingdon sl] 0-3; 4-10 5 Li bot		v-Haplaquept D [Karnak sc] 0-2; 6-? 1 Li+ sla	fa-Haplaquoll E Dunning scl 0-2; 5+ 1 Li bot/pon

VEGET-ATION	MORE HILLY LANDSCAPES IN GENERAL all well-drained		INTERMEDIATE LANDSCAPES IN GENERAL mostly deep soils		LESS HILLY LANDSCAPES IN GENERAL less well-drained
UPLANDS mostly steeper slopes, some excess drainage	Red-cedar Chinquapin oak White oak Ashes, elms	White oak Black oak Hickories Ashe, elm, maple	Oak woodland (with local rocky glades)	Barrens (with frequent rocky areas)	
UPLANDS gentle or steep slopes, mostly well drained	Chinquapin oak White oak Ashes, elms Sugar maple	Oak woodland	Barrens	Barrens	
UPLANDS mostly gentler slopes/flats; some poorly drained	Sugar maple Beech Black walnut Tulip poplar	Oak woodland	Barrens	Barrens	Barrens (seasonally wet)
TERRACES mostly old alluvium	Sugar maple Black walnut Beech Tulip poplar	Sugar maple Black walnut Beech Tulip poplar	Green ash Sweetgum etc.	Green ash Sweetgum Pin oak Sw. chestnut oak	Sw. white oak etc.
BOTTOMLAND mostly fresh alluvium (higher)	Boxelder Sycamore Cottonwood	Boxelder Sycamore	Green ash Sweetgum etc.	Green ash Sweetgum Pin oak Sw. chestnut oak	Overcup oak etc.
BOTTOMLAND mostly fresh alluvium (lower)		Sycamore Boxelder Silver maple		Marshes	Marshes

Appendix Two. Early Forest Survey in Warren County and narby Counties.

Barton (1919) provided estimates of standing timber made in each Kentucky county during the period ca. 1900-1915. Unfortunately, no details of surveying methods were provided, and some of the data appear to be based on small samples, and there may be considerable inaccuracies. The following nine counties include Warren and others to the NE and SW with large areas of the Pennyrile karst plain. They are arranged below from west (left) to east (right). The upper row is the more northern series of counties, which include areas of the Shawnee Hills (especially the "Dripping Springs" escarpment). The lower row of counties include areas of the Cumberland-Green River Hills, except for Simpson, which lies almost all within the karst plain.

Percent Forest Cover. Note: Edmonson Co. was one of only five non-Appalachian counties to have more that 50% forest cover in this survey (also Trigg, Lyon, Monroe and Russell).

TODD	LOGA	WARR	EDMO	HART
26	38	23	55	13
	SIMP	ALLE	BARR	GREE
	19	31	32	21

Average Stand Volume: in hundreds of board feet per acre (calculated from county areas and total board feet statistics). Note: total timber estimates do not correlate closely with the percent forest cover estimates above; further research into the geography and logging history of these counties is needed to properly interpret these data; it would appear that Edmonson Co. had experienced particularly intense timber extraction, but that Barren and Green Cos. still had much old-growth with high volumes per acre.

TODD	LOGA	WARR	EDMO	HART
16	14	11	6.1	12
	SIMP	ALLE	BARR	GREE
	9.6	11	18	20

Percent "black oak" (*Quercus*: *velutina, falcata, rubra, coccinea, shumardii, marilandica,* etc.)

TODD	LOGA	WARR	EDMO	HART
38.2	41.2	59.7	45.0	46.7
	SIMP	ALLE	BARR	GREE
	55.3	40.6	42.1	55.1

Percent "white oak" (*Quercus*: *alba*, *muhlenbergii*, *bicolor*, *macrocarpa*, *michauxii*, etc.)

TODD	LOGA	WARR	EDMO	HART
23.9	12.5	9.5	15.0	9.3
	SIMP	ALLE	BARR	GREE
	2.0	12.8	11.7	4.6

Percent "post oak" (*Quercus stellata*)

TODD	LOGA	WARR	EDMO	HART
6.8	<	0.7	2.0	21.1
	SIMP	ALLE	BARR	GREE
	15.0	0.2	0.3	<

Percent "hickory" (*Carya* spp.)

TODD	LOGA	WARR	EDMO	HART
10.6	2.2	3.5	5.0	8.5
	SIMP	ALLE	BARR	GREE
	8.3	4.1	4.3	9.3

Percent "beech" (*Fagus grandifolia*)

TODD	LOGA	WARR	EDMO	HART
4.5	18.9	11.5	8.7	<
	SIMP	ALLE	BARR	GREE
	1.9	15.4	19.2	17.2

Percent "poplar" (*Liriodendron tulipifera*)

TODD	LOGA	WARR	EDMO	HART
3.5	1.3	4.7	3.0	3.8
	SIMP	ALLE	BARR	GREE
	0.3	8.5	6.8	5.0

Percent "maple" (*Acer saccharum, A. nigrum, A. rubrum, A. saccharinum*)

TODD	LOGA	WARR	EDMO	HART
2.3	1.3	3.0	2.0	<
	SIMP	ALLE	BARR	GREE
	4.1	8.5	2.0	0.9

Percent "gum" (*Liquidambar styraciflua, Nyssa sylvatica*)

TODD	LOGA	WARR	EDMO	HART
3.7	4.7	3.8	2.0	0.3
	SIMP	ALLE	BARR	GREE
	2.6	1.0	0.1	1.9

Percent "chestnut" (*Castanea dentata*)

TODD	LOGA	WARR	EDMO	HART
1.8	1.3	1.1	4.3	6.2
	SIMP	ALLE	BARR	GREE
	0.5	1.0	9.0	4.6

Percent "walnut" (*Juglans nigra, J. cinerea*)

TODD	LOGA	WARR	EDMO	HART
0.1	0.3	<	1.0	<
	SIMP	ALLE	BARR	GREE
	<	0.1	1.2	0.9

Percent "elm" (*Ulmus rubra, U. americana, U. alata*)

TODD	LOGA	WARR	EDMO	HART
0.2	<	0.1	2.3	<
	SIMP	ALLE	BARR	GREE
	2.0	1.1	<	<

Percent "ash" (*Fraxinus americana, F. pennsylvanica, F. quadrangulata*)

TODD	LOGA	WARR	EDMO	HART
0.4	0.6	1.1	1.0	<
	SIMP	ALLE	BARR	GREE
	1.2	0.1	<	<

Percent "sycamore" (*Platanus occidentalis*)

TODD	LOGA	WARR	EDMO	HART
1.8	4.7	0.1	3.0	<
	SIMP	ALLE	BARR	GREE
	1.5	2.9	3.0	0.4

Percent "cedar" (*Juniperus virginiana*)

TODD	LOGA	WARR	EDMO	HART
<	3.1	0.2	0.6	<
	SIMP	ALLE	BARR	GREE
	<	<	0.1	<

Percent "locust" (*Robinia pseudoacacia, Gleditsia triacanthos*)

TODD	LOGA	WARR	EDMO	HART
<	<	<	<	0.3
	SIMP	ALLE	BARR	GREE
	<	<	<	<

Percent "scattered" (other species for that county, but not a consistent group for each county, since not all of the above taxa are itemized in each county). *The only county with basswood recorded was LOGA (with 0.5% that is included here in "scattered"). Hemlock, cucumber tree, buckeye, hackberry and cherry were not specifically recorded in any of these counties; but they were in more eastern regions.

TODD	LOGA*	WARR	EDMO	HART
1.0	6.0	1.2	5.2	3.7
	SIMP	ALLE	BARR	GREE
	5.3	3.7	0.1	0.3

Appendix Three: (a) list of all vascular species found on the Cave Springs Cavern Tract or nearby (along fencerows).

Abbreviations for abundance are as follows:
abu = abundant; com = common; fre = frequent; pre = present; occ = occasional; rar = rare; nea = nearby; loc = locally

Also: dbh = diameter at breast height; esp = especially; lvs = leaves; sev = several

SCIENTIFIC NAME	COMMON NAME	ABUNDANCE	COMMENT: A = alien (a = uncertain/adventive)
TREES		*TREES*	
Acer nigrum Michx. f.	black maple	occ?	see saccharum; perhaps introgressed
Acer saccharum Marsh.	sugar maple	com	understory; lvs pale below but hairy
Broussonetia papyrifera (L.) L'Hér. ex Vent.	paper mulberry	occ	A: thicket behind sinkhole; yard corner
Carya cordiformis (Wangenh.) K. Koch	bitternut hickory	loc fre	to 8-10 dm
Celtis laevigata Willd.	southern hackberry	occ	much introgression with occidentalis
Celtis occidentalis L.	common hackberry	com	to 8 dm? much introgression
Ilex opaca Ait.	holly	rar	a: probably adventive
Juglans nigra L.	black walnut	loc fre	
Juniperus virginiana L.	redcedar	rar	
Morus alba L.	white mulberry	occ	A: esp upper edges; check ids
Morus rubra L.	red mulberry	occ	edges and thin woods
Prunus serotina Ehrh.	black cherry	com	
Quercus alba L.	white oak	loc com	to 11-15 dm
Quercus imbricaria Michx.	shingle oak	loc com	to 7-12 dm
Quercus muehlenbergii Engelm.	chinquapin oak	loc fre	to 12 dm
Salix nigra Marsh.	black willow	loc	small pond on NE side
Ulmus americana L.	white elm	loc	to 8 dm; all rough-leaved (slight in sun)
SHRUBS		*SHRUBS*	
Asimina triloba (L.) Dunal	pawpaw	occ	by big Carya cord
Euonymus alata (Thunb.) Sieb.	burning-bush	sca	
Hydrangea arborescens L.	wild hydrangea	loc abu	lower banks of gullies
Ligustrum sinense Lour.	Chinese privet	loc fre	A: probably most is this
Ligustrum vulgare L.	European privet	occ?	A: apparently good id; smooth lvs

Lonicera maackii (Rupr.) Herder	Amur honeysuckle	rar	A: few plants
Malus pumila P. Mill.	European apple	occ	A: edge/trailside saplings/sprouts
Rhamnus caroliniana Walt.	common buck-cherry	occ	upper edge saplings/sprouts
Rhus copallinum L.	shining sumac	loc	edge
Rosa multiflora Thunb. ex Murr.	multiflora rose	loc abu	
Rubus argutus Link	southern blackberry	loc com	edges
Sambucus canadensis L.	elderberry	loc	
Symphoricarpos orbiculatus Moench	coralberry	loc abu	
VINES		*VINES*	
Lonicera japonica Thunb.	Japanese honeysuckle	loc abu	A
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	loc fre	
Rhus radicans L.	poison ivy	loc	
Smilax bona-nox L.	rough greenbrier	occ	cf var hederifolia
Smilax hispida Raf.	bristly greenbrier	loc	
Smilax rotundifolia L.	common greenbrier	rar	
Vitis vulpina L.	common smooth-grape	occ	edges; check ids more
HERBS		*HERBS*	
Agrimonia pubescens Wallr.	hairy agrimony	occ	
Allium vineale L.	weed onion	occ	A
Ambrosia artemisiifolia L.	common ragweed	loc fre	
Ambrosia trifida L.	giant ragweed	occ	
Andropogon virginicus L.	common broomsedge	loc com	field
Arctium minus Bernh.	burrdock	pre	A
Arisaema dracontium (L.) Schott	green dragon	occ	
Arisaema triphyllum (L.) Schott	jack-in-the-pulpit	occ	lower slopes
Asarum canadense L.	wildginger	occ; loc fre	steepest slope
Asplenium platyneuron (L.) B.S.P.	common ebony spleenwort	occ	
Aster lanceolatus Willd.	swamp little-white-aster	occ?	check id when flowering
Aster ontarionis Wieg.	soft little-white-aster	occ?	
Aster pilosus Willd.	old-field little-white-aster	loc	field
Bromus japonicus Thunb. ex Murr.	Japanese cheat-grass	loc abu?	A: field; check id racemosus group
Bromus sterilis L.	greater-awned cheat-grass	loc	A: roadside
Bromus tectorum L.	lesser-awned cheat-grass	loc com	A: roadside

Cardamine concatenata (Michx.) Sw.	laciniate toothwort	loc com	syn. Dentaria laciniata
Cardamine hirsuta L.	common bittercress	pre	A
Carduus nutans L.	nodding plumeless thistle	occ	A
Carex aggregata Mackenz.	rich meadow spike-sedge	loc fre	grassland and thin woods
Carex blanda Dewey	weedy lax-sedge	sca	
Carex rosea Schkuhr ex Willd.	moist-woods little-spike-sedge	loc	
Carex sparganioides Muhl. ex Willd.	rich-woods spike-sedge	occ	low slopes/trailside
Carex texensis (Torr.) Bailey	field spike-sedge	occ	a: mowed parking area
Chaerophyllum tainturieri Hook.	hairy wild chervil	loc fre	edges
Cichorium intybus L.	chicory	occ	A
Circaea canadensis (L.) Hill	enchanter's nightshade	loc fre	esp lower
Clematis versicolor Small ex Rydb.	smooth leather-flower	occ	one patch on steepest slope
Commelina communis L.	common dayflower	sca; loc fre	A
Croton monanthogynus Michx.	lime croton	loc	roadside
Dactylis glomerata L.	orchardgrass	loc com	A: field
Daucus carota L.	wild carot	occ	A
Delphinium tricorne Michx.	wood larkspur	loc	
Desmodium canescens (L.) DC.	hoary field ticktrefoil	loc fre	grassland
Desmodium glutinosum (Muhl. ex Willd.) Wood	rich wood tick-trefoil	loc	sev on steeper rocky slope ne of cave
Desmodium perplexum Schub.	hairy field tick-trefoil	sca?	check ids more; perhaps paniculatum also
Dryopteris marginalis (L.) Gray	marginal woodfern	rar	gully to NE of cave
Duchesnea indica (Andr.) Focke	false strawberry	loc com	A
Eleusine indica (L.) Gaertn.	goose-grass	occ	A: mowed driveway area
Elymus virginicus L. var. virginicus	smooth common wild-rye	loc fre	
Erigeron annuus (L.) Pers.	common daisy-fleabane	loc	field/trailside
Erigeron canadensis L.	common horseweed	loc fre	roadside
Erigeron philadelphicus L.	early daisy-fleabane	loc fre	
Eupatorium rugosum Houtt.	common snakeroot	loc fre	esp upper slopes
Euphorbia dentata Michx.	toothed spurge	occ	A: roadside
Festuca arundinacea Schreb.	tall fescue	loc dom	A: field
Festuca subverticillata (Pers.) Alexeev	wood fescue	occ?	check ids more; not flw
Galium aparine L.	cleaving bedstraw	loc com	a: esp upper slopes
Galium triflorum Michx.	moist wood bedstraw	occ	low slopes
Geranium carolinianum L.	field geranium	pre	field
Geum vernum (Raf.) Torr. & Gray	spring avens	loc fre	

Hemerocallis fulva (L.) L.	orange daylily	loc fre	A: pathside to SE towards house
Juncus tenuis Willd.	common path-rush	loc com	esp upper paths at edges
Lactuca canadensis L.	common wild lettuce	sca	edges/trails
Lamium amplexicaule L.	dryland henbit	pre	A: field
Lamium purpureum L.	common henbit	loc com	A: edge
Lespedeza stipulacea Maxim.	Korean clover	loc fre	A: more mowed field/roadside
Medicago lupulina L.	black medick	loc	A: field
Melilotus officinalis (L.) Lam.	yellow sweetclover	loc	A: field
Microstegium vimineum (Trin.) A. Camus	Japanese grass	loc	A: not widespread!
Muhlenbergia schreberi J.F. Gmel.	nimblewill	loc fre	along trails/roads
Narcissus pseudonarcissus L.	daffodil	loc fre	A: towards house
Ornithogalum umbellatum L.	star-of-Bethlehem	abu	
Oxalis dillenii Jacq.	weedy wood-sorrel	occ	
Oxalis stricta L.	tall wood-sorrel	occ	a: more open?
Panicum anceps Michx.	meadow fall-panicgrass	loc	grassland
Parietaria pensylvanica Muhl. ex Willd.	pellitory	loc	upper edges by fence
Passiflora incarnata L.	purple passionflower	rar	a: edge in open
Passiflora lutea L.	yellow passionflower	rar	trailside in sink
Perilla frutescens (L.) Britt.	beef-steak-plant	loc fre	A: esp on/near trails
Phytolacca americana L.	pokeweed	loc fre	increasing with seedlings in recent gaps
Pilea pumila (L.) Gray	clearweed	occ	rather few!
Plantago rugelii Dcne.	broad-leaf plantain	loc fre	mowed driveway
Poa annua L.	common annual bluegrass	loc	A: upper paths more/less open
Poa pratensis L.	common bluegrass	loc com	a: field
Poa sylvestris Gray	walnut-wood bluegrass	occ?	check id; only old flw stem seen
Podophyllum peltatum L.	mayapple	loc abu	
Polemonium reptans L.	Jacob's-ladder	occ	one path low on slope
Polygonatum biflorum (Walt.) Ell.	common Solomon's seal	loc com	
Polygonum aviculare L.	lowly knotweed	loc fre	A: mowed driveway area
Polygonum scandens L.	lowland climbing buckwheat	occ	
Polygonum virginianum L.	wood knotweed	loc fre	
Ranunculus abortivus L.	smooth little-buttercup	pre	
Ranunculus hispidus Michx.	common wood-buttercup	occ	few low on slope
Ranunculus sardous Crantz	pasture-buttercup	rar	A: roadside
Rumex crispus L.	curlyleaf dock	occ	A: field

Rumex obtusifolius L.	broadleaf dock	occ	A
Sanicula canadensis L.	common sanicle	loc	esp thin woods
Saponaria officinalis L.	bouncingbet	loc	A: field
Scrophularia marilandica L.	figwort	occ	upper edges/thin woods
Smilax herbacea L.	smooth carrionflower	rar	some hairs on lvs but fairly glaucous
Solanum carolinense L.	horse-nettle	occ	field
Solidago altissima L.	old-field goldenrod	pre	field
Sorghum halepense (L.) Pers.	Johnson-grass	com; loc dom	A: field
Stellaria media (L.) Vill.	common chickweed	loc fre	A
Taraxacum officinale G.H. Weber ex Wiggers	common dandelion	occ	A: esp roadsides/parking area
Torilis japonica (Houtt.) DC.	hedge-parsley	loc	A: field; id confirmed
Tridens flavus (L.) A.S. Hitchc.	purpletop-grass	pre	open
Trifolium campestre Schreb.	yellow clover	loc fre	A: roadside/field
Trifolium pratense L.	red clover	occ	A: open
Trifolium repens L.	white clover	pre	A: open
Trillium cuneatum Raf.	purple sessile-trillium	loc com	
Triodanis perfoliata (L.) Nieuwl.	Venus looking-glass	rar?	small scrap in eroded spot
Typha latifolia L.	broad cattail	loc	small pond on NE side
Verbascum blattaria L.	moth mullein	occ	A: field
Verbena urticifolia L.	white vervain	occ	
Vernonia gigantea (Walt.) Trel.	common ironweed	loc fre	field
Veronica arvensis L.	hairy sessile speedwell	pre	A: field
Veronica hederifolia L.	ivyleaf speedwell	abu	A: woods
Viola bicolor Pursh	common field-pansy	occ	field
Viola papilionacea Pursh p.p.	common blue-violet	loc abu	and local part albino w/blue stripes
Viola pensylvanica Michx.	smooth yellow stemmed-violet	loc fre	smooth stems; lvs thin pilose; frt tomentose
END		*END*	

Appendix Three: (b) list of all vascular species documented from Warren County.

The Kentucky Atlas (draft freely available) provides further explanation of herbarium/source codes (under "WARR"), alien codes and habitat codes ("VegClass" and "AcidBase").

WARR	FullName	AlienOrigin	VegClass	AcidBasic
WK	Abutilon theophrasti Medik.	AS	H-10	D
2	Acalypha deamii (Weatherby) Ahles		4	D
WK	Acalypha virginica L.		h-10,12,7	C
KY	Acer negundo L.		4,6,7	E
ky	Acer nigrum Michx. f.		5,7,4	E?
LO	Acer platanoides L.	EU	7?	D?
WK	Acer rubrum L. var. rubrum		7,11,5	C
WK	Acer saccharinum L.		4,6,3	D
CW	Acer saccharum Marsh. var. saccharum		5,7	D
MU	Achillea millefolium L. agg.	m	F-10	D
WK	Actaea pachypoda Ell.		5	C
WK	Adiantum pedatum L.		5	D
KY	Aegilops cylindrica Host	EU	H-10	D
KY	Aesculus glabra Willd.		7,5,11	E
ha	Aesculus pavia L.		4,5?	D?
1	Aethusa cynapium L.	EU	H-10,8	E?
1	Agalinis tenuifolia (Vahl) Raf. var. macrophylla (Benth.) Blake		f-10,9?	C?
WK	Agalinis tenuifolia (Vahl) Raf. var. tenuifolia		f-10,12,7,11	C
2	Agastache scrophulariifolia (Willd.) Kuntze		8,10?	D?
1	Agrimonia parviflora Ait.		9,6,4	C
1	Agrimonia pubescens Wallr.		7,10,11	D
WK	Agrimonia rostellata Wallr.		7,5,4?	D
1	Agrostemma githago L.	EU	H-10	D
WK	Agrostis gigantea Roth	EU	F-10,9,8,6	D
1	Agrostis perennans (Walt.) Tuckerman		7,11,5	C?
KY	Ailanthus altissima (P. Mill.) Swingle	AS	f-8,7,11,5	D
WK	Albizia julibrissin Durazz.	AS	f-8,10	C
1	Aletris farinosa L.		10,9,11	B
WK	Alisma subcordatum Raf.		2	D
KY	Allium ampeloprasum L.	EU	R-10	D
WK	Allium canadense L.		7,4,10	D
wk	Allium cernuum Roth		12,10	E
WK	Allium vineale L.	EU	R-10,7,4	D
CW	Alnus serrulata (Ait.) Willd.		2,6,1,9	B
WK	Alopecurus carolinianus Walt.		F-10,8	D
WK	Amaranthus albus L.	w	H-10	E
WK	Amaranthus spinosus L.	S	G-10	E
KY	Ambrosia artemisiifolia L. var. elatior (L.) Descourtils		f-10,12	D
WK	Ambrosia trifida L.		f-10,7,4	D
WK	Amelanchier arborea (Michx. f.) Fern.		11,12,7	C
WK	Ammannia coccinea Rottb.		9,2,1	C

WK	Amorpha fruticosa L.		1	C
WK	Ampelopsis arborea (L.) Koehne		2,6,3,9?	C?
KY	Ampelopsis cordata Michx.		1,4,6,7?	D
WK	Anagallis arvensis L. var. arvensis	EU	S-10	D
mm	Andropogon gerardii Vitman		f-10,12,1	C
MM	Andropogon gyrans Ashe		f-10,12	D
WK	Andropogon virginicus L. var. virginicus		F-10,9	C
WK	Anemone virginiana L.		8,7,5	D
WK	Anemonella thalictroides (L.) Spach		5,11,7	C
WK	Angelica venenosa (Greenway) Fern.		10,7,11	B
LO	Antennaria parlinii Fern.		7,11	C
WK	Antennaria plantaginifolia (L.) Richards. var. plantaginifolia		11,7,10	C
WK	Antenoron virginianum (L.) Roberty & Vautier		7,4,5	D
WK	Anthemis arvensis L.	EU	G-10	D
WK	Anthemis cotula L.	EU	G-10	D
WK	Apios americana Medik.		9,6,2,1	C
GH	Apios priceana B.L. Robins.		8,7,5	D
WK	Aplectrum hyemale (Muhl. ex Willd.) Torr.		5,11,7	C
WK	Apocynum cannabinum L.		F-10,1	D
WK	Apocynum sibiricum Jacq.		F-10?	C?
KY	Aquilegia canadensis L.		5,11	D
WK	Arabidopsis thaliana (L.) Heynh.	EU	H-10	C?
RA	Arabis hirsuta (L.) Scop. var. adpressipilis (M. Hopkins) Rollins		12	E?
WK	Aralia spinosa L.		8,7,6,11?	C
WK	Arenaria serpyllifolia L.	EU	S-10,12	D
KY	Arisaema dracontium (L.) Schott		4,5,7	D
KY	Arisaema triphyllum (L.) Schott		5,7,11	D
WK	Aristida oligantha Michx.		f-10,12	C
EK	Arnoglossum muehlenbergii (Schultz-Bip.) H.E. Robins.		5,7	D
KA	Aronia arbutifolia (L.) Pers.		9,6,12	B
wk	Aronia melanocarpa (Michx.) Ell.		12,9,6	B
1	Arrhenatherum elatius (L.) Beauv. ex J.& K. Presl	EU	F-10,8	D
WK	Artemisia annua L.	EU	G-10	E
LO	Arthraxon hispidus (Thunb.) Makino	AS	f-9,6,4	C
WK	Aruncus dioicus (Walt.) Fern. var. dioicus		5,7	C
WK	Arundinaria gigantea (Walt.) Muhl.		8,7,6,4	D
ky	Asarum canadense L. var. reflexum (E.P. Bickn.) B.L. Rob.		5	D
WK	Asclepias hirtella (Pennell) Woods.		9,10,12?	C?
WK	Asclepias incarnata L.		f-9,2	D
MU	Asclepias purpurascens L.		r-9,10,8?	D?
WK	Asclepias syriaca L.		R-10	D
WK	Asclepias tuberosa L.		f-10,12,8	C
WK	Asclepias verticillata L.		f-12,10	D
WK	Asclepias viridiflora Raf.		12	E
KY	Asimina triloba (L.) Dunal		7,5	D
MU	Asparagus officinalis L.	EU	H-10	D

WK	Asplenium bradleyi D.C. Eat.		11	B
WK	Asplenium montanum Willd.		5,11	A
KY	Asplenium pinnatifidum Nutt.		11,5	A
WK	Asplenium platyneuron (L.) B.S.P. var. platyneuron		7,5,11	C
KA	Asplenium resiliens Kunze		5,11	E
WK	Asplenium rhizophyllum L.		5	D
WK	Asplenium trichomanes L.		5	C
WK	Asplenium X trudellii Wherry (pro sp.)		5,11	A
1	Astragalus canadensis L.		r-7,8,11,1	C
WK	Astranthium integrifolium (Michx.) Nutt.		f-10,8,7,1	E
EK	Athyrium asplenioides (Michx.) A.A. Eat.		5,7	C
1	Aureolaria flava (L.) Farw. var. macrantha Pennell		11,7	D
EK	Aureolaria patula (Chapman) Pennell		1,4,5	E
1	Aureolaria pectinata (Nutt.) Pennell		10,7	B
KY	Aureolaria virginica (L.) Pennell		10,7,11	C
KY	Bacopa rotundifolia (Michx.) Wettst.		2	D?
KY	Belamcanda chinensis (L.) DC.	AS	f-12,10	D
1	Betula alleghaniensis Britt. var. macrolepis (Fern.) Brayshaw		5	A
WK	Betula nigra L.		4,6,1	C
WK	Bidens bipinnata L.		f-10,12	D
WK	Bidens polylepis Blake	w	f-9,6,1	D?
LO	Bignonia capreolata L.		7,4,5,6	D
WK	Blephilia ciliata (L.) Benth.		r-10,7,12	E
2	Boechera dentata (Raf.) Al-Shehbaz & Zarucchi		5,4	E
KY	Boechera laevigata (Muhl. ex Willd.) Al-Shehbaz var. laevigata		11,5,12	E
WK	Boehmeria cylindrica (L.) Sw.		6,4,9	D
MU	Botrypus virginianus (L.) Holub		7,5,11	D?
KA	Bouteloua curtipendula (Michx.) Torr.		12,10	E
EK	Brachyelytrum erectum (Schreb. ex Spreng.) Beauv.		5,11,7	C
wk	Brassica napus L.	EU	H-10	D
wk	Brassica nigra (L.) W.D.J. Koch	EU	H-10	D
WK	Bromus japonicus Thunb. ex Murr.	AS	H-10	D
WK	Bromus pubescens Muhl. ex Willd.		7,11,5	D
KY	Bromus racemosus L.	EU	H-10	D
KY	Bromus tectorum L.	EU	R-10,12	E
WK	Broussonetia papyrifera (L.) L'Hér. ex Vent.	AS	f-8,7	E?
LO	Buchnera americana L.		10,12,9	B
WK	Buglossoides arvensis (L.) I.M. Johnston	EU	F-10,12	D
sp	Bulbostylis capillaris (L.) Kunth ex C.B. Clarke		12,10	C
cw	Calycanthus floridus L. var. glaucus (Willd.) Torr. & Gray		11,5,7	B
CW	Calycocarpum lyonii (Pursh) Gray		6,4?	C?
WK	Calystegia fraterniflora (Mackenzie & Bush) Brummitt		F-10,8	D
MM	Camassia scilloides (Raf.) Cory		5,7	E
WK	Campanulastrum americanum (L.) Small		7,8,11	D
WK	Campsis radicans (L.) Seem. ex Bureau		f-8,6,4,1	D?
WK	Capsella bursa-pastoris (L.) Medik.	EU	G-10	D
WK	Cardamine bulbosa (Schreb. ex Muhl.) B.S.P.		6,9	D

WK	Cardamine douglassii Britt.		7,5,11	E
WK	Cardamine hirsuta L.	EU?	H-10,7,4	D
WK	Cardamine parviflora L. var. arenicola (Britt.) O.E. Schulz		h-10,12,9	C?
WK	Cardamine pensylvanica Muhl. ex Willd.		h-9,6,1?	D
WK	Carduus nutans L.	EU	H-10,9	D
ky	Carex aggregata Mackenzie		g-10,8,7	D
BE	Carex albicans Willd. ex Spreng.		11,7,5	D
sp	Carex albursina Sheldon		5	E
KY	Carex blanda Dewey		7,10,4,6	D
sp	Carex cephaloidea (Dewey) Dewey		7?	D?
sp	Carex cephalophora Muhl. ex Willd.		11,7	C
KY	Carex conjuncta Boott		G-10,9,7,6	E
wk	Carex crus-corvi Shuttlw. ex Kunze		9,6	D
KY	Carex cumberlandensis Naczi, Kral & Bryson		7,5,4,11	C
KY	Carex digitalis Willd. var. digitalis		11,5,7	C
WK	Carex frankii Kunth		f-9,6,2	D
np	Carex gigantea Rudge		4,6,9	C
sp	Carex glaucodea Tuckerman ex Olney		r-10,9	C
WK	Carex granularis Muhl. ex Willd.		g-9,10,6,7	E
KY	Carex grayi Carey		4,6	D
BE	Carex hirsutella Mackenzie		F-10,9,7	C
DO	Carex jamesii Schwein.		5,7,11	D
DO	Carex kraliana Naczi & Bryson		5,11	D
wa	Carex laxiflora Lam.		5,7	D
KY	Carex leavenworthii Dewey		9,6	D
KY	Carex louisianica Bailey		6,9	D
KY	Carex lurida Wahlenb.		6,9	C
KY	Carex muhlenbergii Schkuhr ex Willd.		11,7,10	C
KY	Carex oligocarpa Schkuhr ex Willd.		7,5,11	E
KY	Carex planispicata Naczi		5,4	C
KY	Carex radiata (Wahlenb.) Small		6,9	C
KY	Carex retroflexa Muhl. ex Willd.		7,11,10	C
NK	Carex rosea Schkuhr ex Willd.		7,5,11	D
KY	Carex shortiana Dewey		g-9,10	E
KY	Carex squarrosa L.		9,6	C
BE	Carex swanii (Fern.) Mackenzie		11,7	B
KY	Carex vulpinoidea Michx.		f-9	D
KY	Carpinus caroliniana Walt. var. virginiana (Marsh.) Fern.		7,5,4,6	D
WK	Carya carolinae-septentrionalis (Ashe) Engl. & Graebn.		11,10,7	D?
WK	Carya cordiformis (Wangenh.) K. Koch		5,7	D
WK	Carya glabra (P. Mill.) Sweet		11,7	C
1	Carya illinoinensis (Wangenh.) K. Koch		6,4	E?
hg	Carya laciniosa (Michx. f.) G. Don		7,6,9	E
LO	Carya tomentosa (Lam. ex Poir.) Nutt.		7,11,10	C
WK	Castanea dentata (Marsh.) Borkh.		11,5,7	B
1	Castanea pumila (L.) P. Mill.		8,7,11,10	B?
2	Castilleja coccinea (L.) Spreng.		10,12,9	D

wk	Catalpa bignonioides Walt.	s	4,6?	C?
wk	Catalpa speciosa (Warder) Warder ex Engelm.	s	f-4,6,7?	D?
WK	Caulophyllum thalictroides (L.) Michx.		5	E
WK	Ceanothus americanus L.		f-10,7,11	C
1	Celastrus orbiculatus Thunb.	AS	8,7	D
hg	Celastrus scandens L.		8,7,11	D
WK	Celtis laevigata Willd.		6,4,7	E
WK	Celtis occidentalis L.		7,6,4,8	E
WK	Celtis tenuifolia Nutt.		12,10,9,8	E?
EK	Centaurea biebersteinii DC.	EU	R-10,12	D
MM	Centaurea cyanus L.	EU	H-10	C
KA	Centaurea solstitialis L.	EU	F-10	D
KY	Cephalanthus occidentalis L.		2,3,1	C
WK	Cerastium brachypetalum Desportes ex Pers.	EU	S-10	D
WK	Cerastium brachypodum (Engelm. ex Gray) B.L. Robins.	w	F-10,12?	C?
WK	Cerastium glomeratum Thuill.	EU	G-10,8	D
2	Cerastium velutinum Raf.		12,11	E
WK	Cerastium vulgare Hartman	EU	G-10,8	D
KY	Cercis canadensis L.		8,12,7,11	D
WK	Chaerophyllum procumbens (L.) Crantz var. procumbens		f-7,8,4	E
WK	Chaerophyllum tainturieri Hook.		R-10,12	D
WK	Chamaecrista fasciculata (Michx.) Greene		f-10	C
WK	Chamaecrista nictitans (L.) Moench		f-10,12	C
KY	Chamaelirium luteum (L.) Gray		7,6,9	C
WK	Chamaesyce maculata (L.) Small		S-10	D
WK	Chamaesyce nutans (Lag.) Small		R-10,1	D
wk	Chamaesyce prostrata (Ait.) Small	S	S-10	D
WK	Chasmanthium latifolium (Michx.) Yates		7,8,4,1	D
KA	Cheilanthes lanosa (Michx.) D.C. Eat.		12,11	C
WK	Chelone glabra L. var. glabra		6,4	C
WK	Chenopodium album L.	EU?	H-10	D
1	Chenopodium standleyanum Aellen		11,7	E
WK	Chimaphila maculata (L.) Pursh		7,11	B
mm	Chloris verticillata Nutt.	W	F-10	D
WK	Cichorium intybus L.	EU	R-10	D
WK	Cicuta maculata L.		9,2	C
KA	Cinna arundinacea L.		6,4,9	C
WK	Circaea canadensis (L.) Hill		5,7,4	D
WK	Cirsium altissimum (L.) Hill		8,7,10,11	D
WK	Cirsium discolor (Muhl. ex Willd.) Spreng.		f-10,8,7	D
WK	Cirsium vulgare (Savi) Ten.	EU	G-10	D
WK	Claytonia caroliniana Michx.		5	B
WK	Claytonia virginica L.		7,5,10	D
NC	Clematis catesbyana Pursh		7,10	D
MB	Clematis cf. versicolor/glaucophylla ?		7,11?	C
KY	Clematis viorna L. {widespread/hairy variant}		11,5	D
WK	Clematis virginiana L.		7,10	C
KY	Clitoria mariana L.		r-10,7,11	B

KY	Cocculus carolinus (L.) DC.		7,11,5	D
WK	Collinsonia canadensis L.		5,7	D
KY	Commelina communis L.	AS	F-10,9,8	D
WK	Conoclinium coelestinum (L.) DC.		f-9,10	D
WK	Conopholis americana (L.) Wallr. f.		11,7,5	C
WK	Consolida ambigua (L.) P.W. Ball & Heywood	EU	G-10,7	D
WK	Convolvulus arvensis L.	EU	R-10	D
WK	Conyza canadensis (L.) Cronq.		F-10	D
WK	Coreopsis lanceolata L.	W	f-12,10	D?
KY	Coreopsis major Walt.		11,7,12	B
WK	Coreopsis tinctoria Nutt.	W	R-10	C
WK	Cornus drummondii C.A. Mey.		8,7,11,4	E
KY	Cornus florida L.		7,11,8,5	C
WK	Cornus obliqua Raf.		1	C
WK	Cornus stricta Lam.		2,3,9	C?
KY	Corydalis flavula (Raf.) DC.		7,4,5,11	D
CW	Corylus americana Walt.		8,7,9,6?	C
1	Crataegus chrysocarpa Ashe ?		8,10?	B?
MB	Crataegus collina Chapman		f-8,7,10?	D?
WK	Crataegus crus-galli L.		f-10,8	D
WK	Crataegus mollis Scheele		f-8,10,7,4	E?
GH	Crataegus phaenopyrum (L. f.) Medik.	e	f-8,7,10	C?
WK	Crataegus viridis L.		6,9,7,10	D
lb	Croton capitatus Michx.	w	G-10	D
KY	Croton monanthogynus Michx.		r-12,10	E
MM	Cruciata pedemontana (Bellardi) Ehrend.	EU	F-10,12	D
KY	Cuphea viscosissima Jacq.		r-12,10,9	D
hg	Cuscuta epithymum (L.) L.	EU	H-10	D?
1	Cuscuta glomerata Choisy		f-9,10?	C?
EK	Cuscuta gronovii Willd. ex J.A. Schultes		f-9,2,1	D?
wk	Cuscuta pentagona Engelm.		f-10,8,1,12?	D
1	Cuscuta polygonorum Engelm.		f-9,2	D?
WK	Cynanchum laeve (Michx.) Pers.		R-8,10,7	D
WK	Cynodon dactylon (L.) Pers.	S?	F-10,9	D
2	Cynoglossum officinale L.	EU	G-0	D?
WK	Cynoglossum virginianum L.		7,11,5	C
WK	Cyperus acuminatus Torr. & Hook. ex Torr.		9?	C?
WK	Cyperus echinatus (L.) Wood		f-10	B?
BE	Cyperus esculentus L.	s	H-10	D
EK	Cyperus iria L.	AS	h-9,2	C
WK	Cyperus lancastriensis Porter ex Gray		10	B
sp	Cyperus lupulinus (Spreng.) Marcks		h-9,2?	C?
EK	Cyperus odoratus L.		H-9,10	D?
WK	Cyperus pseudovegetus Steud.		9,2	C
sp	Cyperus refractus Engelm. ex Boeckl.		10,8?	B
KY	Cyperus retrofractus (L.) Torr.		10,12	B
MM	Cyperus squarrosus L.		h-9,10,12,1	D
WK	Cyperus strigosus L.		H-10,9	D
EK	Cystopteris bulbifera (L.) Bernh.		5	D
EK	Cystopteris protrusa (Weatherby) Blasdell		7,5	D

WK	Dactylis glomerata L.	EU	F-10	D
WK	Dalea candida Michx. ex Willd.		12	E
1	Dalea purpurea Vent.		10,12	D
KY	Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes		f-11,12,10,8	C
WK	Dasistoma macrophylla (Nutt.) Raf.		11,12	E
WK	Datura stramonium L.	s	G-10	D
WK	Daucus carota L.	EU	F-10,12	D
WK	Delphinium carolinianum Walt. ssp. calciphilum Warnock		12	E
WK	Delphinium tricorne Michx.		5,7,11	E
WK	Dennstaedtia punctilobula (Michx.) T. Moore		11,7	B
WK	Dentaria heterophylla Nutt.		5,7	B
WK	Dentaria laciniata Muhl. ex Willd.		7,5	D
KY	Dentaria multifida Muhl. ex Ell.		5,7	D
WK	Deparia acrostichoides (Sw.) M. Kato		5	C
KY	Descurainia pinnata (Walt.) Britt. var. brachycarpa (Richards.) Fern.		r-12,10,11	D
WK	Desmodium canescens (L.) DC.		F-10,8	C
WK	Desmodium glutinosum (Muhl. ex Willd.) Wood		5,11	D
WK	Desmodium nudiflorum (L.) DC.		11,7,5	C
WK	Desmodium paniculatum (L.) DC.		f-7,10,11	C
ky	Desmodium perplexum Schub.		F-10,7	D
WK	Desmodium rotundifolium DC.		f-7,10,11	C
WK	Desmodium sessilifolium (Torr.) Torr. & Gray		10	B
WK	Dianthus armeria L.	EU	G-10	D
EK	Diarrhena americana Beauv.		11,5	E
KY	Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. fasciculatum (Torr.) Freckmann		F-10,8,12	C
KY	Dichanthelium boscii (Poir.) Gould & C.A. Clark var. boscii		11,7,5	C
1	Dichanthelium depauperatum (Muhl.) Gould		12,10	B
3	Dichanthelium dichotomum (L.) Gould		11,7,5	C
KY	Dichanthelium laxiflorum (Lam.) Gould		f-7,8,10	C
2	Dichanthelium microcarpon (Muhl. ex Ell.) Mohlenbrock		9,6	B
sp	Dichanthelium scoparium (Lam.) Gould		f-9,6,10	B
KY	Dichanthelium scribnerianum (Nash) ?		f-12,10	D?
KY	Dichanthelium sphaerocarpon (Ell.) Gould		8,10,12,6	B
WK	Didiplis diandra (Nutt. ex DC.) Wood		2	C
WK	Diodia teres Walt.		F-10,12,9	C
WK	Diodia virginiana L.		f-2,9	C
WK	Dioscorea quaternata J.F. Gmel.		7,8,5,11	C
WK	Diospyros virginiana L. var. pubescens (Pursh) Dippel		6,7,8?	C
WK	Diospyros virginiana L. var. virginiana		8,7,6,11	C
rc	Diplazium pycnocarpon (Spreng.) Broun		5	E
CW	Dirca palustris L.		7,11,5,4	D
EK	Dodecatheon frenchii (Vasey) Rydb.		5,11	B
KY	Dodecatheon meadia L.		12,11	E

WK	Draba brachycarpa Nutt. ex Torr. & Gray		12,10	C?
MB	Draba cuneifolia Nutt. ex Torr. & Gray		12,10?	D?
WK	Draba verna L.	EU	R-10,12	E
WK	Dryopteris intermedia (Muhl. ex Willd.) Gray		5,7	B
MB	Dryopteris ludoviciana (Kunze) Small		6	C
WK	Dryopteris marginalis (L.) Gray		5,11	D
WK	Dysphania ambrosioides (L.) Mosyakin & Clemants	S?	G-10	D
EK	Echinacea simulata R.L. McGregor		12	D
LO	Echium vulgare L.	EU	R-10,12	D
CW	Elaeagnus angustifolia L.	EU	f-10,8	D?
wk	Eleocharis acicularis (L.) Roemer & J.A. Schultes		9	C
bt	Eleocharis bifida S.G. Smith		12	E
ky	Eleocharis engelmannii Steud.		2,9	C
KY	Eleocharis obtusa (Willd.) J.A. Schultes		h-2,9	D
WK	Elephantopus carolinianus Raeusch.		f-7,8,10,6	D
WK	Eleusine indica (L.) Gaertn.	EU	G-10	E
EK	Elymus glabriflorus (Vasey) Scribn. & Ball var. australis (Scribn. & Ball) J.J.N. Campb.		f-10,11,8	D
WK	Elymus hystrix L. var. hystrix		11,7,8,5	D
WK	Elymus macgregorii R. Brooks & J.J.N. Campb.		7,8,4	E
WK	Elymus villosus Muhl. ex Willd. var. arkansanus (Scribn. & Ball) J.J.N. Campb.		11,8	D
KY	Elymus villosus Muhl. ex Willd. var. villosus		7,11,8	D
WK	Elymus virginicus L. var. intermedius (Vasey) Bush		1,4,10	D
WK	Elymus virginicus L. var. virginicus		f-8,7,10	D
WK	Endodeca serpentaria (L.) Raf.		5,11	C
WK	Enemion biternatum Raf.		5	E
WK	Epifagus virginiana (L.) W. Bart.		5,7,11	C
WK	Equisetum arvense L.		1,4	C
MB	Equisetum hyemale L. var. affine (Engelm.) A.A. Eat.		1	C
2	Eragrostis pectinacea (Michx.) Nees ex Steud.		R-10,1	D
WK	Eragrostis spectabilis (Pursh) Steud.		F-10	C
WK	Erechtites hieraciifolia (L.) Raf. ex DC.		H-8,11,10	C
WK	Erianthus alopecuroides (L.) Ell.		f-8,10	B
WK	Erigenia bulbosa (Michx.) Nutt.		5,7,4?	E
WK	Erigeron annuus (L.) Pers.		F-10	D
KY	Erigeron philadelphicus L.		f-10,7	D
WK	Erigeron strigosus Muhl. ex Willd.		F-10,12	C
WK	Erodium cicutarium (L.) L'Hér. ex Ait.	EU	S-10	E?
WK	Eryngium yuccifolium Michx.		10,12,9	C
KY	Erythronium albidum Nutt.		7,5,11	E
WK	Erythronium americanum Ker-Gawl.		5,11,7	D
KY	Euonymus americanus L.		7,5,8	C
WK	Euonymus atropurpureus Jacq.		8,7,4,5	E
MU	Eupatorium album L.		10,8	B
2	Eupatorium capillifolium (Lam.) Small	s	H-10	C
WK	Eupatorium perfoliatum L.		f-9,2	D
1	Eupatorium semiserratum DC.		9,1?	B
KA	Eupatorium serotinum Michx.		f-9,10	C
WK	Eupatorium sessilifolium L.		11,7	C

KY	Euphorbia commutata Engelm.		5,11,7	D
WK	Euphorbia corollata L.		f-10,12,7	C
WK	Euphorbia dentata Michx.	W	R-10,12	D
sp	Euphorbia marginata Pursh	W	H-10	C
2	Euphorbia obtusata Pursh		6,4,9?	D
JC	Eurybia hemispherica (Alexander) Nesom		12,10	D?
WK	Eutrochium fistulosum (Barratt) E.E. Lamont		f-9,2,1	C
KY	Fagus grandifolia Ehrh. var. caroliniana (Loud.) Fern. & Rehd.		5,7	C
MU	Fallopia convolvulus (L.) A. Löve	EU	f-10,7,12?	C
EK	Festuca arundinacea Schreb.	EU	F-10,8	D
2	Festuca paradoxa Desv.	w	8,7?	D
MM	Festuca subverticillata (Pers.) Alexeev		5,7,4	D
WK	Forestiera ligustrina (Michx.) Poir.		12,11,7?	E
WK	Fragaria virginiana Duchesne var. illinoensis Gray		F-10,7	C
LO	Fragaria virginiana Duchesne var. virginiana		F-10,7	C
KY	Frangula caroliniana (Walt.) Gray var. mollis (Fern.) new comb. ?		f-12?	D
WK	Frasera caroliniensis Walt.		7,11	D
WK	Fraxinus americana L. var. americana		7,5,11	E
hg	Fraxinus pennsylvanica Marsh. var. pennsylvanica		6,9,4	D?
WK	Fraxinus pennsylvanica Marsh. var. subintegerrima (Vahl) Fern.		9,6?	E
KY	Fraxinus quadrangulata Michx.		11,7,12	E
WK	Galactia volubilis (L.) Britt.		r-12,10	C
KY	Galium aparine L.	m	f-8,10,7	E
KY	Galium circaezans Michx.		11,7,5	D
WK	Galium concinnum Torr. & Gray		11,5	D
WK	Galium obtusum Bigelow		6,9	D
EK	Galium pilosum Ait.		F-10,12	C
WK	Galium triflorum Michx.		7,5,11	D
KY	Gamochaeta purpurea (L.) Cabrera		F-10	C
np	Gentiana alba Muhl. ex Nutt.		10,12	D
3	Gentiana andrewsii Griseb.		9,6	C?
MB	Gentiana puberulenta J. Pringle		10	D
WK	Gentiana villosa L.		7,8,10	B
LO	Geranium carolinianum L. var. confertiflorum Fern.		h-10	D
KY	Geranium maculatum L.		7,5,4	C
WK	Geum canadense Jacq.		h-8,7,10	D
WK	Geum vernum (Raf.) Torr. & Gray		h-10,8,7	E
WK	Geum virginianum L.		11,7,8	B?
WK	Gillenia stipulata (Muhl. ex Willd.) Nutt.		11,7,10	C
WK	Glechoma hederacea L.	EU	h-7,8,10,4	D
WK	Gleditsia triacanthos L.		8,7,10	E
bt	Glyceria striata (Lam.) A.S. Hitchc.		1,2,6	D
WK	Goodyera pubescens (Willd.) R. Br. ex Ait. f.		7,11,5	B
WK	Gratiola neglecta Torr.		g-9,2	D
KY	Grindelia lanceolata Nutt.		r-12,10	D?
KA	Grindelia squarrosa (Pursh) Dunal	W	R-10,12	C?
wk	Gymnocladus dioicus (L.) K. Koch		8,7	E

KY	Hamamelis virginiana L.		7,11,4,1	C
3	Hasteola suaveolens (L.) Pojark.		4,6	D
WK	Hedeoma hispida Pursh	w	R-10,12	B?
KY	Hedeoma pulegioides (L.) Pers.		G-10,12	D
KY	Helenium amarum (Raf.) H. Rock	W	GR-10,9	C
WK	Helenium autumnale L. var. parviflorum (Nutt.) Fern.		f-9,6,1	D
EK	Helenium flexuosum Raf.		f-9,6,1	C
np	Helianthus eggertii Small		f-8,10	C
WK	Helianthus hirsutus Raf.		f-10,12,8	D?
KY	Helianthus mollis Lam.		f-10,12	C
3	Helianthus pauciflorus Nutt.	w	F-10?	C?
WK	Helianthus tuberosus L.		f-8,4,10	D
WK	Heliotropium indicum L.	s	9,2,1	D?
EK	Heliotropium tenellum (Nutt.) Torr.		12	E
WK	Hepatica acutiloba DC.		5	D
1	Heteranthera dubia (Jacq.) MacM.		2,1	D
2	Heteranthera limosa (Sw.) Willd.		2,9	D
WK	Heterotheca camporum (Greene) Shinners var. glandulissimum Semple	s	R-10	C
WK	Heuchera americana L. var. hirsuticaulis (Wheelock) Rosendahl, Butters & Lakela		5,11	D
EK	Heuchera longiflora Rydb.		5	C
WK	Heuchera parviflora Bartl.		5	A
2	Hieracium longipilum Torr.		10,7	B
WK	Holosteum umbellatum L.	EU	H-10	C?
WK	Hordeum pusillum Nutt.	w	R-10,8,9	E
WK	Houstonia caerulea L.		s-7,10,11	C
1	Houstonia canadensis Willd. ex Roemer & J.A. Schultes		f-12,10	D
WK	Houstonia lanceolata (Poir.) Britt.		f-7,12,10	D
WK	Houstonia purpurea L.		7,11,5	C
WK	Houstonia pusilla Schoepf		S-10,7	C
WK	Huperzia lucidula (Michx.) Trevisan		5	A
KY	Huperzia porophila (Lloyd & Underwood) Holub		5,11	A
KY	Hybanthus concolor (T.F. Forst.) Spreng.		5,11	E
LO	Hydrangea arborescens L.		5,4	D
EK	Hydrastis canadensis L.		5,11	D
WK	Hydrophyllum canadense L.		5,4	D
KY	Hymenocallis occidentalis (LeConte) Kunth		7,11,6	D
1	Hypericum crux-andreae (L.) Crantz		9,6	B
WK	Hypericum dolabriforme Vent.		12	E
WK	Hypericum gentianoides (L.) B.S.P.		12,10	B
WK	Hypericum mutilum L.		f-9,6	B
WK	Hypericum prolificum L.		7,10,12,1	D
WK	Hypericum punctatum Lam.		F-10,7	D
EK	Hypericum stragulum P. Adams & Robson		11,7	B
WK	Hypericum virgatum Lam.		10,7,1	B
WK	Ilex decidua Walt.		6,4,7	C
1	Ilex opaca Ait.		7,6,5,11	B
hg	Ilex verticillata (L.) Gray		6,9,2	B

KY	Impatiens capensis Meerb.		4,6,7,9	D
WK	Impatiens pallida Nutt.		4,5	D
KY	Iodanthus pinnatifidus (Michx.) Steud.		4,7	E
WK	Ipomoea coccinea L.	s	H-8,10	C
WK	Ipomoea hederacea Jacq.	s	H-10	D
WK	Ipomoea pandurata (L.) G.F.W. Mey.		f-10,12,1?	D
WK	Ipomoea purpurea (L.) Roth	SA	H-10	D
WK	Iris cristata Ait.		5,11,4	C
WK	Isanthus brachiatus (L.) B.S.P.		12	E
RC	Isoetes butleri Engelm.		12	E
KY	Isoetes melanopoda Gay & Durieu ex Durieu		6,9,2	C
RA	Isolepis carinata Hook. & Arn. ex Torr.		h-9	B
WK	Isotrema tomentosa (Sims) Huber		5,6?	C?
EK	Juglans cinerea L.		7,5,4	D
WK	Juglans nigra L.		7,8,4	E
KY	Juncus acuminatus Michx.		9,2	C
WK	Juncus diffusissimus Buckl.		9,2	C
2	Juncus dudleyi Wieg.		f-9,6	D
WK	Juncus effusus L. var. solutus Fern. & Wieg.		f-9,6	C
MU	Juniperus virginiana L.		12,10,11,7	D
WK	Justicia americana (L.) Vahl		1	D
KY	Kalmia latifolia L.		11,7	A
KA	Kochia scoparia (L.) Schrad.	EU	H-10	D
WK	Krigia biflora (Walt.) Blake		11,7	C
WK	Krigia caespitosa (Raf.) Chambers		f-10	C
MM	Krigia dandelion (L.) Nutt.		7,11,10	C
WK	Krigia virginica (L.) Willd.		f-12,10	C
ah	Kuhnia eupatorioides L. var. corymbulosa Torr. & Gray		f-10,12?	D?
lb	Kuhnia eupatorioides L. var. eupatorioides		f-10,12	D
WK	Kummerowia stipulacea (Maxim.) Makino	AS	F-10,12	D?
WK	Kummerowia striata (Thunb.) Schindl.	AS	F-10,12	C
WK	Lactuca canadensis L.		F-10	D
WK	Lamium amplexicaule L.	EU	H-10,12	D
WK	Lamium purpureum L.	EU	H-10,7	D
WK	Laportea canadensis (L.) Weddell		4,5,6,7	D
WK	Lathyrus latifolius L.	EU	R-10,8	D
KY	Leavenworthia torulosa Gray		g-12	E
KY	Leavenworthia uniflora (Michx.) Britt.		g-12,10	D
KA	Lechea mucronata Raf.		10,12,11	B
WK	Lechea tenuifolia Michx.		12,11,10	A
WK	Leersia virginica Willd.		r-4,7,6	D
WK	Lepidium virginicum L.		R-10	D
WK	Lespedeza bicolor Turcz.	AS	F-10,8	C
WK	Lespedeza cuneata (Dum.-Cours.) G. Don	AS	F-10,1	C
WK	Lespedeza hirta (L.) Hornem.		f-7,11,10	B
WK	Lespedeza intermedia (S. Wats.) Britt. var. intermedia		f-7,11,10	C
KA	Lespedeza virginica (L.) Britt.		f-10,12,7	C
LO	Leucanthemum vulgare Lam.	EU	F-10,8	D

WK	Leucospora multifida (Michx.) Nutt.		H-10,1,12	D
2	Liatris microcephala (Small) K. Schum.		12	A
WK	Liatris squarrosa (L.) Michx.		f-12,10	C
WK	Liatris squarrulosa Michx.		12,10	C
KY	Lilium michiganense Farw.		7,4,6,5	E
np	Lilium superbum L.		7,4,6,5	D
WK	Lindera benzoin (L.) Blume		5,7,4,6	D
WK	Lindernia anagallidea (Michx.) Pennell		2	D
KY	Lindernia dubia (L.) Pennell		s-9,2	D
WK	Linum medium (Planch.) Britt. var. texanum (Planch.) Fern.		f-10,12	C
WK	Linum striatum Walt.		f-9,6	B
EK	Liparis liliifolia (L.) L.C. Rich. ex Ker-Gawl.		5,7,11	C
hg	Liquidambar styraciflua L.		6,9,7,4	C
WK	Liriodendron tulipifera L.		5,7	C
WK	Lithospermum canescens (Michx.) Lehm.		12,10	D
EK	Lithospermum latifolium Michx.		11,5	D
WK	Lobelia cardinalis L.		6,9,2,1	C
NP	Lobelia gattingeri Gray		12	D?
WK	Lobelia inflata L.		f-10,7,11	C
WK	Lobelia puberula Michx.		f-10,9,12,7	B
WK	Lobelia siphilitica L.		f-9,1,10	D
WK	Lobelia spicata Lam. var. leptostachys (A. DC.) Mackenzie & Bush		12,10	D
KY	Lobelia spicata Lam. var. spicata		10,12?	D
WK	Lolium multiflorum Lam.	EU	F-10,8	D
du	Lonicera dioica L. var. dioica		11,5	D
WK	Lonicera japonica Thunb. var. japonica	AS	f-8,7,11,5	C
wk	Lonicera sempervirens L.		8,10,12	C
BE	Lotus corniculatus L.	EU	R-10	D
WK	Ludwigia alternifolia L.		9,6	C
np	Ludwigia hirtella Raf.		9	A
WK	Ludwigia palustris (L.) Ell.		2,6,9	C
WK	Luzula echinata (Small) F.J. Herm.		11,7	C
BE	Luzula multiflora (Ehrh.) Lej.		11,8?	C?
1	Lycium barbarum L.	EU	H-10	D?
WK	Lycopus virginicus L.		9,6,2	C
WK	Lysimachia ciliata L.		4,5	D
WK	Lysimachia lanceolata Walt.		f-7,11,6,10	C
WK	Lysimachia quadrifolia L.		f-7,11,10	B
WK	Lythrum alatum Pursh var. alatum		9,10	E
KY	Maclura pomifera (Raf.) Schneid.	w	f-8,7,4	E
1	Magnolia acuminata (L.) L.		5	C
mm	Magnolia macrophylla Michx.		5,11,7	A
sp	Magnolia tripetala (L.) L.		5,4,7	B
3	Malus angustifolia (Ait.) Michx. var. puberula Rehd.		8,10,12	B?
FI	Malvastrum hispidum (Pursh) Hochr.		g-12,10	E
EK	Manfreda virginica (L.) Salisb. ex Rose		12	D
WK	Matelea obliqua (Jacq.) Woods.		11,7,8	E
WK	Medicago lupulina L.	EU	S-10,7	D

KY	Melica mutica Walt.		11,7,10	D
WK	Melica nitens (Scribn.) Nutt. ex Piper		12	D
WK	Melilotus albus Medik.	EU	R-10,12	D
WK	Melilotus officinalis (L.) Lam.	EU	R-10	D
1	Melissa officinalis L.	EU	H-10	D?
2	Melothria pendula L.	s	r-9,6	C?
WK	Menispermum canadense L.		7,4,5	D
WK	Mentha spicata L.	EU	F-9	E
WK	Mertensia virginica (L.) Pers. ex Link		5,4,7	D
WK	Micanthes virginiensis (Michx.) Small		5	D
WK	Microthlaspi perfoliatum (L.) F.K. Mey	EU	R-10,12	D
WK	Mimulus alatus Ait.		9,2,1	D
WK	Minuartia patula (Michx.) Mattf.		r-12	E
WK	Mitchella repens L.		7,5,11	B
WK	Mitella diphylla L.		5	D
WK	Mollugo verticillata L.	SA	H-10,9,1,2	D
WK	Monarda bradburiana Beck		11,5,7	C
EK	Monarda clinopodia L.		5,7,4	C
EK	Monarda fistulosa L. var. fistulosa		R-10	C?
WK	Monarda fistulosa var. mollis (L.) Benth.		R-10	D
WK	Monarda sp. nov. (clinopodia-fistulosa intermediates)		r-7,4?	D?
WK	Morus alba L.	AS	f-7,4	D
WK	Morus rubra L.		7,5,4	D
1	Muhlenbergia schreberi J.F. Gmel.		f-8,7,10,4	E
EK	Muhlenbergia sobolifera (Muhl. ex Willd.) Trin.		11,12,5	D
EK	Muhlenbergia tenuiflora (Willd.) B.S.P.		11,5	B
WK	Myosotis macrosperma Engelm.		7,8,10	D
WK	Myosotis verna Nutt.		F-10,12,8	D
NK	Myosurus minimus L.	w	H-9	C
2	Myriophyllum heterophyllum Michx.		2,1	C?
bt	Najas gracillima (A. Braun ex Engelm.) Magnus		2	C
LO	Najas minor All.	EU	2	D
2	Nicandra physalodes (L.) Gaertn.	SA	H-10	D
KY	Nothoscordum bivalve (L.) Britt.		12,11,10	D
WK	Nuphar advena (Ait.) Ait. f.		2,1	D
WK	Nuttallanthus texanus (Scheele) D.A. Sutton	w	F-10	C?
WK	Nyssa sylvatica Marsh.		7,6,11,9	C
WK	Obolaria virginica L.		7,5	C
WK	Oenothera biennis L.		H-10	D
1	Oenothera fruticosa L.		f-10,7	B
WK	Oenothera laciniata Hill		H-10	C?
KY	Oenothera speciosa Nutt.	W	F-10	D?
WK	Oenothera triloba Nutt.		r-12	E
MM	Oligoneuron rigidum (L.) Small var. rigidum		10,12?	D
WK	Onoclea sensibilis L.		6,4,9	C
2	Onosmodium hispidissimum Mack.		g-10,12	E
KY	Ophioglossum engelmannii Prantl		12	E
rc	Ophioglossum pycnostichum (Fern.) A.& D. Löve		7,5	C
WK	Opuntia humifusa (Raf.) Raf. ?		g-12,10	D

WK	Orbexilum pedunculatum (P. Mill.) Rydb. var. pedunculatum		r-10,7	B
EK	Osmorhiza claytonii (Michx.) C.B. Clarke		5,7	D
EK	Osmorhiza longistylis (Torr.) DC.		7,4	E
WK	Osmunda claytoniana L.		7,11	B
rc	Osmundastrum cinnamomeum (L.) C. Presl		6	B
WK	Ostrya virginiana (P. Mill.) K. Koch		11,5,7	D
WK	Oxalis dillenii Jacq.		h-7,8,10,11	D
MB	Oxalis illinoensis Schwegm.		5,7,11	E?
MB	Oxalis priceae Small		11,12	D
KY	Oxalis stricta L.	EU?	H-10,7	D
KY	Oxalis violacea L.		7,11,5	C
WK	Oxydendrum arboreum (L.) DC.		7,11,5	A
WK	Pachysandra procumbens Michx.		5	D
WK	Packera anonyma (Wood) W.A. Weber & A. Löve		f-10,12,7	C
WK	Packera aurea (L.) A.& D. Löve		4,6,7,8	C
WK	Packera glabella (Poir) C. Jeffrey	w	H-10,6,4	D
WK	Packera obovata (Muhl. ex Willd.) W.A. Weber & A. Löve		5,11	D
WK	Panax quinquefolius L.		5,11,7	C
WK	Panicum anceps Michx.		F-10,8	C
2	Panicum capillare L.		H-10,8	D
1	Panicum virgatum L.		f-1,9	D
WK	Parietaria pensylvanica Muhl. ex Willd.		11,7,12	D
WK	Parthenocissus quinquefolia (L.) Planch.		7,5,11,4	D
1	Paspalum dilatatum Poir.	S	G-9,10,6	D
3	Paspalum laeve Michx. var. laeve		F-10,8	C
1	Paspalum setaceum Michx. var. muehlenbergii (Nash) D. Banks		G-10,8	D
KY	Passiflora incarnata L.	s	R-10	D
WK	Passiflora lutea L. var. glabriflora Fern.		r-7,8,5	D
WK	Paulownia tomentosa (Thunb.) Sieb. & Zucc. ex Steud.	AS	r-8,7	C
MB	Pedicularis canadensis L.		7,11,4?	C
1	Pedicularis lanceolata Michx.		9,2	E
EK	Pellaea atropurpurea (L.) Link		11,12	E
EK	Penstemon calycosus Small		f-10,7,12	E
KY	Penstemon hirsutus (L.) Willd.		12,10	E
BE	Penstemon pallidus Small		f-10,7,12?	D?
WK	Penstemon tenuiflorus Pennell		12,10?	E
WK	Penthorum sedoides L.		2,6,9	C
MM	Perideridia americana (Nutt. ex DC.) Reichenb.		7,12,10?	E
WK	Persicaria hydropiperoides (Michx.) Small		2,3	D
WK	Persicaria longiseta (de Bruyn) Moldenke	AS	f-7,10,4,1	D
KY	Persicaria maculata (Raf.) S.F. Gray	EU	F-10,9	D
WK	Persicaria pensylvanica (L.) G. Maza		f-9,10,1	D
WK	Phacelia bipinnatifida Michx.		5	E
WK	Phacelia purshii Buckl.		7,8,4	E
WK	Phalaris arundinacea L.	m	f-9,6,2	D
rc	Phegopteris hexagonoptera (Michx.) Fée		5,11,7	C

KY	Phleum pratense L.	EU	F-10,8	D
WK	Phlox amoena Sims var. amoena		r-10,12,7	C
WK	Phlox amplifolia Britt.		5,4,7?	D
KY	Phlox divaricata L. var. divaricata		5,7,4	D
WK	Phlox paniculata L.		4,6,7	D
WK	Phlox triflora Michx.		8,7,4?	B
WK	Phoradendron serotinum (Raf.) M.C. Johnston		7,10,11	D
WK	Phryma leptostachya L.		7,5,4,6	D
WK	Phyla lanceolata (Michx.) Greene		s-9,2,1	D
ek	Physalis grisea (Waterfall) M. Martinez		H-10	C?
WK	Physalis heterophylla Nees var. ambigua (Gray) Rydb.		G-10	D?
MU	Physalis heterophylla Nees var. heterophylla		G-10	E?
WK	Physalis subglabrata Mackenzie & Bush		G-10	E?
hg	Physocarpus opulifolius (L.) Maxim.		12,1	D
WK	Phytolacca americana L.		f-7,10	D
WK	Pilea pumila (L.) Gray		7,4,6,5	D
CW	Pinus virginiana P. Mill.		12,10,11,7	B
WK	Planodes virginica (L.) Greene		H-10	D
WK	Plantago aristata Michx.		S-10,12	C
WK	Plantago lanceolata L.	EU	S-10	D
MM	Plantago pusilla Nutt.		S-10?	C?
WK	Plantago virginica L.		S-10	C
bt	Platanthera clavellata (Michx.) Luer		6	C
WK	Platanthera peramoena (Gray) Gray		6,9	C
WK	Platanus occidentalis L.		4,6,7,1	D
WK	Pleopeltis polypodioides (L.) Andrews & Windham var. michauxiana (Weatherby) Andrews & Windham		5,11	C
MM	Pluchea camphorata (L.) DC.		f-9,2	C
sp	Poa alsodes Gray		8,7,10,4	B
WK	Poa annua L.	EU	S-10,8	D
WK	Poa compressa L.	EU	R-10,8,11,12	D
WK	Poa pratensis L.	EU	G-10,8,4?	D
MM	Poa sylvestris Gray		7,5,4	D
KY	Podophyllum peltatum L.		5,7	D
WK	Polemonium reptans L. var. reptans		5,4,7	D
WK	Polygala ambigua Nutt.		f-10,7	B
WK	Polygala sanguinea L.		f-9,6,10	B
BE	Polygala verticillata L. var. isocycla Fern.		f-7,10,11	B
KA	Polygala verticillata L. var. verticillata		f-7,10,11	B
WK	Polygonatum biflorum (Walt.) Ell.		5,11,7	C
LO	Polygonatum commutatum (J.A. & J.H. Schultes) A. Dietr.		7,10	D
MU	Polygonum erectum L.		G-10	E
WK	Polymnia canadensis L. var. canadensis		11,5	D
WK	Polypodium virginianum L.		5	A
WK	Polystichum acrostichoides (Michx.) Schott		5,7	C
KY	Populus deltoides Bartr. ex Marsh.		1	D
WK	Portulaca oleracea L.	AS?	H-10,1	D

KY	Potamogeton diversifolius Raf.		2	C
1	Potamogeton pusillus L.		2	D
WK	Potentilla norvegica L.	m	F-10,8	D
KY	Potentilla recta L.	EU	F-10	D
WK	Potentilla simplex Michx.		f-10,7,9	C
PH	Prenanthes crepidinea Michx.		8,4,10,7	E
1	Proboscidea louisianica (P. Mill.) Thellung	s	H-10,9?	E?
WK	Prunella vulgaris L. var. lanceolata (W. Bart.) Fern.		F-10,7	D
CW	Prunus americana Marsh.		8,7	D
KY	Prunus mahaleb L.	EU	12,11	E
WK	Prunus mexicana S. Wats.		8,7,11	D
WK	Prunus munsoniana W. Wight & Hedrick		8,10	E?
WK	Prunus persica (L.) Batsch	EU	f-8	D
WK	Prunus serotina Ehrh.		8,7,5	D
WK	Pseudognaphalium obtusifolium (L.) Hilliard & Burtt		F-10,7	C
WK	Ptelea trifoliata L.		12,8,11,7	E
KY	Pteridium aquilinum (L.) Kuhn var. latiusculum (Desv.) Underwood ex Heller		10,11,7	B
sp	Pycnanthemum muticum (Michx.) Pers.		f-9?	C?
WK	Pycnanthemum pilosum Nutt.		f-10,7,12	C
WK	Pycnanthemum tenuifolium Schrad.		F-10,9,12	C
LO	Pycnanthemum verticillatum (Michx.) Pers.		f-9,10	C
WK	Pyrrhopappus carolinianus (Walt.) DC.		F-10	C
NK	Pyrus calleryana Dcne.	AS	f-8,10,7?	D?
WK	Quercus alba L.		11,7,5	C
hg	Quercus bicolor Willd.		9,6	D
WK	Quercus falcata Michx.		10,7,11,12	C
MU	Quercus imbricaria Michx.		10,12,7	D
WK	Quercus lyrata Walt.		9,6,3	D
hg	Quercus macrocarpa Michx.		10,8,7,6	E
KY	Quercus marilandica Muenchh.		10,12	B
KA	Quercus michauxii Nutt.		6,9	D
KY	Quercus montana Willd.		11,12,7	A
KY	Quercus muehlenbergii Engelm.		11,7,12,5	E
CW	Quercus pagoda Raf.		6,9,7	C
WK	Quercus palustris Muenchh.		9,6	C
WK	Quercus phellos L.		9,6	C
hg	Quercus rubra L.		5,11	C
CW	Quercus shumardii Buckl. var. shumardii		7,6,11	E
WK	Quercus stellata Wangenh.		10,12,7,11	C
WK	Quercus velutina Lam.		11,7,10	C
WK	Ranunculus abortivus L.		4,7,5	D
KA	Ranunculus bulbosus L.	EU	g-10,9,6?	C
WK	Ranunculus fascicularis Muhl. ex Bigelow		12,10	E
WK	Ranunculus hispidus Michx.		5,4,7	D
MM	Ranunculus micranthus Nutt.		7,5,11	D
KA	Ranunculus parviflorus L.	EU	G-9?	C
WK	Ranunculus recurvatus Poir.		4,5,6,7	D
1	Ranunculus repens L.	EU	g-9,6,2	D
KY	Ranunculus sardous Crantz	EU	G-9,10	D

MM	Ranunculus sceleratus L.		2,9,1	D
WK	Ratibida pinnata (Vent.) Barnh.		f-12,10	E
WK	Rhexia virginica L.		9,2	B
WK	Rhus aromatica Ait.		12,11,8	E
WK	Rhus copallinum L. var. latifolia Engl.		f-8,10,12	C
WK	Rhus glabra L.		f-8,10	D
CW	Rhus typhina L.		f-8,10,7	D
1	Rhynchosia tomentosa (L.) Hook. & Arn.		10,1	B
bt	Rhynchospora glomerata (L.) Vahl		9	B
bt	Rhynchospora recognita (Gale) Kral		9,6,10	B
LO	Robinia pseudoacacia L.		f-8,7,11,10	D
WK	Rorippa palustris (L.) Bess.		9,6,1	D
WK	Rorippa sessiliflora (Nutt.) A.S. Hitchc.		9,2,1	D
WK	Rosa carolina L. var. carolina		12,11,7,10	D
WK	Rosa multiflora Thunb. ex Murr.	AS	f-8,10,7,4	C
WK	Rosa palustris Marsh.		9,2,6	C
WK	Rosa setigera Michx. var. setigera		f-8,10,7	D
WK	Rosa setigera Michx. var. tomentosa Torr. & Gray		f-8,10,7	D
WK	Rotala ramosior (L.) Koehne		2,9	C
WK	Rubus allegheniensis Porter var. allegheniensis		7,8,5,11	C
cw	Rubus argutus Link		f-10,8	D
3	Rubus depavitus Bailey		f-10?	B?
MM	Rubus enslenii Tratt.		f-10,7,11	C
WK	Rubus occidentalis L.		f-8,7,10	D
wk	Rudbeckia hirta L.		7,10	D
WK	Rudbeckia serotina Nutt.		F-10	D
WK	Ruellia caroliniensis (J.F. Gmel.) Steud.		f-10,7	C
WK	Ruellia humilis Nutt. var. humilis		f-12,10	E
WK	Ruellia strepens L.		f-10,7,4	D
EK	Rumex acetosella L.	EU	F-12,10	C
WK	Rumex crispus L.	EU	F-10,9	D
WK	Sabatia angularis (L.) Pursh		f-10,7,9	C
2	Sagina decumbens (Ell.) Torr. & Gray		s-12,10,9?	C?
wk	Sagittaria australis (J.G. Sm.) Small		2	D
KY	Sagittaria calycina Engelm.		2	D
np	Sagittaria graminea Michx.		2	C
cw	Salix babylonica L.	AS	1	C?
MB	Salix caroliniana Michx.		1	C
WK	Salix humilis Marsh.		f-10,8	C
WK	Salix nigra Marsh.		2,3	D
NY	Salix occidentalis Walt.		f-9,10,8	B?
WK	Salvia lyrata L.		R-10,7	C
WK	Sambucus canadensis L. var. canadensis		9,8,7,6	D
WK	Samolus floribundus Kunth		f-4,6,9	D
WK	Sanguinaria canadensis L.		5,7,4	E
WK	Sanicula canadensis L.		f-7,10,11,4	D
LO	Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe		7,11,5	E
EK	Sanicula smallii Bickn.		11,7	B
WK	Sanicula trifoliata Bickn.		5,7	D?
WK	Saponaria officinalis L.	EU	R-10	D

WK	Sassafras albidum (Nutt.) Nees		7,8,10	C
WK	Saururus cernuus L.		2,3,1	C
rc	Sceptridium dissectum (Sprengel) Lyon var. obliquum (Muhl. ex Willd.) ?		7,5,8	C
mm	Schizachyrium scoparium (Michx.) Nash		f-12,10	C
WK	Schoenoplectus tabernaemontani (K.C. Gmel.) Palla		9,2,1	D
KY	Scirpus atrovirens Willd.		9,2	D
bt	Scirpus georgianus Harper		9	C
KY	Scirpus pendulus Muhl.		9,10	D
WK	Scrophularia marilandica L.		7,10,4	D
WK	Scutellaria australis (Fassett) Epling		f-12,10,7	D?
1	Scutellaria elliptica Muhl. ex Spreng. var. elliptica		7,11,8?	B
WK	Scutellaria elliptica Muhl. ex Spreng. var. hirsuta (Short & Peter) Fern.		7,11,8	B
WK	Scutellaria incana Biehler var. incana		8,7,10	C
1	Scutellaria lateriflora L.		2,1,6,9	D
1	Scutellaria nervosa Pursh var. nervosa		7,8,4?	D?
EK	Scutellaria ovata Hill var. versicolor (Nutt.) Fern.		11,7,5	E
KY	Scutellaria parvula Michx.		f-12,10,7	E?
KY	Securigera varia (L.) Lassen	EU	R-10	D
WK	Sedum pulchellum Michx.		r-12	E
WK	Sedum ternatum Michx.		5,11	D
WK	Selaginella apoda (L.) Spring		6,7,5	B
WK	Senecio vulgaris L.	EU	H-10	D
KY	Senna marilandica (L.) Link		f-10,7	D
WK	Sericocarpus linifolius (L.) B.S.P.		f-10,12	B
WK	Setaria viridis (L.) Beauv. var. viridis	EU	H-10,12	D
WK	Sherardia arvensis L.	EU	F-10	C
WK	Sicyos angulatus L.		4,1,6	D
WK	Sideroxylon lycioides L.		12,11,7,10	E
WK	Silene antirrhina L.	w?	R-10	D
WK	Silene latifolia Poir.	EU	F-10	E
KY	Silene ovata Pursh		5,11	D
MB	Silene regia Sims		10,7	C
KY	Silene rotundifolia Nutt.		5,11	C
EK	Silene stellata (L.) Ait. f.		7,11	D
KY	Silene virginica L.		11,7	C
WK	Silphium perfoliatum L.		4,6,7	E
MM	Silphium pinnatifidum Ell.		f-10,12	D
lb	Silphium terebinthinaceum Jacq. var. terebinthinaceum		f-10,9,12	D
WK	Silphium trifoliatum L.		10,8,12	D
WK	Sisymbrium officinale (L.) Scop.	EU	F-10	D
WK	Sisyrinchium albidum Raf.		12,10	D
WK	Sisyrinchium angustifolium P. Mill.		F-10,8	D
WK	Smallanthus uvedalius (L.) Mackenzie ex Small		8,7,4	D
WK	Smilacina racemosa (L.) Desf.		5,7,11	D
WK	Smilax bona-nox L. var. bona-nox		12,11,7,10	D
WK	Smilax ecirrata (Engelm. ex Kunth) S. Wats.		5,7	C
WK	Smilax glauca Walt. var. glauca		f-10,11,7	C

KY	Smilax hispida Muhl. ex Torr.		4,5,7	D
KY	Smilax rotundifolia L.		7,11,6,10	C
MU	Solanum carolinense L.		G-10	D
sp	Solanum dulcamara L.	EU	R-8	D
WK	Solanum ptychanthum Dunal		H-10,8,7	D
KA	Solanum rostratum Dunal	W	G-10	D
WK	Solidago altissima L. var. altissima		F-10,8,9	D
WK	Solidago caesia L.		5,11	C
WK	Solidago erecta Pursh		f-8,11,10	C
WK	Solidago flexicaulis L. var. flexicaulis		5,4	D
WK	Solidago nemoralis Ait.		f-12,10	D
sp	Solidago patula Muhl. ex Willd.		6	B
1	Solidago speciosa Nutt. var. rigidiuscula Torr. & Gray		8,10	D
WK	Sonchus asper (L.) Hill	EU	H-10	D
sp	Sorghastrum nutans (L.) Nash		f-10,8,12	C
WK	Sorghum halepense (L.) Pers.	EU	F-10,8,6	D
WK	Spermacoce glabra Michx.		1,2,9?	D
mm	Sphenopholis intermedia (Rydb.) Rydb.		7,6,4,5	D
2	Sphenopholis pensylvanica (L.) A.S. Hitchc.		6,9	B
WK	Spigelia marilandica (L.) L.		7,11	D
WK	Spiraea tomentosa L.		9	B
WK	Spiranthes tuberosa Raf.		7,10,11	B
wk	Spiranthes vernalis Engelm. & Gray		f-9,10	C
MM	Sporobolus compositus (Poir.) Merr.		f-10,12,8	D
MM	Sporobolus vaginiflorus (Torr. ex Gray) Wood		r-12,10	D
WK	Stachys tenuifolia Willd.		4,6	D
WK	Staphylea trifolia L.		5,11	E
WK	Stellaria media (L.) Vill.	EU	f-10,7,4	D
WK	Stellaria pubera Michx.		5,7	C
WK	Strophostyles umbellata (Muhl. ex Willd.) Britt.		r-10,12	C
KY	Stylosanthes biflora (L.) B.S.P.		f-10,7,12	B
WK	Symphyotrichum cordifolium (L.) Nesom		7,5,8	D
wk	Symphyotrichum lateriflorum (L.) A.& D. Löve		f-8,6,10,4	C
WK	Symphyotrichum patens (Ait.) Nesom		12,10,11	C
WK	Symphyotrichum pilosum (Willd.) Nesom		F-10,9	D
1	Symphyotrichum praealtum (Poir.) Nesom		f-6,9?	D
1	Symphyotrichum pratense (Raf.) Nesom		12,10	D
NY	Symphyotrichum priceae (Britt.) Nesom		f-10,12	D
WK	Symphyotrichum shortii (Lindl.) Nesom		11,5,7	E
WK	Synandra hispidula (Michx.) Baill.		5,7,4	D
WK	Taraxacum officinale G.H. Weber ex Wiggers (sensu lato)	EU	S-10,7,12,9	D
WK	Tephrosia virginiana (L.) Pers.		12,10,11,1	B
KY	Teucrium canadense L. var. virginicum (L.) Eat.		f-8,7,6,4	D
WK	Thalictrum dioicum L.		5	D
WK	Thaspium aureum (L.) Nutt.		7,5,11	D
rc	Thelypteris palustris Schott var. pubescens (Lawson) Fern.		9,6	B
BE	Thlaspi alliaceum L.	EU	R-10	E?

KA	Thlaspi arvense L.	EU	H-10	E
WK	Tilia americana L.		5,7,6	D
KY	Tilia heterophylla Vent.		5,7,11	D
WK	Tipularia discolor (Pursh) Nutt.		11,7,5	C
WK	Toxicodendron radicans (L.) Kuntze		7,8,4,6	D
wk	Tradescantia ohiensis Raf.		1,4,8,9?	C
LO	Tradescantia subaspera Ker-Gawl. var. subaspera		5,11	D
WK	Tradescantia virginiana L.		11,7,8	D
WK	Tragia cordata Michx.		11,7,10	E
WK	Tragopogon dubius Scop.	EU	F-10,12	D
WK	Triadenum tubulosum (Walt.) Gleason		2,3,6,9	C
KY	Trichomanes boschianum Sturm		5	A
WK	Trichostema dichotomum L.		f-12,10	B
1	Tridens flavus (L.) A.S. Hitchc.		F-10,7,12	D
WK	Trifolium campestre Schreb.	EU	F-10	D
WK	Trifolium hybridum L.	EU	R-10	D
WK	Trifolium pratense L.	EU	F-10	D
5	Trifolium reflexum L.		r-7,10,11,12	C
WK	Trifolium repens L.	EU	G-10,7	D
sp	Trifolium stoloniferum Muhl. ex Eat.		7,4,6	E
KY	Trillium cuneatum Raf.		5	D
KY	Trillium flexipes Raf.		5	E
np	Trillium ozarkanum Palmer & Steyermark		11,7	C
WK	Trillium recurvatum Beck		5,7,11	C
EK	Trillium sessile L.		7,5,11	E
WK	Triodanis biflora (Ruiz & Pavón) Greene		f-12,10	C
KY	Triodanis perfoliata (L.) Nieuwl.		f-10,12	D
EK	Triosteum angustifolium L.		7,11,8?	D
MM	Triphora trianthophora (Sw.) Rydb.		7,5,6	C?
WK	Tripsacum dactyloides (L.) L.		r-9,10,1	C
WK	Truellum sagittatum (L.) Soják		9,6	C
wk	Typha angustifolia L.	n	2	D
bt	Typha latifolia L.		2	D
wk	Typha X glauca Godr. (pro sp.)	n	2	D
WK	Ulmus alata Michx.		10,12,8,7	D
WK	Ulmus americana L.		6,4,7	D
KY	Ulmus rubra Muhl.		5,7,4,11	D
WK	Ulmus serotina Sarg.		11,5,12	E
2	Urtica gracilis Ait.		4,6,7	D
WK	Uvularia grandiflora Sm.		5	D
WK	Uvularia perfoliata L.		5,11	C
KY	Vaccinium arboreum Marsh.		12,11,7	A
CW	Vaccinium pallidum Ait.		11,12,7,10	B
KY	Vaccinium stamineum L.		11,7	A
WK	Valeriana pauciflora Michx.		5,4	E
KY	Valerianella locusta (L.) Lat.	EU	H-10,9	D
WK	Valerianella radiata (L.) Dufr.		f-4,7,10	D
WK	Verbascum blattaria L.	EU	F-10	D
WK	Verbascum thapsus L.	EU	R-10,12	D
KY	Verbena simplex Lehm.		R-10,12?	D

WK	Verbena urticifolia L.		f-7,8,4,6	D
KY	Verbesina alternifolia (L.) Britt. ex Kearney		f-10,7,6,4	D
WK	Verbesina helianthoides Michx.		f-12,10,7	D
KY	Verbesina virginica L.		f-10,7	D
WK	Vernonia gigantea (Walt.) Trel.		G-10,9	D
1	Vernonia noveboracensis (L.) Michx.		G-9	C
WK	Veronica arvensis L.	EU	H-10	D
WK	Veronica peregrina L. var. peregrina		H-9,10	D
MB	Veronicastrum virginicum (L.) Farw.		10,7,1	D
WK	Viburnum acerifolium L.		5,11	C
wk	Viburnum prunifolium L.		8,7,5,4	D
KY	Viburnum rufidulum Raf.		12,8,11,7	D
WK	Vicia dasycarpa Ten.	EU	F-10,8	D
WK	Vinca minor L.	EU	7,5,11	D
WK	Viola bicolor Pursh		S-10	D
NK	Viola bicolor Pursh {blue form}		S-10	C?
MM	Viola lanceolata L.		f-9	B
WK	Viola palmata L.		11,5,7	C
US	Viola papilionacea forma albiflora Grover		s-10,7	D
WK	Viola papilionacea Pursh p.p.		s-7,4,10	D
EK	Viola pedata L.		r-12,10	C
WK	Viola pensylvanica Michx.		5	C
LO	Viola sagittata Ait.		f-10,9	B
WK	Viola sororia Willd.		5,11,7	D
WK	Viola striata Ait.		7,4,10	D
CW	Vitis aestivalis Michx. var. aestivalis		8,7,10,11	C
WK	Vitis aestivalis Michx. var. bicolor Deam		10,11,8,7?	C
wk	Vitis riparia Michx.		1,4	D
WK	Vitis vulpina L.		8,7,10,4	D
MM	Vulpia octoflora (Walt.) Rydb. var. glauca (Nutt.) Fern.		h-10,12	C
hg	Wisteria macrostachya (Torr. & Gray) Nutt. ex B.L. Robins. & Fern.		1,2	D
KY	Woodsia obtusa (Spreng.) Torr.		11,5	D
WK	Woodwardia areolata (L.) T. Moore		6	A
KA	Xanthium spinosum L.	EU	G-10	D?
WK	Xanthium strumarium L. var. glabratum (DC.) Cronq.		f-1,9,10?	D
MB	Xerophyllum asphodeloides (L.) Nutt.		12,11,10	A
WK	Yucca filamentosa L.	s	f-10,7,12	C
1	Zizania aquatica L. var. interior Fassett		2	D
WK	Zizia aurea (L.) W.D.J. Koch		1,4,8	E

Appendix Four.

HISTORIC INFORMATION ON VEGETATION IN THE MAMMOTH CAVE AREA (BEFORE PARK FORMATION IN 1930s)

A. Deed records

The following table presents the percentages of different tree taxa noted at survey corners in some early deed books. Typically, the early surveys noted one or more trees at most corners; each survey was generally 100-1000 acres, with 5-20 corners. The first few hundred trees accumulated in these books are summarized here. Surveys that are clearly repeated in whole or part, from earlier parts of the deed book, are not included here, but there may be some remaining redundancy that is not clearly apparent.

EDMO = Edmonson County Deed Book A, ca. 1826 [Microfilm series M-583 at Special Collections, University of Kentucky.]: data are from pages 1-163. Edmonson County was formed in 1824, and this is the first deed book. The county boundaries have not changed significantly since then.

BARR = Barren County Deed Book L, ca. 1826 [Microfilm series M-346 at Special Collections, University of Kentucky.]: data are from pages 1-88. The year 1826 was chosen to make these data contemporaneous with the Edmonson County data; also, before 1820, Barren County included large parts of the present Allen and Monroe Counties. Not until 1860, however, was the final extract of Barren County taken to help form Metcalfe County.

	EDMO	BARR
Post oak (*Quercus stellata*)	15.9%	15.7%
White oak (*Q. alba*; some *muhlenbergii*?)	10.3	9.7
Black jack (*Q. marilandica*)	7.2	4.4
Black oak (*Q. velutina, coccinea*?)	6.7	5.8
Spanish oak (*Q. falcata mostly*?)	2.1	1.4
Red oak (*Q. rubra, falcata, shumardii, velutina,* etc.)	8.9	4.0
Pin oak (*Q. palustris, shumardii, coccinea*?)	0.2	---
Whig oak (?)	0.3	---
Hickory (*Carya* spp.)	14.8	11.5
Chestnut (*Castanea dentata*)	1.0	1.3
Beech (*Fagus grandifolia*) also "beach" in Edmonson Co.	9.8	14.2
Poplar (*Liriodendron tulipifera*)	2.0	5.0

Sugar tree (*Acer saccharum, nigrum*)	3.6	6.5
Maple (*Acer rubrum, saccharinum*)	1.3	0.8
Black gum (*Nyssa sylvatica*)	1.0	2.5
Sweet gum (*Liquidambar styraciflua*)	0.3	0.4
Gum (*Nyssa, Liquidambar*)	0.3	0.4
Black walnut (*Juglans nigra*)	1.6	0.4
White walnut (*Juglans cinerea*)	1.0	0.3
Walnut (*Juglans* spp.)	0.8	0.4
Sycamore (*Platanus occidentalis*)	1.6	0.1
Ash (*Fraxinus* spp.)	1.3	2.2
Blue ash (*Fraxinus quadrangulata*)	0.2	0.3
Elm (*Ulmus* spp.)	1.3	1.7
Hackberry (*Celtis* spp.)	0.3	0.1
Mulberry (*Morus rubra*)	0.3	0.1
Sassafras (*Sassafras albidum*)	0.2	0.3
Persimmon (*Diospyros virginiana*) also "pofsimmony" [?]	0.3	0.8
Honey locust (*Gleditsia triacanthos*)	0.7	---
Cherry (*Prunus serotina*)	---	0.1
Dogwood (*Cornus florida*)	2.8	7.8
Sourwood (*Oxydendrum arboreum*)	0.3	---
Holly (*Ilex opaca*)	0.2	0.1
Hornbeam (*Carpinus carolinana*)	0.8	---

Ironwood (*Ostrya virginiana* mostly?)	0.2	0.3
Pawpaw (*Asimina triloba*)	---	0.1
Redbud (*Cercis canadensis*)	---	0.1
TOTAL NUMBER OF TREES	610	720
Total corners with trees*	372	212
Corners with just "stake"*	65	19
References to "the Barrens"	3	6
Trees noted as "small; saplin; sprout; or bush"	6	36

* Corners with just "stone", "large rock", "bank", "bluff", etc., are not included.

Other items of interest in these deeds are as follows:

Edmonson Co.

Page 1: "...on the side of a bufalow road or path that leads from nolands Lick to the head waters of lower beaver dam Creek where the said path runs the dividing ridge between nolands Creek waters and the waters of the said beaver dam Creek..." [Was this between Alexander Creek and Little Beaver Creek; and was Noland's Lick near Chalybeate and Sulphur Branch of Alexander Creek?]

Page 38: "...Co. of Grayson on Bear Creek...1157 acres..."stake in the barrens..." [Presumably this was in the Bear Creek area of NW Edmonson Co., and referred to the previous assignment of this section to Grayson Co.; note also the current placename "Grassland" between Bear Creek and Nolin River drainages.]

Page 123: "lying on Green River on the north side of the river between the mouth of Nolynn and Bear Creek about one mile and a half or two miles above the mouth of Bear Creek...crossing an old bufaloe road..." [Is this road now Route 655?]

Page 125: "whig oak [?]...stake in the barrens..."

Page 132: "...whig oak [?]..."

Page 147: "...intersection of Gum thicket Branch with the big Valley...the Gum thicket...corner in the barrens..." [The big valley probably referred to the Brownsville area along Beaver Dam Creek.]

Barren County

Page 3: "...three black jacks in a saplin grove..."

Page 20: "...in the Barrens near the Big Blue Spring grove..."

Page 24: "...on Beaver Creek near the road to Columbia...stake in the barrens..."
Pages 27, 40, 59: "...in the barrens..."

Page 57: "...post oak in the barrens..."

Page 61: ..."mouth of small branch on west side of south Fork of Little Barren River near the spots [?] where there is sign of an Indian improvement (tow [too-whit] a mound in a circular form)..."

Page 77: "...on Skaggs Creek...white oak on an old Buffalo trace..."

The following percentages of tree species were recorded at corners of tracts included in the deed of the Mammoth Cave estate, from the Gratz family to F. Gorin on 7th November, 1853 (transcribed in Carroll, ????; reference lost but in archives of park somewhere).

Red oak (*Quercus* spp., red group)	33%
Post oak (*Q. stellata*)	31%
Black jack (*Q. marilandica*)	8%
White oak (*Q. alba* mostly?)	6%
Hickory (*Carya* spp.)	17%
Cherry (*Prunus serotina*)	3%
Dogwood (*Cornus florida*)	3%
TOTAL NUMBER OF TREES	36

B. Descriptions of Vegetation

Baskin & Baskin (1981, and unpublished) and Baskin et al. (1994) have recently summarized several early descriptions of the Barrens Region in general (see also Ray 1997). All of this general material is not repeated here, but those sources with more details of localities, habitats, fires and species are quoted extensively below, especially if they are refer to barrens close to Mammoth Cave, in Edmonson, Hart or Barren Counties.

Note that, in interpreting the following accounts, *Quercus marilandica* was commonly called *Q. nigra* before 1900; its common names apparently included "black oak" in some early accounts (e.g., the Michauxs), and also "black-jack" and "barren oak" (e.g., Gray 1889). The true *Q. nigra* (our "water oak") was then known as *Q. aquatica*. *Q. velutina*, our common "black oak" today, was often regarded as just a variety of *Q. coccinea*, or sometimes made a species, *Q. tinctoria*. *Q. shumardii*, our "shumard oak", was generally not distinguished, and it was probably confused with *Q. palustris, Q. coccinea, Q. rubra* and *Q. velutina*; it may have been called "pin oak" in some cases (Campbell 1989).

Andre Michaux (1793-96 in Thwaities 1904, p. 64), in referring to his travels of June, 1795, noted: "The 23rd crossed the Barren oaks [about 30-60 miles from Nashville] and slept at [Drakes] Creek [S Warren Co.?]. There is no house in the interval. The Soil produces only black oaks [probably *Quercus marilandica*]. 30 miles. The 24th passed by Big Barren River. The man who keeps the Ferry is well supplied with provisons [McFadden's ferry, E Warren Co.?]. The distance is 3 Miles from [Drakes] Creek. Crossed the Barrens and slept on the ground without a fire and without allowing my horse to graze at large through fear of the Savages [C Barren Co.]. The 25th passed by Little Barren River, the first house 43 miles from Big Barren River [SW Green Co.]. Afterward passed by Green River 6 Miles from Little Barren River."

In February, 1796 (p. 92), he noted: "The 12th passed through a country covered with grass and Oaks which no longer exist as forests, having been burned every year [between N Larue Co. and NW Hart Co.]. These lands are called Barren lands although not really sterile. The grasses predominate: *Salix pumila* [*S. humilis*], *Quercus nigra* [*Q. marilandica*], *Quercus alba* called Mountain White oak [*Q. stellata*?]. *Gnaphalium dioicum* [*Antennaria plantaginifolia*?] also grows there in abundance. It is called by the Americans White Plantain... The 13th of February traveled 37 Miles without seeing a House through the lands called Barren lands [from C Hart to S Warren Co.]. The *Salix pumila* that grows there in abundance is the same as that which is very common in the Illinois prairies..."

Francois Michaux (1805 in Thwaities 1904, p. 215-222): referring to his travels in August, 1802, he noted on the 25th: "About 10 miles from Green River flows the Little Barren [SW Green Co.], a small river, from thirty to forty feet in breadth; the ground in the environs is dry and barren, and produces nothing but a few Virginia cedars [*Juniperus virginiana*], two-leaved pines [*Pinus virginiana*], and black oaks [probably *Quercus marilandica*]. A little beyond this [SE Hart Co.] commence the Barrens, or Kentucky Meadows.

[His journey through the Barrens went from "Bears-Wallow", in S Hart Co., to "Dripping Spring", probably in SE Edmonson Co., to the ferry of "one Macfiddit" (= MacFadden?) across Big Barren River, probably in W Warren Co., to "the oldest settlement on the road" at Mr. Kelsey's, probably on Drakes Creek in S Warren Co.]

"On the 27th August...about thirteen miles from Mr. Kelsey's crossed the line that separates the State of Tennessee from that of Kentucky [S Simpson Co.?]. There also terminates the Barrens; and to my great satisfaction I got into the woods. Nothing can be more tiresome than the doleful uniformity of these immense meadows where there is nobody to be met with; and where, except for a great number of partridges [bobwhite quail], we neither see nor hear any species of living beings, and are still more isolated than in the middle of the forests...

"The Barrens, or Kentucky Meadows [on the Pennyrile Karst Plain], comprise an extent from sixty to seventy miles in length, by sixty miles in breadth. According to the signification of this word, I conceived I should have had to cross over a naked space, sown here and there with a few plants. I was confirmed in my opinion by that which the country people had given me of the meadows before I reached them. They told me that in this season I should perish with heat and thirst, and that I should not find the least shade the whole of the way, as the major part of the Americans who live in the woods have not the least idea that there is any part of the country entirely open, and still less that they could inhabit it. Instead of finding a country as it had been depicted to me, I was agreeably suprised to see a beautiful meadow, where the grass was from two to three feet high. Amidst these pasture lands I discovered a great variety of plants, among which were the gerardia flava [*Aureolaria f.*], or gall of the earth; the gnaphalium dioicum [*Antennaria plantaginifolia*?], or white plantain; and the rudbeckia purpurea [*Echinacea p.*]. I observed that the roots of the latter plant participated in some degree with the sharp taste of the leaves on the spilanthus oleracea [*Spilanthes*, a related southern genus]. When I crossed these meadows the flower season was over with three parts [quarters] of the plants, but the time for most of the seeds to ripen was still at a great distance [in time]; nevertheless I gathered about ninety different species of them which I took with me to France.

"In some parts of the meadows we observed several species of the wild vine, and in particular that called by the inhabitants summer grapes, the bunches as large, and the grapes of as good a quality as those in the vineyards round Paris, with this difference, that the berries are not quite so close together [*Vitis aestivalis* or perhaps *V. labrusca*, the origin of concord grapes].

"The Barrens are circumscribed by a wood about three miles broad, which in some parts joins to surrounding forests. The trees are in general very straggling, and at a greater distance from each other as they approach the meadows. On the side of Tennessee this border is exclusively

composed of post oaks [*Q. stellata*], the wood of which being very hard, and not liable to rot, is in preference to any other, used for fences. This serviceable tree would be easy to naturalize in France, as it grows among the pines in the worst of soil. We observed again [also], here and there in the meadow, several black oaks [probably *Q. marilandica*]; and nut trees, or juglans hickery [mostly *Carya tomentosa*?], which rise about twelve or fifteen feet. Sometimes they formed small arbors, but always far enough apart from each other so as not to intercept the surrounding view. With the exception of small willows, about two feet high, salix longirostris [*S. humilis*], and a few shumacs [*Rhus*], there is not the least appearance of a shrub. The surface of these meadows is generally very even; towards Dripping Spring [SE Edmonson Co.?] I observed a lofty eminence, slightly adorned with trees, and bestrewed with enormous rocks, which hang jutting over the road...

"...According to the observations we have just made, the want of water, and wood adapted to make fences, will be long an obstacle to the increase of settlements in this part of Kentucky. Notwithstanding, one of these two inconveniences might be obviated, by changing the present mode of enclosing land [with rail fences], and substituting hedges, upon which the *gleditsia triacanthos*, one of the most common trees in the country, might be used with success. The Barrens are at present very thinly populated, considering their extent; for on the road where the plantations are closest together we counted but eighteen in a space of sixty or seventy miles.

Every year, in the course of the months of March or April, the inhabitants set fire to the grass, which at that time is dried up, and through its extreme length, would conceal from the cattle a fortnight or three weeks longer the new grass, which then begins to spring up. This custom is nevertheless generally censured; as being set on fire too early, the new grass is stripped of the covering that ought to shelter it from the spring and frosts, and in consequence of which its vegetation is retarded. The custom of burning the meadows was formerly practiced by the natives, who came in this part of the country to hunt; in fact, they do it now in the other parts of North America, where are savannas of an immense extent. Their aim in setting fire to it is to allure the stags, bisons, &c into the parts which are burnt, where they can discern them at a greater distance. Unless a person has seen these dreadful conflagrations, it is impossible to form the least idea of them. The flames that occupy generally an extent of several miles, are sometimes driven by the wind with such rapidity, that the inhabitants, even on horseback, have become a prey to them. The American sportsman and the savages preserve themselves from this danger by a very ingenious method; they immediately set fire to the part of the meadow where they are, and then retire into the space that is burnt, where the flame that threatened them stops for want of nourishment."

Burnet (in Applegate 1965, p. 19) wrote in his journal on December 29th, 1815: "After breakfast, left Thompsons [probably southcentral Hart Co.] and road 24 Miles through the barrens and came to Bustus Inn [probably SE Edmonson Co. or NE Warren Co.], where we put up. Barrens so far very thinly settled bearing nothing but a few schrub black oaks [probably *Quercus marilandica*] & covered with a wild grass."

Flint (1822, reprinted in 1970, p. 258): "In the neighborhood of Salt River and Green River, in Kentucky, there are extensive tracks of barren wastes. Small hazel bushes [*Corylus americana*] from two to three feet in height abound in these; and the quantity of nuts produced exceeds any thing of the kind which I have ever seen. The soil of these wastes seems to be very similar to that of the adjoining woods; and on account of the trees diminishing gradually in size, from the forest to the waste, it is sometimes impossible to discover a line where the one stops and the other begins. This, being told by an old settler, that some small saplings which stood on his farm twenty years ago, are now become tall trees, leads me to adopt the opinion entertained by some, that the wastes or barrens owe their characteristic form to the Indians, who set fire to dried grass and other vegetables with the design of facilitating their hunting."

Davidson (1840, p. 29-32): "This locality [Mammoth Cave] forms part of that extensive region called the *Barrens of Kentucky*, reaching from the Tennessee line to the Rolling Fork of Salt River, and embracing a large portion of the Green River country. This tract, extending over several counties, was originally styled the *Barrens*, not from any sterility of soil, for although the soil is not of the first quality, it is generally good; but because it was a kind of rolling prairie, destitute of timber. While the central parts of the State were covered with forests of heavy timber, or overspread with tall canebrakes, the Barrens, with the exception of a few scattered groves along the water-courses, were clothed with a thick growth of prairie grasses. The face of the country, however, presented great attractions to the botanist..." [here follows a quotation from C.W. Short, which is provided under "Floristic Records" below.]

"The destitution of timber in the Barrens was owing to the frequent burning of the prairie by hunters to drive out the game, by which means the young and tender shoots were scorched and destroyed... With the advancing settlement of the country, the prairie fires were gradually extinguished, and the young timber had liberty to grow. The consequence is, that tracts which were destitute of shade ten to twenty years ago, are now covered with extensive forests of Black Jack, or scrub oak, an inferior wood indeed, yet capable of being converted to various uses, and which will no doubt be succeeded in time by some more valuable growth... To the traveller in the fall of the year, the unvaried and monotonous drab of the foliage presents an extremely dull and dreary aspect, and an agreeable sensation of relief is experienced when he makes a transition to the brighter hues of green edged with yellow, of the beech woods."

Bullitt (in Meloy 1985, p. 10), writing in 1844: "In going to the Cave from Munfordville, you will observe a lofty range of barren highlands to the North, which approaches nearer and nearer the Cave as you advance, until it reaches within a mile of it... For a distance of two miles from the Cave, as you approach it from the South-East, the country is level. It was, until recently, a prairie, on which, however, the oak, chestnut and hickory are now growing; and having no underbrush, its smooth, verdant openings present, here and there, no unapt resemblance to the parks of the English nobility. Emerging from these beautiful woodlands, you suddenly have a view of the hotel and adjacent grounds, which is truly lovely and picturesque."

Kite (1847, p. 7 in 1943 copy) summarized the trip through Russellville and Bowling Green towards Mammoth Cave as follows: "Since leaving Clarksville [TN] we have been passing through what are called the Barrens, formerly an extensive prairie, now overgrown with a scrubby Oak called Black Jack, the soil appears to be thinner than in some other portions of the state, yet well repays the labor of the husbandman."

Owen (1856, p. 81-84): In his geological notes on "southern belt" of the "sub-carboniferous" [Mississippian] limestones in western Kentucky, he stated: "The upper division is formed by the Archimedes and Pentremital limestones [now known as the Girkin Formation]. Where these are associated, as they frequently are, with beds of greenish and grey shales, they give rise to a narrow belt of unproductive gladey land, almost destitute of vegetation. What little timber it supports is usually a scanty growth of scrubby post oak on the ridges; on the slopes, post-oak, sassafras, shumach, and white oak, with black gum towards the base. The soil is of a stiff marly nature and must necessarily contain a large amount of argillo-calcareous matter. [This soil was probably equivalent to clayey inclusions of the typic hapludalf series complex, Talbott-Caneyville-Fredonia, or sometimes mapped as the vertic hapludalf series, Colbert; see, for example, Figure 6 in Baskin et al. (1994).]

"Indeed the sterility of the land is probably due to the superabundance of lime and alumina; the former exerting a too powerful solvent effect over its organic contents, and thus exhausting it of these constituents; the latter renders it stiff and refractory, so that it bakes, cracks, and forms extensive slides on the slopes of hills. The seeds of plants, in such soil, are frozen out in winter, super-saturated with moisture in spring, and deprived of the organic matter necessary for their nutriment. In dry weather the ground becomes hard and compact, yet full of fissures, so that the germinating plant has no power to penetrate its way to the surface; or, if already in an advanced state of growth, its roots are laid bare, and the tendrils perhaps torn asunder; yet these stiff calcareous clays, when subdued by cultivation and supplied with organic manures, are capable or returning abundant crops, while they are, as I have already stated elsewhere, materials well adapted for the amelioration or poor siliceous soils."

"The second division of the sub-carboniferous limestone, in the descending order, comprises the Lithostrotion bed, or Barren limestone [now known as the Ste. Genevieve and Ste. Louis Limestones]... This limestone group produces, for the most part, an excellent soil, well adapted for the growth of corn, wheat, barley, and certain grasses.

"In the early settlement of Kentucky the belt of country over which it extended was shunned, and stamped with the appellation of "Barrens;" this arose, in part, from the numerous cherty masses which locally encumbered the ground, in part from the absence of timber over large tracts, and in consequence of the few trees which here and there sprung up, being altogether a stunted growth of black-jack oak, *quercus ferruginea* [*Q. marilandica*], red oak, *quercus rubra* [probably including *Q. falcata* and others more than *Q. rubra*], and white oak, *quercus alba* [probably including much *Q. stellata* as well as *Q. alba*]... At the present time the so called "Barrens" of Kentucky are, to a considerable extent, timbered with the above varieties of oak, black Hickory [*Carya glabra*?], and occasionally Butternut, *juglans cathartica* [*J. cinerea*]; Black Walnut, *juglans nigra*; Dogwood, *cornus florida*; Sugar-tree, *acer saccharinum* [then meaning *A. saccharum*]."

"The old inhabitants of that part of Kentucky all declare that when the country was first settled it was, for the most part, an open prairie district, with hardly a stick of timber sufficient to make a rail, as far as the eye could reach, where now forests exist of trees of medium growth, obstructing entirely the view. They generally attribute this change to the wild fires which formerly use to sweep over the whole country, in dry seasons, being now, for the most part, avoided or subdued, if by accident they should break out. No timber appears capable of surviving the scorching effects of such fires, but the thick-barked black-jack oak, which, here and there resisting its ravages, stood monuments of its hardy nature, and the blasting influence of the prairie fire.

"It is probable, however, that some other influence contributed to suppress the growth of timber in the Barrens of Kentucky, since wild fires were equally liable to occur in the heavy timbered land of adjacent formations. It is altogether probable that there was a peculiar tendency in the soil to produce that luxuriant growth of barren grass which took possession of the soil, to the exclusion of all timber, and which is described as having attained a height of five to six feet. Since the settlement of the country this grass has almost become extinct, whereby opportunity has been afforded for timber to take root and flourish."

[Note that Owen did not consider edaphic and topographic relationships with fire, nor the notion that Native American burning, not just "wild fire", was concentrated in this region. He omitted the simple idea that the deep productive soils here allow much grass growth, which then provides much fuel for hot, tree-killing fires.]

Owen (1857, p. 162) noted, with reference to Barren County, that "the Barren limestone region" was "originally an open country of grass and hazel bushes, destitute of timber, now grown up, to a great extent, with the barren oak. (*Quercus Catesbaei*.)" [This is an old synonym of the Coastal Plain species, *Q. laevis*, but it was probably used to mean *Q. marilandica* in this region.]

Hussey (1876, p. 8-17): "My observations in Barren county would lead me to the conclusion that the traditions which are current as coming from the settlers are true; that is to say, that when the whites first came to these parts, it was, indeed a barren region, destitute at least of trees. On the more level parts of this county the trees are yet small in size and few in species. The size of the trees alone would settle the question as to the length of time in which the present forest has stood, especially when taken in connection with the absence of the remnants of an older forest in the matter of fallen trunks and stumps. One the line of sandstone-capped hills seen rising between the line of the railroad and Green river are to be found larger trees than any in the more level portions of the county, showing that when the rest of the county was bare of trees, there were some crowning these hills. The limited number of species found in Barren County would itself be conclusive of the question of the recent introduction of forest growth into this region. The most of the oaks are of the following species: *Quercus, coccinea* [and *velutina, shumardii*?], *rubra* [and *falcata*?], *nigra* [*marilandica* mostly?]. [*Quercus*] *Alba* is found, but not abundant; also *imbricaria* and *obtusiloba* [= *stellata*], about the numerous sinkholes. I saw no poplars [*Populus*?], no tulip trees [*Liriodendron*], linn [*Tilia*], beech [*Fagus*], black walnut [*Juglans nigra*] or butternut [*J. cinerea*]."

> [Note: in later pages, Hussey also lists *Quercus falcata* ("Spanish oak"): "very plentiful in some localities"; and *Celtis occidentalis* v. *pumila* [= *C. tenuifolia*] "commences to appear in Barren county, and extends everywhere through the country as far as Hopkinsville, in Christian county."

"The largest trees are oaks, about fifteen inches in diameter three feet from the ground [ca. 30-40 cm dbh]. I saw scarely a willow [*Salix*] or maple [*Acer*] of any kind.... Not in the trees only, but also in the herbaceous flora was the limited number of species noticeable. It is well understood that the aboringines of this country were accustomed to burn over the surface of the prairies; but for what purpose it does not seem to be perfectly understood. It has been said that they thus destroyed the old culms of grass, and cleared the way for the springing of the tender shoots in the spring. They may also have had in view the destruction of hurtful insects, as the grasshoppers, by destroying their eggs, or of noxious serpents, which must have been destroyed in immense numbers by the annual fires on the prairies. Another reason may have had consideration; the tall dead grass would be liable to be fired by accident at any time, and thus human life and many villages be endangered in the night, or in times of high winds, with no means of escape; but if at a certain time, when all are on the lookout, the firing should take place, there would be no danger to life or property.

"The habit of firing the prairies must have exerted a wide influence on the character and distribution of plants in the parts of our country where prairies existed... The annuals must have been greatly diminished by the custom... But as these fires were annually kindled, how did it happen that here and there all over the broad prairies clusters of trees withstood their destructive influence, and lived and flourished? The reason of the deficiency of trees on the prairies has been held by some to be the absence of the nutriment in the soil which they required, or the fineness of the soil, which was supposed to be unfavorable to the growth of timber trees. This latter view, taken in connection with the fact that the knolls on which the clumps of trees are generally found are composed of more porous material, as sand or gravel, seemed to receive confirmation. But the fact that all kinds of trees do grow well when planted and protected in prairie soil, upsets both these

theories without further refutation. The soil is not too finely divided; it does not lack the necessary constituents...

"...To the westward, in Edmonson county, there is evidence of the treeless condition existing. The very numerous ravines, valleys, and hillsides, become covered with tree growth first. The large tulip trees, hemlocks, sugar maples, beeches ["very abundant on Green River", p. 15], and chestnuts ["abundant"] found in these less exposed localities, prove that generations of tree growth have passed since their seeds were scattered here; but the uplands show, that long since the deep valleys and hillsides were covered with forest growth, these were almost or entirely bare. Nothwithstanding this, however, Edmonson county was forest-covered a generaton before Barren county."

Other miscellaneous notes on the abundance of trees are as follows:

"The tulip tree...is abundant along the triburaries of Green river."

"The sweet gum...is still very abundant on the river and its tributaries."

"There is not much linn...found on the tributaries of Green river" [and perhaps none along Nolin river!]

"...white oak, attains an enormous development along Green river."

"The Spanish oak [*Quercus falcata*] is very plentiful is some localities."

"Chestnut oak is abundant on the ridge on both side of the Green river, but especially to the west of it."

"The hickories are among the largest trees--very tall, but not so great in diameter as the oaks and sweet gum, but exceedingly numerous... Black hickory (*Carya tomentosa*), when from five to ten inches in diameter...In the counties of Grayson and Edmonson there is an immense supply of this class of wood."

"Neither black nor white walnuts are here found in abundance, and the trees which are found are of inferior quality."

"The wild cherry is not abundant."

"The sugar maple, black birch, and hemlock are common in the gulches."

"The white soft maple [*Acer saccharinum* or *A. rubrum*?]. On the uplands hoop-poles [*Acer rubrum*?] seem quite inexhaustible in quantity, and of very good quality."

"White elm, so-called in this State (*Ulmus alata*), is very abundant all through the counties of Grayson and Edmonson..."

"The sassafras springs up everywhere in old fields and abandoned ground."

"The dogwood is specially abundant, and of large size for that little tree, sometimes eight or nine inches in diameter..."

> [He did not note *Juniperus virginiana* or *Pinus virginiana* in the text at all, though he did list these species in his appendix.]
>
> [Other woody species of interest in his list include *Aesculus flava* (and *glabra*), *Rhus venenata, Robinia pseudoacacia, Gymnocladus dioicus, Pinus pungens* and *Taxus baccata* var. *canadensis*; however, *P. pungens*, at least is highly unlikely in this region, and Hussey's identifications in general should not be trusted completely; his collections are said to be lodged at Purdue University, and should be thoroughly checked.]

DeFriese (1880, p. 25-27) reported on his 1878 timber survey across Kentucky: "Again, forest fires have not denuded certain portions of the country in the neighborhood of Mammoth Cave. What is known as Doyle's Valley for instance, has been, for some reason, largely protected from the ravages of fire, even if the entire district has not been. From the growth of chestnut I am inclined to think it has never been continuously burned over.

"On leaving Glasgow Junction [now Park City], toward Mammoth Cave, plenty of white oak is found in the sinks; post oak, black oak, scarlet oak, and red oak are found on the higher grounds, and as soon as Chester sandstone, which caps the so-called hills, is reached, chestnut is found in great abundance. This is the first chestnut worthy of note found, and all that has been found, so far [from the Mississippi River to here], if a few bushes on the silicious limestone, near the Tennessee river, be excepted; though doubtless all this Chester sandstone, from Hopkinsville to Glasgow Junction, would have been covered with it, but for the fires that long ago swept over this richly timbered country, year after year, and drove its choicest trees from the forests.

"On the hill sides facing Doyle's Valley the trees are magnificent, and white oak, liriodendron, white hickory [*Carya tomentosa*?], massive chestnut, scarlet oak, red oak, black oak, Spanish oak, chestnut [oak?], ashes and redbud &c., abound. The chestnut, however, is limited to the sandstone and stops abruptly when the limestone is reached descending the hill.

"On nearing Mammoth Cave, and all along the banks and cliffs of Green river, hornbeam (*Carpinus Americanus*, often called iron-wood, but not the true iron-wood) and hop hornbeam (true iron-wood) abound. On the long high level above the cave the principal timbers are red, black and Spanish oak. They are worthless except for firewood.

"In the immediate vicinity of Mammoth Cave, and crowning the hill-side facing Green River, above and below it, the timbers are red oak, liriodendron, chestnut (on sandstone or its detritus), white hickory, white oak, black walnut, blue ash, an occasional sugar and rock maple, winged elm, &c. At the base of the hill, on Green river, are beeches, sycamores, spicewood (the

first met with), white hickory, liriodendron, and whte oak. Black sumach [*Rhus copallina*?], woodland huckleberry [*Gaylussacia baccata*?], buckeye, dogwood, &c., are among the small growths.

"About two miles from Mammoth Cave, toward Cave City, the hill-tops are poor, and are covered with Spanish oak, scarlet oak, black-jack, and an occasional mountain oak [*Quercus montana = Q. prinus*]. In the sink-holes, and on their steep sides grow splendid chestnut, pig and white hickory [*Carya cordiformis* and *C. tomentosa*?], liriodendron, some white oak, post oak and black locust. The chestnut os found only on the sandstone. These upland and lowland timbers alternate, without any changes worthy of note, except occasional swamp chestnut oaks [*Q. michauxii*], Bartram's oak [*Q. lyrata*?], laurel oak [*Q. imbricaria*] and black hickory [*Carya glabra*?], until we begin to pass into the present eastern barrens, about twelve miles [perhaps mistated two, or was his route to the N?] from Cave City and within about eighteen miles of Greensburg. White oak and chestnut cease to exist, except the former on streams, &c., and a repetition of the barren timbers of the Purchase occurs. There seems to be a neck of country about Mammoth Cave which has, for some reason, more or less escaped the ravages of fire."

After passing out of the Karst Plain further east, crossing the Little Barren River towards Greensburg, DeFriese (p. 27) noted: "The Keokuk [= Salem and Warsaw Formation?] is an exceedingly fertile formation, and its timbers are nearly always, on the limestone, of the finest. Its soils are rich in marls, it furnishes a good supply of surface water, and has all the requisites for the production of splendid forests. Timbers, therefore, grow better and more valuable at once on passing onto the Keokuk; but white oak, chestnut and liriodendron, have been driven from the forests in this locality by fire. With these exceptions, the hill-side facing Little Barren river on the west furnishes a good sample of the timbers that grow on the Keokuk limestone. They are black cherry, black locust, swamp chestnut oak [or *Quercus muhlenbergii*?], black walnut, some liriodendron, white and shag hickory [*Carya cordiformis, C. ovata*], sycamore, mulberry, blue ash, red elm, white maple [*Acer saccharinum*], redbud, water beech [*Carpinus*], hackberry and cedar. On the same formation, immediately after crossing the Little Barren river, plenty of chestnut and white oak are found, with scarlet oak, black oak, pig hckory, and sugar maple, in addition to the timbers just mentioned; and all through the hills white oak, chestnut, and liriodendron become exceedingly fine and valuable. This points to the probability that Little Barren river was the eastern barrier to the ancient fires." [Compare F. Michaux's description of the same area in 1802, with just red cedar, scrub pine and blackjack oak mentioned.]

Note quoted here, but also relevant, are DeFreiese's notes (p. 11, 21-22) suggesting that the land between Tennessee River and Cumberland River in western Kentucky had experienced less fire due to the fire-break effect of these large river valleys. He cited the presence of frequent white oak and chestnut here, in contrast to former barrens regions to the west (on Upper Gulf Coastal Plain) and east (on Pennyrile Karst Plain).

Ross (1882, p. 213-215) recalled his early life with his grandfather in NW Montgomery Co., TN at the state line, on the road to Hopkinsville, Christian Co., KY: "It was late in the fall [1812] when we reached our new home. There was not the slightest improvement on the place besides the unfinished house. All around looked sad and dreary, especially, when the wind swept over the dry

and withered grass, or rustled among the dead leaves of the post-oak and black-jack trees. None who ever witnessed the desolate appearance of the Kentucky Barrens in early times, during the winter season, can forget the feeling they produced. Far as the eye could reach, it seemed one barren, cheerless waste.

"Seen at this season of the year by the early explorers, it is not strange that they called them the Barrens, or the barren lands. The pioneer hunters had no conception of their fertility, and very naturally supposed that there were only a few stunted trees in these wide prairies, because the ground was so poor. No greater mistake could have been made. During the winter [1812-1813] I first saw the tremendous fires caused by the burning of the dry grass. In many places, this grass was very thick and tall; and when perfectly dry, should it get on fire, the wind being high, the spectacle became truly sublime, especially at night. The country around far and wide, would then be illuminated by a lurid light, reflected from the clouds of black smoke in the upper regions of the atmosphere. The flames, when the wind blew strong, would move with such rapidity that animals of all kinds had to hurry forward to avoid perishing in them. They would sometimes burn the leaves on trees, twenty, or thirty feet in height. Sometimes they would consume all the fencing around the fire, in spite of all that could be done to save it.

"No one who ever witnessed one of these great fires would ever afterward be at a loss to account for the scarcity of timer in the Barrens, as trees of all kinds, when small, were destroyed by them. Should a little twig or bush put up from the ground one season, it was sure to be burned the next. The Indians, in early times, used to set this grass on fire, when hunting, and killed great quantities of game as it fled before the flames.

"But if, in winter, the barrens looked cheerless and dreary, it was far otherwise in spring and early summer. It would be difficult to imagine anything more beautiful. Far as the eye could reach, they seemed one vast deep green meadow, adorned with countless numbers of bright flowers springing up in all directions. At that time of the year I was sometimes sent to Hopkinsville--then called "Christian Court-house"--distant sixteen or eighteen miles. The whole distance was a scene of unvarying loveliness and beauty; only a few clumps of trees and now and then a solitary post-oak were to be seen, far as the eye could reach. Here I first saw the prairie bird, or barren-hen [prairie chicken], as we called it, which I afterwards met with in such vast numbers on the great prairies of Illinois. Here the wild strawberries grew in such profusion as to stain the horse's hoof a deep red color."

Sargent (1884, p. 545): "In Barren, Edmonson, and other counties extensive tracts of prairie existed at the time of the earlest settlement of the state. The presence of thse prairies in the midst of a heavily-timbered region is ascribed to the annual burning to which they were subjected by the aborigines. With the disappearance of the Indians trees sprang up, and this region is now well covered with a vigorous growth of black oaks of different species. White oaks, however, are not abundant, and other species common to the region, such as the walnuts, the yellow poplar, and the beech are wanting in these young forests, indicating perhaps the effect of fires in checking the subsequent growth or development of many useful timber trees."

Shaler (1884, p. 29-30): "In the northern [-western] part of the State, lying adjacent to the present line of the Louisville and Nashville Railroad, there was a considerable territory afterwards called the "Barrens," where the forest growth had been destroyed, except along the borders of the streams. his destruction of the timber was brought about by the custom, common to the Western Indians, of burning the grass of open grounds and the undergrowth of the woods, in order to give a more vigorous pasturage to the buffalo and other large game. To this custom we may fairly attribute the deforesting of the prairie lands in Indiana and Illinois, and perhaps of more westerly regions. The annual firing of the low-growth plants led to the killing of all the young trees. The Indians apparently began their burning of the woods on the line of the great trail from the Ohio Falls to Nashville, Tennessee. When the whites came to this country this savage custom had deforested an area of at least five thousand square miles. In another two hundred years the Indians would probably have reduced the larger part of the surface of Kentucky to the condition of prairies.

"At first the white immigrants conceived a strong prejudice to this untimbered ground, deeming the absence of trees an evidence of poverty of soil. But as soon as the incursions of the Indians were stopped they saw that the forests speedily repossessed the surface. Although they then made haste to occupy it, the swift return of the forests after the Indian fires were stopped caused a large part of this prairie country to be rewooded before it could be subjected to the plough. The late Senator Underwood, a very observant person, told the writer that when he came to this region, in the first years of this century, the whole surface was covered by a dense growth of young forest trees, which had sprung into life in the preceding twenty years, or since the Indians had ceased to hunt within the State.

"In woods of beech and ash it takes some centuries of repeated fringe of the undergrowth to reduce the area to treelessness, but in the barren district this process had gone on long enough to bring five or six thousand square miles to an essentially treeless condition, while around the border of the long-fired region there was a broad fringe of forest, where the fire-scarred trunks of old yet living trees stood as an open forest that would have been added to the open land when time came for the old trees to die. This was a process of forest-killing that had doubtless been carried on over the territory of the southwest, only there the extermination of the woods was more complete and the history of its process less traceable than in Kentucky.

"As already noted, when the regular hunting expeditions of the Indians into Kentucky were arrested, as they were in 1790, this region [the Barrens], relieved from further firing, began to spring up in forest again. The germs of the small-seeded trees, maples, etc., were rapidly transported by the wind from the nearest remaining trees which clung about the entrances to the canyons that abound in this district and other damp places; so that before settlements had made any great headway the region had been covered by a new but very dense and vigorous forest, which was harder to clear away than the older primeval woods."

Allen (1899a); reprinted in McIntire & Blakeman (1947, p. 22-24): "The barrens were covered with hazel bush, wild strawberry and native grasses, with here and there a bunch of scrubby oaks. But little water was to be had in those dry barrens, as they were then called. Around the knobs and at the sink of the creeks on the east were some groves of timber, such as the oak and a few sugar maple, walnut and poplar."

"There was a variety of grass called barren grass, that grows six of seven feet high [presumably *Andropogon gerardii*], which grew here in abundance, and served no doubt as a rich pasture for the wild animals to graze upon. Some of the grass can yet be seen in the rocky country south of Smith's Grove; and in the Green river knobs north, there are still a few patches of hazle to be seen. The hazel grew in great profusion before the country was settled up, and served for birds to nest in. There were also immense crops of nuts, which furnished food for the wild turkey, prairie chicken, deer and wild pigeon."

"THE WILD PIGEON ROOST. Some things I remember about it; it was located in the grove of timber around Smith's Grove knob, and extended out several miles. There is no record of the beginning of the roost. It may have been centuries old for all we know. When the first settlers came to the new West in the seventeenth century, they found the rivers and their tributaries lined with beech and oak forest, that furnished food for the millions of birds that annually came there to find a roosting place for the fall and winter months and when spring came, they would fly away to their favorite hatching ground where they would raise their young. They usually left before corn planting time, but there was an exception to that rule. On one or more occasions they stayed till the corn was up in the field and made short work of destroying the crop. There were millions of birds, like the sands on the sea shore, could not be counted. The roost covered from eight to ten thousand acres or more. As the flocks of hundreds and thousands of birds would come in of evenings from the beech and oak forest of Green, Barren and Cumberland rivers and their tributaries, they would circle around and often light in the tree tops, seeming to rest from their long flight of ten, fifty, and as far as one hundred miles. As night would approach, they would gather in large gangs, and when they reached the roost, the fluttering of the wings and chatter of their songs would roar like thunder in the distance...

"The droppings from these millions of birds covered the ground and was an inch deep in places. That accounts for the deep rich soil of the Smith's Grove county..."

"The pigeon roost covered hundreds of acres of scrubby timber and millions of birds would roost there in good mast years..."

[Other large roosts or flocks of passenger pigeons in Kentucky were recorded at Shelbyville during 1806 (A. Wilson); between Hardinsburg and Louisville, especially at Young's Inn, at West Point in Hardin Co. during 1813 (J.J. Audubon); along banks of the Green River (Audubon); in Calloway Co.; literature to be researched further.]

(p. 42) "In the early settling of Kentucky the greater part of the lands were covered with forests of large trees, especially on the rivers and creeks. Between the water courses there was barren land with scrubby oaks and under brush. The land had to be cleared before it could be cultivated. With the assistance of slaves the white man cleared away the forests to plant his corn and garden vegetables to feed his family, getting his supply of meat from the wild animals, such as deer, bear and the wild turkey, that were in large numbers. The buffalo was killed and drove further West by the Indians and the first white men like Boone and the "Long Hunters."

Allen (ca. 1899b) provided further historical notes on the "Smith's Grove Country" in eastern Warren County. Some material is more or less the same as printed by McIntire & Blakeman (1947; see Allen 1899a), and not repeated here.

In Allen's notes, there seem to have been interchangeable names for the knobs to east and west of Smiths Grove. The eastern one, now known as Pilot Knob, may have also been informally called the "long knob." The western one, now known as Little Knob, was perhaps also known as the Little Pilot Knob" or "Smith's Grove knob." Allen noted evidence of prehistoric native american fortifications on both hills, which commanded views to the south and west. And he noted: "There is a large burying ground about one mile west of the little knob, covering several square rods. It was plain to be seen in early days but has been plowed over until it is level now. It is on the land of J.C. Walton..."

"There are two knobs embraced in this boundary; Pilot knob on the east and Smith's Grove knob on the west of the boundary of Smith's Grove. The balance of this territory was treeless barrens or prairies, and was not thought to be valuable, as there was neither timber or water. Around the base of the little knob west of town [perhaps the same as "Smith's Grove knob"] was a beautiful grove of timber, and here a man by the name of Rollins settled, and it was called Rollin's Grove. The exact date of the first entry of land, or the first settlement made, I have no means of ascertaining, but it was long before the organization of the county* [1796]. The first settlers located where they could have wood and water, near the rivers or creeks, or groves of timber around the knobs. The first town we have any knowledge of in this territory is the old town of Martinsville, on Barren river, two miles south of Three Forks, and twelve miles east of Bowling Green... A sugar camp was once worked on the east side of the long knob as late as 1844. A nice grove of sugar maples grew luxuriously there, and there were large poplars, walnut trees, black haws and pawpaws. The soil is black and rich and very productive..." [This account goes on to include details of the Crump or Wright Cave.]

Another fragmentary account titled "Smiths Grove, Kentucky" at the public library is apparently based largely on Allen's notes. It includes the following statements, to be merged at the asterisk in the preceding paragraph.

"Around the base of the little knob was a beautiful grove of trees and this was made a settlement—date unknown except that it seemed to be before the county was organized. The man who settled it was named Rollins and it was called Rollins' Grove [spelled as "Hollins" in another fragment]... In an old entry book Lawrence Smith received 200 acres of second rate land in Warren County and the names of James Bollin and John Walker made improvements on this land, the land having been granted to John Walker on July 5th, 1799, and said that they lived in the Smith part of the Big Grove that lies two-four miles southwest of Dripping Springs. In the same entry book and same date—July 5th, 1799—there is a grant of 200 acres of second rate land in Warren County to John Smith. This was to begin near the southeast corner of Lawrence Smith. This could be the same Jackie Smith mentioned in an old newspaper account of the naming of Smiths Grove. This says that in the 1800's there lived a man by the name of Jackie Smith who owned a plot of land between the farm now owned by James McGuirk on one side and what is now Oakland and the little knob on

the other side. This was part of the Wild pigeon Roost (which we shall take up later). It seemed to be a common expression to say "Lets go down to Smiths Grove and shoot pigeons."

Gorin (1929, p. 2): "At that time [ca. 1800] the whole country was a wilderness, the cane and pea vines which covered it [presumably outside the Barrens], in many places being as high as a man's head when on horseback... The "Barrens" which were covered with the strawberry and a heather grass, five or six feet high, afforded fine grazing for stock, elk, deer and buffalo, but were then thought unfit for cultivation, for which reason surveyors planted stakes on their borders. They, however, subsequently proved to be the richest lands... "The Barrens" were not entirely destitute of timber; the traveler would occasionally meet with clumps of black jack, post oak, or white oak, numbering not more than twelve trees in a place; also a few groves of forest trees embracing several hundred acres, largest of which, perhaps, were Hall's and the Blue Spring Creek grove."

Ibid. (p. 10): “Immediately after Glasgow was decided on for the site, Curd and Logan commenced laying it off. It was almost all covered with large timber, cane and pea-vines, a few acres only having been cleared on the north and east of John Gorin’s cabin. The beginning corner of the town was at the northeast corner of Trabue’s meadow at the end of Front Street… The next thing to be done was to clear the timber off the square; this was a heavy job, for it was thickly covered with poplar trees, (many of which were from three to five feet in diameter,) black walnut, hickory, hackberry, beech, dogwood, &c.”

Dicken and Brown (1938, p. 39-43); see also Dicken (1935) and interpretation of Baskin et al. (1997): "The first settlers in the Glasgow Junction [now Park City] area found three types of vegetation: Grassland in the broad valley [presumably Happy Valley to the south]; oak-chestnut forests on the north-facing slopes and tops of the knobs; and cedar glades on the steep, south-facing limestone slopes... The climax oak-chestnut forest, found on most slopes and tops of ridges, included many hardwoods, but oaks predominated. Chestnut was common on the ridge tops, and maple, elm, sycamore, and beech intermingled with the oaks on the lower slopes.

"The cedar glade is the most distinctive type within the area (Fig. 24)... Its typical location is on the steep, south-facing limestone slopes, where the soil is extremely thin or does not even cover the fissured bedrock... [The vegetation] is limited chiefly to red cedar, scrub oak (mostly blackjack), and bluestem (*Andropogon virginicus*), locally called broom sedge [probably was referring mostly to *A. scoparius* = *Schizachyrium s.*]. In some places the vegetation forms a parklike landscape, and in others there is a continuous cover of scrubby trees.

"Cedar glades form a striking contrast to the characteristic vegetation on slopes that face the north. In a cove with an east-west alignment, for example, the northward-facing slope is mantled with deep soil and supports a dense oak-chestnut forest, whereas the southward-facing slope is covered with a scattered growth of cedars, blackjack, and broomsedge growing on thin soil between the limestone outcrops... This contrast exists even where the northward-facing slopes are much steeper than those facing south. Where the towering hardwoods (including red, black, white and chestnut oaks, hickory, maple, and many other species), have been cut off... [the] cedar glades of the south slope, however, are rarely cleared.

"Many of the old glades on south-facing slopes are of presettlement origin, but second-growth glades have developed on badly eroded land, irrespective of exposure."

Gardiner (1940, p. 178-179) compiled descriptions of the early settlement landscape by her father, Cyrus Edwards [ca. 1846-1935], whose grandfather was a pioneer in the 1790s: "Within the "barrens," between Green River and Beaver Creek, were three large bodies of heavily timbered land which was mostly taken up on military warrants several years before any settlements were made in that region. The first was the was the Blue Spring Grove, extending along Blue Spring Creek from a point about east of Hiseville to the sinks of said creek, about a mile or more northward of [towards?] the village of Seymour [NE Barren Co.]. This grove contained probably 3,000 acres. The creek valley above the point first named was in places heavily timbered, but was not equal, in quality of timber or land, to the lower stretches. but it was a goodly land and was settled by a fine class of people.

"The second was the Bear Wallow Grove, at the village of that name, containing about 1,000 acres in a compact body [perhaps around Vaughn Knob to the SE, NC Barren Co.].

"The third was the Rich Grove, which ran along the north slope of Crump's Ridge from a point east of the present Jackson Highway to the old Ellis farm and thence, bordering on the swamps and the Flint Knob, to Lee Seminary and into the Wells--or "Happy"--Valley near Pruitt's Knob [NW Barren Co.], covering probably 3,000 acres.

"The timber in these groves consisted largely of the finest quality of Ash, Sugar Tree, Scaly Bark Hickory, Black and White Walnut, Yellow Poplar and other valuable varieties, while along the lower lands those varieties were mixed with considerable Elm, Beech, and Hackberry and some Sycamore, and the land was nearly all of the very finest quality. These groves were entirely surrounded by the "barrens," thus giving to the early settlers the advantage of free and abundant pasturage from the start.

"There were also smaller, but considerable, groves of the same sort of timber on land equally as good on the north slopes of knobs in that region, among which were the Buck and the Vineyard Knobs [N Barren Co.], the Hayes Knob near Randolph [W Metcalfe Co.], the Pilot Knob near Lafayette [E Warren Co.], and the Maxey, Alderson, Bunnell, Payton, Richardson, Dawson and other knobs [mostly SW Hart Co.] between the L.& N. Railroad and the Edmonson County line."

Another reference to the grove along Blue Spring Creek is as follows (p. 310): "Its course is through the "Barrens," but was originally bounded for about a mile or more on each side by a body of heavy timber--Yellow Poplar, Beech, Scaly Bark Hickory, White Oak, Sugar Tree &c--now gone."

Cole (1941, p. 1-2) provided historical notes on "The Oakland Country" in eastern Warren County.

"In an early day a well defined Indian trace ran through the country, coming from the direction of Pilot Knob and passing near a large spring at Oakland and passed on down near the [Barren] river.

This spring at Oakland was called Trunk Spring because the water came from under the trunk of a tree at that time. This stream has disappeared. When the white man first came to this country it was bare of timber—hence the name Barrens. The wild strawberry grew in aboundance [sic] and the country south of Oakland was called the strawberry plains. As the travelers rode through during the strawberry season, the hoofs of their horses would be stained red by the berries. These berries were larger than the wild berries found growing here now..."

"The Big Sink on the farm formerly owned by the late W.R. Allen, is about one-fourth of a mile long, about one hundred feet deep and contains twelve acres. There is an underground stream in this sink that rises in the sink to a depth of fifty or sixty feet when we have excessive rains. Until it was cleared up trees and wild flowers grew in this sink that are usually found only on the banks of streams..."

"The road that was opened up when the Henry Cowle's farm was sold goes through a section of country known as the pigeon roost. The pigeons roosted in the young timber that was then growing up. They came into the roost late in the afternoon; so great was their number that they darkened the sun. Many pigeons were killed for food not only by men of this section, but they came from other counties and killed them by wagon loads. Their number grew less from year to year until they finally quit coming."

C. Early Floristic Records

Several of the accounts quoted above, under "Descriptions of Vegetation" note species of plants other than trees, but there are only a few that go into detail, such as providing scientific names of typical grassland species. These more floristic accounts are quoted here, including any from the Karst Plain region, even outside Barren and Hart Counties.

F. Michaux (1805 in Thwaites 1904, p. 218) reported collecting seed of some ninety species of plant from the Barrens of Kentucky. Whether these collections have been retrieved and catalogued is currently unclear; this question deserves further examination. The only species alluded to in his text appear to be *Antennaria plantaginifolia*, *Aureolaria flava* and *Echinacea purpurea* (see quotation above).

Rafinesque (1819); see also Stuckey & Pringle (1997): "THE BARREN REGION, or rather the open region. This has an extensive range in Kentucky, particularly in the western and southern parts of the state. The numerous *barrens* and *licks* compose it, [the licks] lying scattered and irregularly among the central and hilly regions. The *barrens* are tracts of ground destitute of trees, or with few scattered small ones; but thickly covered with a luxuriant growth of plants; while the *licks* are almost destitute of them, and those that grow in their immediate neighborhood are all small, which is owing to their poor, slaty or argillaceous soil. Their vegetation is however similar to that of the *barrens*. Both have a growth of plants very similar to the vegetation of the prairies of Ohio, Indiana, and Illinois, and more different from that of the Atlantic states, than the three foregoing regions. The plants peculiar to them are very numerous; I shall mention only a few, among the most remarkable and singular." [In the following list brackets { } indicate corrections Rafinesque published in a subsequent note.]

"(41) *Solidago rigida*, Stiff Golden-rod
(42) *Polygama polygama*, Nimble weed
(43) *Rudbeckia purpurea*, Purple Sun-flower [*Echinacea p.*]
(44) *Ruellia oblongifolius*, Rough Bell [*R. carolinensis*?]
(45) *Andropogon arenaceum*, Barren Oats [*Andropogon* sp.?]
(46) [*Andropogon*] *nutans*, Barren Oats [*Sorghastrum nutans*]
(47) *Petalvitemon* {*Petalostemon*} *candidum*, Nimble clover [*Dalea candida*]
(48) {*Petalostemon*} *purpureum*, Nimble clover [*Dalea purpurea*]
(49) *Silphium therebinthaceum*, Turpentine weed [*S. terebinthinaceum*]
(50) *Silene catesbri* {*catesbei*}, Scarlet Pink [*S. regia*?]
(51) *Gentiana amarellvides* {*amarelloides*}, Yellow Gentian [*Gentianella quinquefolia*?]
(52) *Buchnera americana*, Black Wort, &c.&c."

Short (1836; reprinted 1841, p. 120-121). Short, C.W. 1836. A sketch of the progress of botany in western America. Transylvania Journal of Medicine and Associated Sciences 9: 324-350. Reprinted: 1841. [Hooker's] Journal of Botany 3: 97-124.

"For the last twenty years we have paid some attention to the botany of Kentucky, and whilst actively engaged in the practice of medicine, in that portion of the State most inaptly called "The Barrens," opportunities were constantly presented for admiring and noting the varied vegetable productions of that interesting region. In many a long and solitary ride through these natural flower gardens, have our fatigues been lightened, and our spirits cheered by their floral charms. Here at one point, the ground was carpeted with the flame-coloured flowers of the dazzling *Euchroma* [*Castilleja coccinea*]; and there enamelled with the parti-coloured blossoms of *Violets* [perhaps *Viola pedata*], *Gentians* [perhaps including *G. puberulenta* and *G. quinquefolia*] and *Trilliums* [perhaps *Trillium cuneatum, T. sessile* and even *T. pusillum* var. *ozarkanum*]. In this spot, from amidst a tuft of humbler beauties, the majestic *Frasera* [*Frasera caroliniensis*] was seen shooting up its pyramidal head, crowned with wreaths of its very peculiar flowers; and in that, various *Sumachs* [*Rhus copallina* and perhaps *R. glabra*] overhung the path, emitting from their clumps of berries a shower of acid on the traveller. Now, would burst upon the view a smooth sheet of water, skirted with the blue and purple hues of the *Pontederia* [*P. cordata*] and *Decodon* [*D. verticillatus*], intermixed with the scarlet berries of the *Prinos* [*Ilex verticillata*] whilst its surface was covered over with the large and floating leaves and splendid flowers of the *Cyamus* [*Nelumbo lutea* and perhaps *Brasenia schreberi*]; and then, in endless vista, was stretched before the eye a waving sea of gigantic grasses [presumably including much *Andropogon gerardii*]. In such a field as this, none but a recreant to nature and undeserving of her pleasures, could remain indifferent to the charms spread in such lavish profusion around; and, although we were not idle, inattentive or unobservant of them, yet do we now find cause for bitter regrets, that we did not then more industriously avail ourselves of the opportunities thus enjoyed, for studying, examining and collecting the productions of that rich and interesting region."

Davidson (1840, p. 30-31) noted botanical details of the barrens as follow: "With great enthusiasm have I heard the late Professor of Botany, in Transylvania, descant on the topic." The following

material is provided in a footnote, from: "Charles W. Short, M.D. now of Louisville; a gentleman who is as estimable in private life, as he is eminent in his favourite walk of science."

""In many a long solitary ride through the Barrens of Kentucky," said he, has my labour been lightened and my spirits cheered, by the floral varieties of that interesting region. Here in one spot the ground was carpeted with the flame-coloured flowers of the *Euchroma*, there enamelled with the party colored blossoms of violets and trilliums. In this spot, from amidst a tuft of humbler beauties, the majestic *Frazera* shot up its pyramidal head, crowned with wreaths of its peculiar beauties, and on that [spot], various *sumachs* overhung the path, emitting from their clumps of fruit, a shower of acid on the traveler. Here at one point, would burst upon the view a sheet of water skirted with the numerous bright blue petals of the pondeteria and decodon, and covered over with the purple flowers of the *cyanus*; and then, at another [spot] was stretched before the eye a waving sea of gigantic grasses. In such a scene as this," continued the enthusiastic naturalist, "none but a recreant to nature, and undeserving its pleasures, could remain indifferent to the charms spread in such lavish profusion around."

Drake (1850, p. 237-238) also quoted the following account from his "colleague. Professor Short, of the University of Louisville [Charles Wilkins Short]", cited as "MSS. penes me" [manuscript written to me].

"When I first went to Hopkinsville [Christian Co.], where I practiced medicine from 1817 to 1826, the aspect of the barrens was very much the same with that presented by the prairies of Illinois; and, I suppose, the characteristic feature of both--the destitution of timber--is in both cases attributable to the same cause--the annual ravages of fire; which, fed by the tall grasses, and dead herbaceous plants, in autumn, is so intense as to destroy all the ligneous growth which may have sprung up during the preceding spring and summer. The vegetable productions of both these regions--barrens and prairies--are very similar; the grasses being, for the most part, various species of *Andropogon* and *Panicum*, and the herbaceous vegetation consisting, chiefly, especially in autumn, of the various *compositae--Silphium, Aster, Solidago, Eupatorium*, &c.; while along the water-courses, in both regions, the arborescent species are very much the same; as they are, also, in certain woodland tracts, called by the people 'groves.' This difference, however, obtains, between the barrens of Kentucky and the prairies north of the Ohio, viz, that the former are superimposed on a bed of limestone, which is wanting in Illinois... By cultivation, and the prevention of destroying fires, the barrens are losing, yearly, their once peculiar features; for, no sooner are the fires kept out for a few years, than the surface becomes clothed with a dense growth of timber--oaks and hickories--so dense, indeed, as to stifle entirely all herbaceous undergrowth.

"*Marshes*, in the proper sense of that term, are exceedingly rare among the barrens. Indeed, within the limits of the three counties in which I practiced--Christian, Todd, and Trigg--I know of but one marsh of any magnitude; and that I shall never forget, from the circumstance of finding in it the *Cyamus luteus* [*Nelumbo lutea*], the most magnificent of all aquatic plants. Around the margins of this marsh, in the shallow, muddy water, were growing thickets of *Decodon verticillatus, Cephalanthus occidentalis, Rosa carolina* [probably *R. palustris*], and other semi-aquatic shrubs."

Hussey (1876) reported many plants identified from May to early August in Barren and Edmonson Cos. Collections from his survey are reportedly housed at Indiana State University, Purdue, but have not been researched; this should be done. Among the species he listed, the following are typical of grassy open woods but are currently rare or sensitive in the modern landscape.

Asclepias phytolaccoides [= *A. exaltata*]
Castilleia coccinea [= *Castilleja coccinea*]: this is endangered in KY currently, and known only from scattered sites in the Knobs Region and northern Appalachian Plateaus.
Cirsium virginianum [probably meaning *C. carolinianum*]
Collinsia verna
Corydalis glauca [= *C. sempervirens*]: typical of rocky woods on sandstone in the Cumberland Mountains, but currently unknown elsewhere in Kentucky.
Leavenworthia michauxii [= *L. uniflora*]: "just northwest of town [Glasgow Junction = Park City now], growing in a nearly filled-up sinkhole. This is quite a rare plant..."
Oenothera fruticosa
Parthenium integrifolium
Phlox amoena
Phlox pilosa
Pycnanthemum lanceolatum [probably meaning *P. pilosum*]
Scutellaria galericulata
Trifolium reflexum: "occurs in several localities between the railroad and Mammoth Cave... I mention it because I have never found so many specimens in any one locality before, and also to make a note of the fine rose-pink color it everywhere had [p. 12]."

Price (1893): her "Flora of Warren County, Kentucky" includes several conservative species typical of native grasslands and open woodlands, as listed below. Price's herbarium collections are generally lodged at Missouri Botanical Garden (St. Louis), and these need further study to support her paper. These records provide provisional insight to the early flora and vegetation of the Big Barrens Region, including hilly transitions represented in Warren County. In several cases, the names are outdated, and common modern synonyms (or other suggested substitutions?) are provided in parentheses.

Asclepias purpurascens
**Aspidium thelypteris* (*Thelypteris palustris*)
#Aster sericeus (*A. pratensis*)
Bouteloua racemosa (*B. curtipendula*)
#Bumelia lycioides
**Cacalia suaveolens*
***Calamagrostis porteri* (? ssp. *insperata*)
***Castanea pumila*
Coreopsis gladiata (? *C. lanceolata*)
Delphinium azureum (*D. carolinianum*)
#Desmodium cuspidatum
#Desmodium rigidum (*D. obtusum*)
***Draba brachycarpa* [in handwritten addenda]

#Echinacea angustifolia (*E. simulata*)
***Eupatorium semiserratum*
***Gaylussacia dumosa* (id. perhaps doubtful)
#Gentiana puberula (refound at Athey barrens)
**#Gerardia pedicularia* (*Aureolaria p.*)
#Helianthus doronicoides (? *H. mollis*)
**#Helianthus strumosus* (? *H. eggertii*)
#Hexalectris aphyllus (*H. spicata*)
**Hieracium longipilum*
#Hypericum virgatum (*H. denticulatum*)
Leavenworthia michauxii (*L. uniflora*)
#Liatris squarrosa
#Lilium superbum (? *L. michiganense*)
**Lophanthus scrophulariaefolius* (*Agastache s.*)
Malvastrum angustatum (*M. hispidum*)
**Oenothera triloba*
Onosmodium carolinianum (*O. molle* ssp. ?)
***Pedicularis lanceolata* (id. perhaps doubtful)
Petalostemon candidus (*Dalea candida*)
***Petalostemon violaceous* (*Dalea purpurea*)
Pycnanthemum lanceolatum (? *P. virginianum*)
#Pycnanthemum pilosum
#Ranunculus fascicularis
***Rhynchosia erecta* (*R. tomentosa*)
***Rhynchosia volubilis* (? *R. latifolia*)
***Silene regia*
#Silphium terebinthinaceum var. *pinnatifidum* (S. p.)
#Solidago speciosa var. *angustata*
#Veronica virginica (*Veronicastrum v.*)

This list of rare or conservative species provides invaluable insight to the kind of vegetation that must have been associated with the fire-regime during the pioneer era. Several of these species, as shown by asterisks above (*), can no longer be found in Warren County. Several, as shown by double asterisks (**), can no longer be found in the whole Pennyrile Karst Plain or adjacent hills--including the intensively covered Mammoth Cave area. However, several have been found in the Mammoth Cave area (USGS quads of the park) during the past 50 years, as shown by numerisks (#).

Hibbard (1934b-35): on June 8, 1934: "...east of Cedar Sink...Woolsey Valley...Many different kinds of clover scattered along ravines and hillsides throughout the valley, but no extensive patches." On Aug 20, 1934: "[from camp in Flint Ridge area?] by way of Dennison Ferry. The road was followed but part of the trip as we cut through on the ridges... Wild clover is scattered over the entire area."

May 1, 1935: "On the ridge between Houchins and Eaton Valleys, I found what I believe to be willow oak." [Note: this may, however, have been shingle oak (*Quercus imbricaria*), which he also noted in the area.]

D. Barton (1919).

Barton provided estimates of standing timber made in each Kentucky county during the period ca. 1900-1910. Unfortunately, no details of surveying methods were provided, and some of the data appear to be based on small samples, and there may be considerable inaccuracies. The following six counties are selected here as representing an east-west gradient across the Mammoth Cave area. Hart and Barren Counties are largely in the Pennyrile Karst Plain; Grayson and Edmonson Counties are largely in the transitional "Dripping Springs Hills" (with various calcareous and non-calcareous rocks); Ohio and Butler Counties are largely in the "Outer Shawnee Hills" (with non-calcareous Pennsylvanian bedrock).

Percent Forest Cover

OHIO	GRAY	HART
24	26	13
BUTL	EDMO	BARR
49	55	41

Note: Edmonson Co. was one of only five non-Appalachian counties to have more that 50% forest cover in this survey (also Trigg, Lyon, Monroe and Russell).

Total Standing Timber Estimate (millions of board feet)

OHIO	GRAY	HART
101	75	139
BUTL	EDMO	BARR
96	55	178

Note: these total timber estimates do not correlate closely with the percent forest cover estimates above; further research into the geography and logging history of these counties is needed to properly interpret these data; it would appear that Edmonson Co. had experienced particularly intense timber extraction.

Percent "black oak" (*Quercus velutina, Q. falcata, Q. rubra, Q. coccinea, Q. shumardii, Q. marilandica*)

OHIO	GRAY	HART
20.1	49.4	46.7
BUTL	EDMO	BARR
22.4	45.0	49.9

Percent "white oak" (*Quercus alba, Q. muhlenbergii, Q. bicolor, Q. macrocarpa, Q. michauxii*)

OHIO	GRAY	HART
8.3	9.3	3.4
BUTL	EDMO	BARR
8.4	15.0	9.3

Percent "post oak" (*Quercus stellata*)

OHIO	GRAY	HART
1.8	4.4	26.0
BUTL	EDMO	BARR

2.2	2.0	21.0

Percent "hickory" (*Carya* spp.)

OHIO	GRAY	HART
10.5	9.1	7.4
BUTL	EDMO	BARR
3.2	5.0	8.5

Percent "beech" (*Fagus grandifolia*)

OHIO	GRAY	HART
26.0	9.4	5.5
BUTL	EDMO	BARR
41.8	8.7	<3.7

Percent "poplar" (*Liriodendron tulipifera*)

OHIO	GRAY	HART
1.0	2.2	<0.5
BUTL	EDMO	BARR
3.3	3.0	3.8

Percent "maple" (*Acer saccharum, A. nigrum,. A rubrum, A. saccharinum*)

OHIO	GRAY	HART
8.3	3.2	0.5
BUTL	EDMO	BARR
2.1	2.0	<3.7

Percent "gum" (*Liquidambar styraciflua, Nyssa sylvatica*)

OHIO	GRAY	HART
15.0	3.1	1.5
BUTL	EDMO	BARR
5.0	2.0	0.3

Percent "chestnut" (*Castanea dentata*)

OHIO	GRAY	HART
1.2	4.1	2.5
BUTL	EDMO	BARR
3.3	4.3	6.2

Percent "walnut" (*Juglans nigra, J. cinerea*)

OHIO	GRAY	HART
<	0.3	<
BUTL	EDMO	BARR
<	1.0	<

Percent "elm" (*Ulmus rubra, U. americana, U. alata*)

OHIO	GRAY	HART
1.2	2.1	1.5
BUTL	EDMO	BARR
1.2	2.3	<

Percent "ash" (*Fraxinus americana, F. pennsylvanica, F. quadrangulata*)

OHIO	GRAY	HART
0.7	1.0	0.5
BUTL	EDMO	BARR
0.5	1.0	<

Percent "sycamore" (*Platanus occidentalis*)

OHIO	GRAY	HART
1.2	0.3	<
BUTL	EDMO	BARR
2.6	3.0	3.0

Percent "cedar" (*Juniperus virginiana*)

OHIO	GRAY	HART
<	0.3	0.5
BUTL	EDMO	BARR
<	0.6	<

Percent "locust" (*Robinia pseudoacacia, Gleditsia triacanthos*)

OHIO	GRAY	HART
<	<	0.3
BUTL	EDMO	BARR
<	<	<

Percent "scattered" (other species for that county, but not a consistent group for each county, since not all of the above taxa are itemized in each county)

OHIO	GRAY	HART
4.5	1.8	3.7
BUTL	EDMO	BARR
4.2	5.2	0.1

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Appendix Five: notes on "submesic-to-subhydric forest formation" in the Mammoth Cave region, extracted more or less verbatim from Campbell (1999); classes 6 and 7 were later subdivided into more distinct classes within in future work; code numbers after vegetation type names are short-hands for vegetation types (classes 1-12, A-E, etc.) or plot codes; see original report for details.

Note that these types occur in a wide variety of topographic situations, but they are loosely united by a generally intermediate character between mesic, hydric and subxeric conditions. Also, these types are often intermediate along disturbance gradients, from dense forest to open woodland. Fairly widespread (often more or less mid-successional) tree species are perhaps most characteristic and are used in the superalliance names below. In addition, there are often odd mixes of species with different habitat associations (prompting the informal term "mixed messy-phytic"). To the north, there are few distinctive tree species, except perhaps *Juglans* spp. on drier ground (note also *Acer rubrum var. trilobum* on wetter). To the south, there appear to be more distinctive species (often late successional), with habitat distributions centered in this intermediate zone, e.g., *Quercus michauxii, Q. pagoda, Liquidambar styraciflua, Carya illinoinensis* and even *Celtis laevigata*. (To the west, *Gymnocladus* and *Maclura* may be distinctive.) In the partly open, occasionally disturbed stands of this formation, shrubby understories are often dense, and *Arundinaria gigantea* reaches its peak abundance.

SUBHYDRIC FOREST

6A. Soils extremely low in base-status and overall fertility; generally associated with ground-water seepage instead of alluvial flooding: *Acer rubrum* var. *trilobum, Nyssa biflora, N. sylvatica; local Ilex opaca, Pinus spp., Tsuga canadensis.*

ACER RUBRUM VAR. TRILOBUM, ILEX OPACA SUPERALLIANCE (?)
[Unknown in MCNP.]

6B. Transition from A to C.

ACER RUBRUM VAR. TRILOBUM, QUERCUS ALBA TRANSITION

Subhydric sites, associated with ground-water seepage more often than alluvial flooding; *Acer rubrum, Nyssa* spp. generally dominant; local *Tsuga canadensis, Pinus strobus* in regions with sandstone: IC3Ng020 ("d020"); IB2Ng015, g020; IIB2Ng010.

Acer rubrum-Nyssa sylvatica forest (IB2Ng015).
= KSNPC acid seep forest
= Seymour IIJ1: acid seep
= not used by Badger
This type may occur on sandstone ridges with poorly drained streamheads fed by ground water seepage. The forest composition should be checked at the Sphagnum site with *Carex stricta* and *Solidago patula.*

6C. Soils moderate in base-status and overall fertility: *Acer rubrum* var. *trilobum, Liquidambar styraciflua, Nyssa sylvatica, Quercus michauxii, Q. pagoda, Q. alba, Q. falcata*; local *Fagus grandifolia, Liriodendron tulipifera.*

LIQUIDAMBAR, QUERCUS (*ALBA, MICHAUXII*) SUPERALLIANCE (?)

Subhydric sites, seasonally flooded or saturated; wetland species predominant: IB2Ne060.

Liquidambar styraciflua (*Acer rubrum, Nyssa sylvatca*) forest (IB2Ne060)
= KSNPC depression swamp in part
Such forest may occur around upland depressions (and perhaps locally on poorly drained bottomlands). Some sites may have *Quercus palustris* (see below).

6D. Transition from C to E.

LIQUIDAMBAR; FRAXINUS TRANSITION (?)

Subhydric sites, seasonally flooded or saturated; wetland species predominant: IB2Ne020.

Undisturbed forest phases: to be defined.
= Campbell N115,N116.
Some variants exist in backwater swales along floodplains. *Fraxinus pennsylvanica-Acer rubrum* var. *trilobum*-(*Liquidambar styraciflua*) forest probably also occurs in small patches around small streamheads and seeps on broad ridges with some calcareous influence. On more poorly drained broad upland flats and depressions, this type grades into (or is a disturbed variant of) oak forest with *Quercus bicolor, Q. palustris,* etc. On subhydric streamhead sites, it intermixes with *Platanus, Liriodendron, Carpinus, Lindera,* etc. (*Q. michauxii, Q. pagoda and Q. shumardii* might establish here if there were seed-sources.) Common species on the ground may include *Cinna arundinacea* and *Elymus virginicus var. virginicus*.

Disturbed/open phases: may have frequent *Diospyros*.

6E. Soils with high base-status and overall fertility; often in larger valleys with richer alluvium: widely abundant *Juglans ngra, Celtis* spp., *Fraxinus* spp., *Ulmus* spp.; local *Acer saccharum* (s.l.), *Aesculus glabra, Carya illinoinensis,* (*C. myristicaeformis*?), *Gymnocladus dioicus, Quercus muhlenbergii, Q. shumardii, (Q. bicolor, Q. macrocarpa, Q. texana*?).

FRAXINUS (*PENNSYLVANICA, AMERICANA*), *JUGLANS NIGRA* SUPERALLIANCE (?)

Subhydric sites, seasonally flooded or saturated; wetland species predominant: IB2Ne020.

SUBMESIC FOREST

7A. Soils extremely low in base-status and overall fertility; generally associated with ground-water seepage instead of alluvial flooding: *Acer rubrum* var. *trilobum, Nyssa biflora, N. sylvatica; local Ilex opaca, Pinus spp., Tsuga canadensis.*

ACER RUBRUM VAR. TRILOBUM, ILEX OPACA SUPERALLIANCE (?)
[Unknown in MCNP.]

7B. Transition from A to C.

ACER RUBRUM VAR. TRILOBUM, QUERCUS ALBA TRANSITION

Submesic sites, with temporary or no flooding: varied composition but generally abundant *Acer rubrum* var. *trilobum, Nyssa sylvatica, Liquidambar*; also locally *Fagus, Ilex opaca, Liriodendron, Oxydendrum arboreum, Quercus* spp., *Pinus* spp., *Tsuga*; IB2Na160x (e.g. Hazel Dell, Pulaski Co. KY); IC2Ng020x (e.g., at Big South Fork).

[Unknown at MCNP, but possible on sandstone uplands.]

High seeps; *Pinus* spp., *Quercus* spp., *Ericaceae* mixed with local *Acer rubrum* var. *trilobum, Nyssa sylvatica*: IIC3Ng080x ("f080", see NE USA).

[Unknown at MCNP, but possible on sandstone uplands.]

7C. Soils moderate in base-status and overall fertility: *Acer rubrum* var. *trilobum, Liquidambar styraciflua, Nyssa sylvatica, Quercus michauxii, Q. pagoda, Q. alba, Q. falcata*; local *Fagus grandifolia, Liriodendron tulipifera.*

LIQUIDAMBAR, QUERCUS (*ALBA, MICHAUXII*)
SUPERALLIANCE (?)

7C1. Submesic sites, with temporary flooding: IB2Nd120, d210.

7C2. Submesic uplands or subxeric transition; generally with upland species: IB2Na160, a200.

Undisturbed forest phase: to be defined.
= Ellsworth: *Liriodendron tulipifera*, in large part (?).
= Campbell N107.
Liriodendron, Acer rubrum, Quercus alba, Q. falcata and other species are typical of some swales on broad ridges where there is probably a stable mix of species typical of mesic and subxeric or subhydric sites. However, all known stands are in a successional state, often with much *Juniperus* and *Pinus*. It is possible that the potential undisturbed forest on such sites might be similar to the *Fagus-Q. alba* alliance of the Coastal Plain (IB2Na160).

Disturbed phase: Campbell N22?

7D. Transition from C to E.

LIQUIDAMBAR; FRAXINUS TRANSITION (?)

7D1. Submesic sites, with temporary flooding: IB2Nd020x.

Undisturbed forest phase: to be defined.
A variant may exist on some higher floodplain sites prone to droughty conditions in summer and fall; *Quercus alba* may be locally abundant, together with *Fagus* and *Acer saccharum* (e.g., along Wet Prong of Buffalo Creek).

Disturbed/seral phases: to be defined.
= Badger 907?,P04? (bottomland *Juniperus*)
= Campbell N128? (sink)
Juniperus is locally abundant in old field succession along the Green River bottomland, presumably on relatively dry ground. Further work is needed to determine if these areas are really influenced by the floodplain, or if they should be combined with the upland variant (see above).

7D2. Submesic uplands, or subxeric transition; upland species predominant: IB2Na160x?

Undisturbed forest phases: to be defined.
= Campbell N14,N18,N39.
In some swales on broad ridges with calcareous influence, *Acer saccharum* is dominant in ca. 60 year old successional stands, often with locally dominant *Liriodendron* and *Fraxinus americana* as well. Other trees include *Acer rubrum var. trilobum, Carya glabra, C. tomentosa, Fagus grandifolia, Juniperus virginiana, Prunus serotina, Quercus alba, Q. falcata, Q. velutina, Ulmus alata*, etc. Although appearing relatively mesophytic, these stands may be subject to browsing, fire, sheet-erosion, droughts and other disturbances, so that long-term dominance of *A. saccharum* is doubtful. It is likely that *Fraxinus americana, Carya* spp. and *Quercus* spp. will establish enough to remain a substantial component. Shrubby species include *Cornus florida, Hypericum prolificum, Rhus copallina, Rubu*s spp. and *Symphoricarpos orbiculatus*. Ground vegetation includes *Asplenium platyneuron, Brachyelytrum erectum, Bromus pubescens, Microstegium vimineum, Euonymus americanus, Eupatorium rugosum, Galium triflorum, Leersia virginica, Lonicera japonica, Polystichum acrostichoides, Sanicula canadensis,* etc.

Disturbed/seral phase: to be defined; with *Liriodendron tulipifera, Juglans nigra, Fraxinus americana, Juniperus virginiana, etc.*.
= Campbell N108, N109

7E. Soils with high base-status and overall fertility; often in larger valleys with richer alluvium: widely abundant *Juglans ngra, Celtis* spp., *Fraxinus* spp., *Ulmus* spp.; local *Acer saccharum* (s.l.), *Aesculus glabra, Carya illinoinensis,* (*C. myristicaeformis*?), *Gymnocladus dioicus, Quercus muhlenbergii, Q. shumardii, (Q. bicolor, Q. macrocarpa, Q. texana*?).

FRAXINUS (*AMERICANA, PENNSYLVANICA*), *JUGLANS NIGRA* SUPERALLIANCE (?)

7E1. Submesic sites, temporarily flooded/toe slope transition: IB2Nd020x, d110.

Undisturbed forest phase: to be defined

Disturbed phase: *Juglans nigra*-(*Celtis occidentalis, Aesculus glabra forest* (?)
= Faller "walnut, butternut, Kentucky coffeetree" (Appendix F)
= Campbell N3.
Small areas with such forest may have occurred on highly base-rich, well-drained bottomland terraces that had much disturbance from ungulates or native peoples. Other associates may have included *Gymnocladus dioica, Quercus macrocarpa, Q. shumardii* and *Carya laciniosa.*

7E2. Submesic uplands or subxeric transition; upland species predominant: IB2Na060x?, a035?

Undisturbed forest phase: to be defined as presumed potential undisturbed forest typical of well-drained sinkhole bottoms. Virtually all has been cleared for farmland in the past.

Disturbed/seral phase: *Juglans nigra-Prunus serotina*-(*Celtis occidentalis, Ulmus americana, rubra*) (IB2Na035).
= Campbell N9,N11,N34,N60
This is an early successional type in valleys that have been completely cleared in the past for farmland, and in some cases with eroded soil. *Juglans* is generally dominant, but *Prunus* or others may also be locally dominant. Other associates include *Acer negundo,* A. *saccharum, Carya cordiformis, Gleditsia triacanthos, Juniperus virginiana, Morus rubra, Quercus imbricaria, Q. muhlenbergii, Q. shumardii, Platanus occidentalis*, etc. Perhaps due to heavy browsing by deer, there is remarkably little invasion by *Acer saccharum* at most sites, and even less *Fraxinus americana*, except in drier or more sloping transitions. Shrubby species may include *Cercis canadensis*, *Lindera benzoin, Rhamnus caroliniana, Rubus occidentalis, Symphoricarpos, Vitis vulpina*, etc. Ground vegetation is dense and varied, with locally abundant *Amphicarpaea bracteata, Asarum canadense, Brachyelytrum erectum, Bromus pubescens* (or nottowayanus), *Chasmanthium latifolium, Elymus hystrix, Microstegium vimineum, Eupatorium rugosum, Festuca obtusa, Hackelia virginiana, Lonicera japonica, Panicum clandestinum, Polygonum virginianum, Verbesina alternifolia,* etc. Others include *Agastache nepetoides, Agrimonia pubescens, Arisaema (dracontium, triphyllum), Campanula americana,*

Cirsium altissimum, Elephantopus carolinianus, Galium triflorum, Geum canadense, Leersia virginica, Muhlenbergia frondosa, Pilea pumila, Poa sylvestris, Polygonum scandens, Polymnia uvedalia, Scrophularia marilandica, Scutellaria incana (pubescent), Thalictrum pubescens, etc. Sites closer to the major rivers may have more variety, with abundant vernals such as *Chaerophyllum procumbens* and *Viola striata*. Rare species may include *Lilium michiganense*.

Open woodland/old field phase: to be defined.
= Campbell N76 (old field?)
Even currently, several areas have remained somewhat open, perhaps due to difficulties of tree establishment in dense ground vegetation, plus the intense deer browsing on shade tolerant tree species. *Juniperus* may be locally abundant.