

Campbell, J.J.N., D.D. Taylor, M.E. Medley, & A.C. Risk. 1991. Floristic and historical evidence of fire-maintained, grassy pine-oak "barrens" before settlement in southeastern Kentucky. Pages 359-375 in: S.C. Nodvin and T.A. Waldrop (eds.). Fire and the Environment: Ecological and Cultural Perspectives. Proceedings of an International Symposium. Southeastern Forest Experiment Station, Asheville, North Carolina.

Errata

p. 361: "Carex gravida" was misidentified *C. muehlenbergii*; this material should be excluded from the paper.

p. 365: a block of Table 1 became misplaced in the transfer.

Under "Monocots" the section from *Verbascum thapsus* to *Parthenium integrifolium* should be cut out and reinserted on p. 364 under "Scrophulariaceae" between *Pedicularis canadensis* and *Achillea millefolium*.

A more thorough listing of rare species that may have been part of the original open grassy woodland of this region has been presented within the following document.

Campbell, J.J.N., C.S Major & M. Hines. 2001. Ecological rationale for the fire management plan at Big South Fork National River and Recreation Area. Prepared by The Nature Conservancy for the Big South Fork National River and Recreation Area. Produced Under NPS Cooperative Agreement # 1443 CA5130 99 001.

Posted at:

http://www.bluegrasswoodland.com/uploads/Fire_for_Big_South_Fork.pdf

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Nodvin, Stephen C.; Waldrop, Thomas A., eds.

1991. Fire and the environment: ecological and cultural perspectives: Proceedings of an international symposium; 1990 March 20-24; Knoxville, TN. Gen. Tech. Rep. SE-69. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 429 pp.

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FLORISTIC AND HISTORICAL EVIDENCE OF FIRE-MAINTAINED, GRASSY PINE-OAK BARRENS BEFORE SETTLEMENT IN SOUTHEASTERN KENTUCKY

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Abstract—Several rare plant species in Appalachian Kentucky have been found generally on sandy ridges of the southern Cliff Section in native grassy roadside vegetation or young brushy pine-oak (*Pinus-Quercus*) woods, and almost never in areas with less human disturbance. They include *Agalinis decemloba*, *Aster concolor*, *Castanea pumila*, *Cirsium carolinianum*, *Eryngium yuccifolium*, *Gymnopogon ambiguus*, *Helianthus atrorubens*, *Liatris squarrosa*, *Lilium philadelphicum*, *Oenothera perennis*, *Parthenium integrifolium*, *Phlox amoena*, *Polygala polygama*, *Rhynchosia tomentosa*, *Robinia hispida* var. *rosea*, *Sanicula marilandica* (var. *petiolulata*), *Schwalbea americana* (a candidate for federal protection) and *Sporobolus clandestinus*. Most are concentrated in the southeastern U.S.A., and several are typical of open pine or oak woods with frequent fire. Either these species have invaded roadsides and other disturbed areas after settlement, or they are relicts from openings that were maintained by fire, Indians and large herbivores before settlement. The latter hypothesis is supported by the virtual absence of these species in recent clearings, suggesting low reproductive rates; some species have disappeared since 1950. Also, there are historical indications that fire did maintain some open pine-oak barrens, together with an associated Federally Endangered animal—the red-cockaded woodpecker (*Picoides borealis*).

INTRODUCTION

During ongoing inventory of rare species in the Daniel Boone National Forest (DBNF) and other areas of Appalachian Kentucky (Palmer-Ball and others 1988, Campbell and others 1989, 1990, 1991), it has become clear that several rare plants are largely restricted to roadsides and other currently disturbed upland areas in the southern "Cliff Section" (Braun 1950). The purpose of this paper is to summarize the distributions of these species, and to present the hypothesis that most are relicts from woodland openings maintained by fire, which became suppressed with the establishment of DBNF in 1930-40 (Martin 1990).

The Cliff Section is a highly dissected, largely forested region with exposures of sandstone and, at low elevations, limestone (fig. 1). To the west, it merges with the Highland Rim in the south, or with the Knobs in the north. To the east, there is a transitional "Low Hills Belts", then the "Rugged Eastern Area" of the Appalachian Plateau, then the Cumberland Mountains (Braun 1950). The boundary of DBNF approximates that of the Cliff Section, plus some extensions

into the southern Rugged Eastern Area. The Cliff Section has a much greater density of globally and regionally rare plant species than elsewhere in Appalachian Kentucky, except for some parts of the Cumberland Mountains.

The rare species can be divided into groups based on their typical habitats. These are rocky banks of larger streams, seeping streamheads on broader ridges, overhanging cliffs with rockhouses, flatter rock outcrops on clifftops and ridges, typical upland forest on moist to dry soil (with relatively few examples), and upland roadsides or disturbed woods. There is almost no overlap between these species groups, except for about five of the roadside group that have also been found on rocky riverbanks (see below). The "roadside" group mostly occurs in the southern half of the Cliff Section, especially in McCreary, Pulaski, Whitley and Laurel Counties (fig. 1). Most species are restricted to the southeastern U.S.A., and several are typical of open pine or oak woods with frequent fire. The term "barrens" is adopted in this paper for the putative fire-maintained, presettlement vegetation. This term has similar meaning to "savanna", which has been used more widely in the southeastern Coastal Plain for particularly flat and grassy woodland with greater seasonal changes in hydrology. Species' nomenclature generally follows Kartesz and Kartesz (1980).

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KENTUCKY

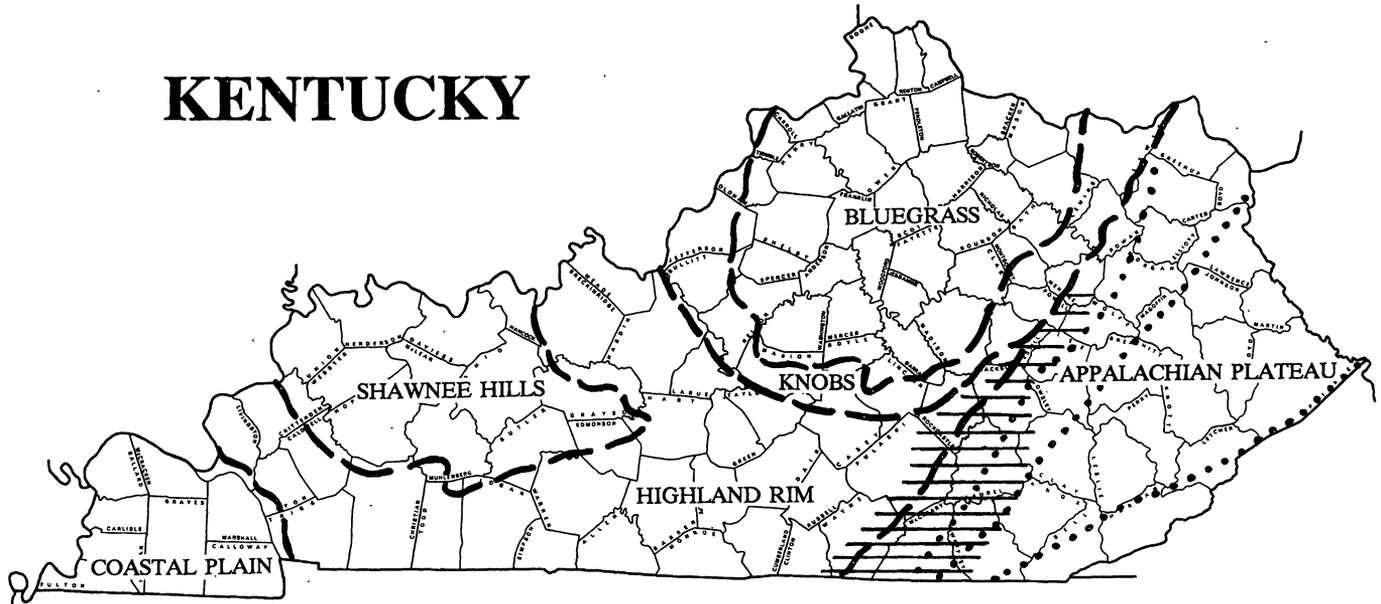


Figure 1. Map of Kentucky showing (a) major physiographic regions (dashed lines); (b) subsections (dotted lines) of the Appalachian Plateau and Mountains--from west to east, Cliff Section, Low Hills Belt, Rugged Eastern Area and Cumberland Mountains; and (c) the study area referred to in text (hatched).

SOURCES OF INFORMATION

Most of the data summarized below is in the database on rare species that the Kentucky State Nature Preserves Commission (KSNPC) has compiled during the past 15 years from all known publications on Kentucky plants, and from unpublished data shared by cooperating researchers. The rare species list used by KSNPC is currently undergoing revision, and relevant unpublished data of the authors should be incorporated soon. Records from the Somerset and Stearns Districts of DBNF, with which this paper is largely concerned, were increased 3-4 times during the 1987 and 1989 cooperative inventories (see Introduction). Most of the earlier records were referred to by Rogers (1941) and Braun (1943, plus her collection labels). The inventories included searches along most public roads in the study areas, and much exploration of remote forested areas. Although transects were not quantitatively sampled, statements below that certain species appear largely restricted to roadsides are based on intensive local exploration. At most open sites with rare species, the adjacent forest was explored to see if these species extended into the shade. For general information on the effects of fire in recent history, D.D.T. interviewed several older USFS personnel and other residents familiar with the southern half of DBNF, especially Winnifer Freeman (Somerset), Clemon Garrison (Mount Victory), Joe Planck (Somerset) and Ray Powell (McKee). The only other summary of fire-history in DBNF is the recent study of Martin (1990), which includes statistical details from USFS files.

NOTES ON RARE SPECIES OF ROADSIDES AND THICKETS

The list below includes all native species that generally meet two criteria.

- (1) Within the Appalachian region of Kentucky, they are largely restricted to well-drained non-calcareous uplands of the Cliff Section (especially the southern half) and, in some cases, the Cumberland Mountains.
- (2) Within this region, there are generally fewer than 10 records of each species (excepting *Helianthus atrorubens*, *Malus angustifolia* and *Phlox amoena*), and most records are from grassy roadsides, brushy areas or open woods disturbed by man within the past 10-20 years.

In parentheses after each species' name is the number of Kentucky counties where it is known, followed by the approximate total of known sites in the state. Unless stated, most records are post-1950.

Agalinis decemloba (2/3). In Kentucky, this southeastern (mostly Piedmont) species of dry open woods and edges is known from only three collections. These were made in 1927 (oak-pine woods), 1934 and 1987 (grassy roadside), all on dry, sandy ridges in the southern Cliff Section.

Asclepias amplexicaulis (11/35). This widespread eastern species of dry openings is scattered over southern Kentucky. Almost all Appalachian records are from roadsides on ridges in the southern half of the Cliff Section.

Aster concolor (4/12). In Kentucky, this southeastern species of dry sandy barrens and open woods is known mostly from the southern Cliff Section (plus two western sites). All post-1970 records are from upland roadsides, with only 1-20 plants, except for one site on Kentucky State Route (KSR) 751 with several hundred. Two of the four older (1940-50) records are from "dry" or "open grassy pine" woods.

Aureolaria pectinata (7/10). In Kentucky, this southeastern species of dry woods and openings is known from scattered southern counties. There is one Appalachian collection, made during 1939 in the southern Cliff Section on a "dry wooded bank of Bridge Fork Pond" [an artificial pond]. The closely related, or sometimes combined, northern species, *A. pedicularia* is known from grassy openings on Pine Mountain (Harlan Co.).

Carex gravida (13/20). This widespread mid-western species of open ground is known from several scattered areas of Kentucky (except the Bluegrass Region), mostly as the more southern var. *lunelliana*. In the Cliff Section, it is known only from disturbed woods, edges and roadsides, on sandy and calcareous soils.

Carex physorhynca (2/4). This southeastern species of sandy open woods was recently discovered in Kentucky, from a barrens in the western Highland Rim (R. Cranfill, pers. comm.), and from roadsides and adjacent young, open *Pinus virginiana* woods in the southern Cliff Section.

Castanea pumila (7/10). In Kentucky, this southeastern species of dry, sandy thickets and disturbed woods is largely restricted to the Cumberland Mountains, but there are a few, mostly old, western records. There are only two verified Cliff Section records, both southern, from 1935 and 1989 (a suppressed individual on a small stream terrace). Johnson (1989) noted "its ability to recover from fire and other disturbances, through rapid suckering and sprouting from the remaining stem at or below the ground level." Near Jasper, Georgia, M.E.M. observed abundant suckers after clearcutting, in association with *Robinia hispida* varieties (see below). In addition to fire-suppression, the chestnut blight (*Endothia parasitica*) has probably reduced this species.

Cirsium carolinianum (6/15). This southeastern species, generally of dry sandy open woods and edges, has been recorded in scattered areas of Kentucky. Most sites are in the Cliff Section with half these in a 50 km² area along the Cumberland River, generally on roadsides, except for one in a more natural grassy pine-oak woods (table 1), and another at the edge of a small calcareous prairie. Only 1-20 plants have been found at each site.

Digitaria violascens (4/4). This southern, pantropical species of open pineland has been reported in scattered non-calcareous regions of Kentucky. The two Appalachian records are from dry sandy roadsides on Cliff Section ridges. Whether it is truly native to open pine woods in this region may be doubted given the weedy nature of this genus.

Eryngium yuccifolium (>20/>50). This southeastern and mid-western species of prairies and barrens is frequent in naturally open vegetation of western Kentucky, but there is only one Appalachian record, from the southern Cliff Section on "a moist flat of pine-oak barrens" (Rogers 1941).

Gymnopogon ambiguus (7/12). In Kentucky, this southeastern species of dry, sandy openings and open pineland (especially fire-maintained *Pinus palustris* woods on the Coastal Plain) is known from scattered southern areas. There are only three Appalachian records, from "sandy shores, South Fork of Cumberland River" in 1935, and, in the 1980s, from an open grassy roadside in the southern Cliff Section and a seasonally wet field in the southern Rugged Eastern Area.

Helianthus atrorubens (6/>50). In Kentucky, this southeastern and Appalachian species, generally of dry open woods and edges, is known only from the southern Cliff Section and the transition to the Low Hills Belt. The sites are mostly roadsides, and occasionally young open woods. It is locally dominant, with patches of several hundred plants, but only non-flowering plants occur in more shady areas.

Leiophyllum buxifolium (1/1). This species of Appalachian heath-balds, Coastal Plain sand-hills and pine-barrens, has been collected once in Kentucky, during 1939: "[a single individual] on top of dry [sandy] bank, Cumberland Falls, within park on S side of road going west, about 100-200 yards from park entrance" (McInteer 1940). The area is generally forested today, except for the roadsides. Another Appalachian heath-bald species, *Rhododendron minus*, still occurs in roadside woods near the park, but these may be planted. There is one other report of *R. minus* from Kentucky, on Pine Mountain (E. Carr, pers. comm.).

Table 1. Vascular plants found on or near grassy roadsides with rare species
 Nomenclature generally follows Kartesz and Kartesz (1980); selected synonyms
 are in parentheses. Family arrangement follows Thorne (1981). + indicates
 species present; * indicates species locally abundant.

A-H: areas of 10-150 m² around patches of *Aster concolor* on KSR 751, from
 1.5 km S of US 27 to 0.4 km N of railroad, Pulaski Co.
 I: ca. 150 m² around patches of *Aster concolor* along dirt road, Hindsfield
 Ridge, 1.5 km SE of KSR 192, Pulaski Co.
 J: ca. 100 m² around patches of *Polygala polygama* by Sand Hill Church on KSR
 700, 8.5 km S of KSR 92, McCreary Co.
 K: areas totaling ca. 50 m² around patches of *Lilium philadelphicum* on KSR 192,
 1.15-2 km E of Craig's Creek Road, Laurel Co.
 L: ca. 100 m² at "Bald Rock" on KSR 192, 1.7 km E of KSR 1193, Laurel Co.
 M: ca. 3000 m² along KSR 700 and adjacent utility right-of-way, 1.5-3 km SW of
 Sand Hill Church, McCreary Co.
 N: ca. 200 m² around *Polygala polygama* along dirt road by Roaring Paunch Creek,
 0.8 stream-km N of KY-TN state-line, McCreary Co..
 O: ca. 300 m² around *Sporobolus clandestinus* and *Phlox amoena* along KSR 791,
 1.3 km W of KSR 92, McCreary Co.
 P: ca. 2000 m² around outcrops at Dobbs Hill on KSR 1363, 0.8-1.1 km W of
 Pleasant Hill Church, McCreary Co.
 Q: ca. 5000 m² of pine-oak barrens (traversed by old road bed), 0.8 km NW of
 Barren Fork Cemetry, 1.6 km SSE of Flat Rock, McCreary Co.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
PTERIDOPHYTES																		
<i>Pteridium aquilinum</i> var. <i>latiusculum</i>					+	+											+	
<i>Pellaea atropurpurea</i>																		*
<i>Asplenium platyneuron</i>						+												+
<i>Woodsia obtusa</i>																		+
<i>Polystichum acrostichoides</i>						+						+						
GYMNOSPERMS																		
<i>Pinus rigida</i>										+		+						
<i>Pinus virginiana</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	**
<i>Pinus echinata</i>					+	+	+	+			+	+			*		+	
<i>Juniperus virginiana</i>	+							+										**
DICOTYLEDONS																		
Magnoliaceae																		
<i>Liriodendron tulipifera</i>					+	+						+	+				+	
Annonaceae																		
<i>Asimina triloba</i>																		+
Lauraceae																		
<i>Sassafras albidum</i>						+					+	+	+	+	+			
Ranunculaceae																		
<i>Anemone virginiana</i>					+							+						+
Aquifoliaceae																		
<i>Ilex opaca</i>											+							+
Clusiaceae																		
<i>Hypericum (Ascyrum) hypericoides</i>					+	+											+	+
<i>Hypericum gentianoides</i>																	+	+
Ericaceae																		
<i>Oxydendron arboreum</i>	+				+		+											
<i>Gaylussacia brachycera</i>																		+
<i>Vaccinium stamineum</i> (and <i>neglectum</i>)													+	+				
<i>Vaccinium arboreum</i>	+	+	+		+	+											+	+
<i>Vaccinium vacillans</i>	+					+					+	+						
Ebenaceae																		
<i>Diospyros virginiana</i>					+						+				+		+	
Caryophyllaceae																		
E <i>Cerastium glomeratum</i> (<i>viscosum</i>)																		+
E <i>Arenaria serpyllifolia</i>																		+
E <i>Dianthus armeria</i>																		+
<i>Silene virginica</i>																		* +
E <i>Silene antirrhina</i>																		+
Portulacaceae																		
<i>Talinum teretifolium</i>																		+
Primulaceae																		
<i>Lysimachia lanceolata</i>																		+
<i>Lysimachia quadrifolia</i>																		+
Polygonaceae																		
E <i>Rumex acetosella</i>																		+

Table 1. (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Geraniaceae																	
Geranium carolinianum																	+
Oxalidaceae																	
E Oxalis fontana ("europaea")																	+
Oxalis violacea																	+
Linaceae																	
Linum virginianum												+	+				
Polygalaceae																	
Polygala polygama												+	+				
Polygala senega var. latifolia																	+
Polygala curtissii																	+
Polygala (verticillata var.) ambigua																	+
Celastraceae																	
Celastrus scandens					+												
Euonymus americanus																	*
Violaceae																	
Viola pedata							+						+				+
Viola hirsutula																	+
Viola cf. emarginata													+	+			+
Viola tripartita var. glaberrima																	+
Viola rafinesquii																	+
Brassicaceae																	
E Arabidopsis thaliana																	+
E Cardamine hirsuta																	+
E Erophila verna (Draba v.)																	+
Lepidium virginicum																	+
Ulmaceae																	
Ulmus alata																	+ *
Celtis tenuifolia																	+
Cistaceae																	
Lechea racemulosa																	+
Rhamnaceae																	
Rhamnus caroliniana																	++
Ceanothus americana						?											+
Euphorbiaceae																	
Euphorbia corollata																	+
Anacardiaceae																	
Rhus (Toxicodendron) radicans																	* +
Rhus glabra																	+
Rhus copallina																	+
Juglandaceae																	
Carya tomentosa																	+
Carya glabra																	+
Carya pallida																	+
Aceraceae																	
Acer rubrum var. r.																	+
Fabaceae																	
Schrankia microphylla																	+
Cassia (Chamaecrista) nictitans																	+
E Lotus corniculatus																	+
E Trifolium agreste (procumbens)																	+
E Melilotus officinalis																	+
Desmodium nudiflorum																	+
Desmodium ciliare																	+
Desmodium marilandicum																	+
Desmodium paniculatum (sensu stricto)																	+
Desmodium glabellum* (not humifusum)																	+
Desmodium viridiflorum																	+
Desmodium laevigatum																	+
Lespedeza repens																	+
Lespedeza virginica																	+
Lespedeza intermedia																	+
Lespedeza intermedia x virginica																	+
Lespedeza hirta																	+
E Lespedeza striata																	?
E Lespedeza cuneata																	+
Stylosanthes biflora																	+
Tephrosia virginiana var. v.																	+
Clitoria mariana																	+

Table 1. (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
<i>Amphicarpa bracteata</i> var. b.												+					
<i>Galactia volubilis</i>					+				++			+				+	
Hamamelidaceae																	
<i>Liquidambar styraciflua</i>																	+
Fagaceae																	
<i>Quercus alba</i>	+++									++		*					
<i>Quercus stellata</i>		+				+			+			+					*
<i>Quercus montana</i> ("prinus")	+					+					+	+				++	
<i>Quercus falcata</i>			+			++											+
<i>Quercus marilandica</i>						+++											++
<i>Quercus velutina</i>	+	+				+++			+	+						++	
<i>Quercus coccinea</i>		+				+			+++	+		+					+
Betulaceae																	
<i>Ostrya virginiana</i>																	+
Rosaceae																	
<i>Fragaria virginiana</i> var. v.						++										*	+
<i>Potentilla simplex</i> var. s.										++							
<i>Potentilla canadensis</i> var. c.	++					+						++					+
<i>Rubus Flagellares</i> (group)		++								++		+					+
<i>Rubus allegheniensis</i> var. a.															+		
<i>Rubus Argutae</i> (group)						+			++						+		
<i>Rosa carolina</i>																	+
<i>Prunus serotina</i>		++															
<i>Amelanchier arborea</i> var. a.		+										+					+
Crassulaceae																	
E <i>Sedum acre</i>																	*
Onagraceae																	
<i>Oenothera biennis</i>						+											+
E <i>Oenothera laciniata</i>																	+
Rubiaceae																	
<i>Hedyotis purpurea</i> (<i>Houstonia lanceolata</i>)										+		+					+
<i>Hedyotis caerulea</i> (<i>Houstonia c.</i>)																	+
<i>Galium pilosum</i> var. p.						+				++							+
Apocynaceae																	
<i>Apocynum cannabinum</i>											+						
<i>Asclepias amplexicaulis</i>										+		+					
<i>Asclepias exalata</i>																	?
<i>Asclepias variegata</i>												+					
<i>Asclepias verticillata</i>																	+
Gentianaceae																	
<i>Gentiana villosa</i>																	+
Scrophulariaceae																	
<i>Agalinis decemloba</i>						+											
<i>Pedicularis canadensis</i>						+							+				
<i>Ambrosia artemisifolia</i>													+				
E <i>Achillea millefolium</i>																	+
E <i>Chrysanthemum leucanthemum</i> (L. vulgare)	+									++		+					+
<i>Senecio anomymus</i> (smallii)	++					+		+++									++
<i>Chrysopsis</i> (<i>Pityopsis</i>) <i>graminifolia</i>	+	++				++		+++				+					+++
<i>Chrysopsis mariana</i>	++	+	++	++	++	++						++					
<i>Solidago hispida</i>																	?
<i>Solidago erecta</i>	+++					++		++		++		++					++
<i>Solidago nemoralis</i>	+++					++		++		++		*					
<i>Solidago arguta</i> var. a.									+						+		
<i>Solidago odora</i>	++	+				++	++	++	++								++
<i>Solidago rugosa</i>													+				
<i>Solidago gigantea</i>								?									
<i>Solidago altissima</i>		+	+										+				
<i>Solidago</i> (<i>Euthamia</i>) <i>graminifolia</i>								+									
<i>Aster undulatus</i>		+				++					+						++
<i>Aster patens</i> var. <i>patens</i>	+++					+++		+++		++		++					+
<i>Aster surculosus</i>		+						+				++					++
<i>Aster concolor</i>	+++	+	+	+	+	+	+	+	+	+							
<i>Aster linariifolius</i>		+	++														++
<i>Aster infirmus</i>																	+
<i>Aster umbellatus</i>																	+
<i>Aster paternus</i>																	+
<i>Aster solidagineus</i>		+				+											
<i>Aster pilosus</i> var. <i>pilosus</i>		++				+						+					+
<i>Aster lateriflorus</i>												++					

Table 1. (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
<i>Aster dumosus</i> var. <i>coridifolius</i>	+	+	+	+	+			+				+					
<i>Erigeron annuus</i>										+	+						+
<i>Erigeron strigosus</i>															+		+
<i>Conyza canadensis</i> var. <i>pusilla</i>															+		+
<i>Gnaphalium obtusifolium</i>		+	+		+	+									+		+
<i>Antennaria plantaginifolia</i>		?					?	?							+		+
<i>Eupatorium fistulosum</i>					+	+											+
<i>Eupatorium album</i>	+																+
<i>Eupatorium rotundifolium</i>	+	+							+	+							+
<i>Eupatorium aromaticum</i>		+									+	+					
<i>Eupatorium rugosum</i> var. <i>r.</i>					+												
<i>Liatris squarrulosa</i>						+	+			+							
<i>Liatris microcephala</i>																	+
<i>Cirsium muticum</i>																+	
<i>Cirsium carolinianum</i>																	+
<i>Cirsium discolor</i>																	+
<i>Elephantopus tomentosus</i>																+	
<i>Prenanthes serpenteria</i>							?	?									
<i>Lactuca canadensis</i>																	+
<i>Hieracium venosum</i>								+									+
<i>Krigia virginica</i>																	+
MONOCOTYLEDONS																	
Liliaceae																	
<i>Lilium philadelphicum</i> var. <i>p.</i>							?									+	+
<i>Uvularia perfoliata</i>																?	+
<i>Aleris farinosa</i>																	+
<i>Smilax glauca</i>	+	+				+				+	+				+	+	+
E <i>Verbascum thapsus</i>																	+
E <i>Veronica arvensis</i>																	+
Plantaginaceae																	
<i>Plantago rugelii</i>						+											
<i>Plantago virginica</i>																	+
E <i>Plantago lanceolata</i>																	+
Acanthaceae																	
<i>Ruellia caroliniensis</i>																	+
Lamiaceae																	
<i>Prunella vulgaris</i> var. <i>lanceolata</i>							+										
<i>Salvia lyrata</i>																+	+
E <i>Satureja</i> (<i>Clinopodium</i>) <i>vulgaris</i>																+	
<i>Pycnanthemum pycnanthemoides</i> var. <i>p.</i>																	+
E <i>Mosla dianthera</i>																+	
Polemoniaceae																	
<i>Phlox amoena</i>																	+
Solanaceae																	
<i>Solanum carolinianum</i>																	+
Convolvulaceae																	
<i>Ipomaea pandurata</i>																	+
<i>Convolvulus</i> (<i>Calystegia</i>) <i>spithameus</i>																	+
E <i>Convolvulus</i> (<i>Calystegia</i>) <i>sepium</i> var. <i>s.</i>																	?
Campanulaceae																	
<i>Lobelia puberula</i> var. <i>simulans</i>	+	+					+	+								+	+
<i>Lobelia inflata</i>																+	
<i>Specularia</i> (<i>Triodanis</i>) <i>perfoliata</i>																	+
Vitaceae																	
<i>Vitis aestivalis</i>	+																+
<i>Vitis vulpina</i>																+	+
<i>Vitis rotundifolia</i>																+	+
<i>Parthenocissus quinquefolia</i>																+	+
Nyssaceae																	
<i>Nyssa sylvatica</i> var. <i>s.</i>	+							+	+								+
Cornaceae																	
<i>Cornus florida</i>																	+
Apiaceae																	
<i>Sanicula marilandica</i> var. <i>petiolulata</i>																	+
<i>Sanicula canadensis</i>																?	
E <i>Daucus carota</i>																+	+
Caprifoliaceae																	
E <i>Lonicera japonica</i>																	+

Table 1. (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
Asteraceae																		
Helianthus atrorubens var. a.									?	+								
Angelica venenosa																	+	
Helianthus divaricatus					+					+							+	
Helianthus microcephalus		+			+					+	+				+			
Helianthus hirsutus		+	+		+					+								
Verbesina (Actinomeris) alternifolia															+			
Verbesina occidentalis																+	+	
Rudbeckia fulgida var. fulgida						+												
Rudbeckia triloba var. t.																	*	
Coreopsis major		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Parthenium integrifolium var. i.											+				*		+	
Smilax bona-nox					+													
Smilax rotundifolia						+		+				+		+	+			
Dioscoreaceae																		
E Dioscorea batatas																	+	
Juncaceae																		
Luzula echinata																		+
Cyperaceae																		
Cyperus ovularis																		+
Carex gravida																		++
Carex artitecta (and C. physorhynca)																		++
Carex umbellata (tonsa)																		+
Carex nigro-marginata																		+
Carex hirsutella (complanata var. h.)																		+
Carex caroliniana																		+
Carex swanii																		+
Poaceae																		
Stipa (Piptochaetium) avenacea																		++*
Danthonia spicata																		++*
Danthonia sericea																		++
Aristida dichotoma																		+
Aristida longespica																		+
Aristida purpurascens var. virgata																		+
E Bromus japonicus																		+
E Poa compressa																		+
E Poa pratensis																		+
E Festuca elatior (sensu lato)																		+
E Festuca (Vulpia) octoflora																		+
E Holcus lanatus																		+
E Dactylis glomerata																		+
Elymus glabriflorus																		+
Gymnopogon ambiguus																		+
Eragrostis spectabilis																		+
Sporobolus clandestinus																		++
Erianthus alopecuroides																		+
Andropogon (Schizochyrium) scoparius		*	+	*	*	*	+	+	+	+	+	+	*	+	*	+	+	
Andropogon gerardii		*	+	*														+
Andropogon virginicus var. v.																		+
Andropogon ternarius																		++
Sorghastrum nutans		*	+	*	+	+												+
Panicum flexile																		+
Panicum anceps																		++
Panicum (Dichanthelium) boscii		+	+															++*
Panicum (D.) commutatum																		+
Panicum (D.) ravenelii																		+
Panicum (D.) polyanthes																		+
Panicum (D.) sphaerocarpon																		+
Panicum (D.) laxiflorum																		+
Panicum (D.) lindheimeri																		+
Panicum (D.) acuminatum (sensu lato)																		+
Panicum (D.) microcarpon																		+
Panicum (D.) dichotomum (sensu stricto)		+																++
Panicum (D.) depauperatum																		+
E? Setaria geniculata																		+

Lespedeza capitata (or hybrids) (>10/>20). In Kentucky, this widespread eastern species of dry openings (often sandy pineland) is scattered in western regions. However, there are only three Appalachian records, all from the Cliff Section during 1935-40 (Rogers 1941, Braun 1943). Braun's plants were identified as *L. simulata*, which has been interpreted as a hybrid between *L. capitata* and *L. virginica* or *L. intermedia*. Also, it was found during 1989 in a wet bottomland meadow half a mile south of the KY-TN state-line.

Liatris squarrosa (>20/>50). In Kentucky, this widespread southeastern species of dry openings is frequent in southern and western regions, but there are only two Appalachian records. Both are from relatively undissected ridges on the eastern side of the southern Cliff Section, in 1937 (dry open woods) and 1989 (dirt roadside). *Liatris* species that are more widespread in the Cliff Section also occur on the roadsides, especially *L. squarrolosa*, less often *L. spicata*, occasionally *L. aspera*, and on rocky sites *L. microcephala*.

Lilium philadelphicum (9/21). In Kentucky, this species of dry to damp, acid openings, thickets and pine barrens is known only along the Cliff Section, as the largely Appalachian var. *philadelphicum*. Most records are from roadsides on ridges, but one is from the edge of a calcareous prairie, and a 1940 record is from dry pine woods. It was locally common (Rogers 1941) but several populations have disappeared in the past 10-30 years. Currently, most sites have only 1-5 plants; none exceed 20. In addition to fire-suppression, digging for ornament may have contributed to its decline.

Malus angustifolia (6/>25). This southeastern species of open woods and thickets is reported from scattered non-calcareous areas of southern Kentucky, mostly in the southern Cliff Section. There may be some intermediates with the more northern *M. coronaria* (especially var. *lancifolia*). Most sites have only 1-10 trees and are on dry ridges along roads and in young woods of *Pinus virginiana* or pine-oak. One population has at least 50 trees (with much *Crataegus* spp. and *Prunus americana*). Less often, it has been found on rocky riverbanks, or on bottomland thickets extending into the Rugged Eastern Area.

Melampyrum lineare (3/3). In Kentucky, this northern species of dry to damp brushy grassland and open woods is known from a few records in the Cumberland Mountains, as var. *latifolium*, and in the Cliff Section, as var. *americanum*. The latter variety is currently known only along the 75 m

paved trail to Sky Bridge, with 400-500 plants at the edge of dry woods dominated by *Pinus rigida*, *Quercus* spp., *Gaylussacia baccata* and *Vaccinium vacillans*. An annual species, it often increases in woods after fire or logging (Swan 1970; Scheiner and Teeri 1981; Abrams and Dickmann 1984; Gibson and Good 1987).

Muhlenbergia torreyana (1/1). This southeastern species of "pine-barrens and meadows" is a candidate for federal protection. There is only one obscure Kentucky record (Hitchcock and Chase 1950), presumably based on a collection in the southern Cliff Section or the adjacent Highland Rim. It was formerly known from the oak-barrens region of Tennessee, in the transition from Highland Rim to Appalachian Plateau (Svenson 1941).

Oenothera perennis (3/3). In Kentucky, this north-central species of wet, or occasionally (in the south) dry, natural openings is known from only three southern records. The only Appalachian record, dated 1935, is from the southern Cliff Section, in "dry soil, open woods" along a ridge road, close to *Schwalbea americana* (Braun 1943 and collections). The only post-1960 record in Tennessee is from a physiographically similar roadside (Patrick and others 1983).

Orbexilum pedunculatum var. *pedunculatum* (*Psoralea psoralioides* var. *p.*) (4/10). In Kentucky, this southeastern variety of dry openings has been found in a few southern counties. The only Appalachian records are from the southern Cliff Section, either on ridgetop roadsides, or on open rocky riverbanks.

Panicum aciculare (4/5). In Kentucky, this southeastern (generally Coastal Plain) species of sandy pine woods is known from a few southwestern sites (as var. *aciculare*), and from two sites in the southern Cliff Section (as var. *angustifolium*) on ridges in dry, open, grassy pine woods near a road and a cliff top. As "*P. angustifolium*", this species was reported to increase greatly with frequent prescribed burning by DeSelm and others (1973). Some other *Panicum* spp. may have similar distributions and responses (e.g., *P. ravenellii*).

Parthenium integrifolium (>20/>50). This mid-western and east-central species of dry openings is not rare in western Kentucky. However, the only Appalachian records are about 15 sites in the southernmost Cliff Section, mostly on ridgetop roadsides with only 1-10 plants. At least 20 non-flowering plants were found in a more shady barrens (table 1).

Paspalum setaceum var. *longepedunculatum* (4/4). In Kentucky, this southeastern taxon of sandy openings with pine is known from a few open ridgetop sites in the southern Cliff Section, and as a railroad waif in Jefferson County.

Phlox amoena (7/ > 25). In Kentucky, this southeastern species of dry openings is known from the southern Cliff Section and the adjacent Highland Rim. It is locally frequent (with 100-1000 plants) along roads and adjacent forest edges, generally on sandy soils and occasionally above limestone. Only one site has frequent plants in more natural vegetation: the rather open, grassy, stunted *Pinus virginiana* woods on the sandstone outcrops of Dobbs Hill (table 1).

Polygala polygama (1/6). In Kentucky, this northern and Coastal Plain species of dry, sandy openings is known only from the southernmost Cliff Section. Most sites are upland roadsides (with 10-50 plants), but a 1935 record is from "pine-oak" woods. It is a short-lived perennial that often increases after fire (Abrams and Dickmann 1984; Niering and Dreyer 1989).

Rhynchosia tomentosa (3/3). In Kentucky, this southeastern species of dry, sandy openings is known from only three records. The only Appalachian collection, dated 1949, is from the "edge of cut-over woods, 4 miles east of Cumberland Falls" (probably along KSR 92). Also, it was found in 1989 about 2 km south of the KY-TN state-line, on Big Island in the Big South Fork.

Robinia hispida var. *rosea* [= *R. boyntonii*] (4/10). In Kentucky, this Appalachian taxon is known only from the Cumberland Mountains (with other varieties) and the southern Cliff Section, mostly in a 10 km² area around Day Ridge, McCreary Co. All sites are on relatively narrow sandstone ridges or knobs in dry pine or oak woods, especially young stands, thickets and edges. It occurs at low density in patches up to 30 m², with flowering observed only in the open.

Sanicula marilandica (1/2). In Kentucky, this north-central (to Rocky Mt.) species is known from only two localities, each with less than 10 plants, in the southern Cliff Section. They were found in edges and burned thickets along roads on rather broad ridges between the Cumberland River and the Big South Fork. The plants are var. *petiolulata*, which typically occurs in "dry sandy pineland" of the southern Atlantic Coastal Plain (Fernald 1950).

Schwalbea americana (1/2). This species is a candidate for federal protection that is known from sandy, acid, damp to dry soil in open pine or oak barrens on the Atlantic Coastal Plain, plus a few old collections from Tennessee (including the "oak-barrens" of the Highland Rim-Cliff Section transition)

and Kentucky. The Kentucky collections were from "dry sandy soil on knobs and sandstone plateau margins" in the southern Cliff Section, "with *Cleistes*" at one site (Braun 1937b, 1943). This species appears restricted to fire-maintained vegetation (S. Orzell, pers. comm.). Musselman and Mann (1977) noted: "particularly vigorous growth of *Schwalbea* was evident after early spring fire at the Horry Co. [SC] site. In such years, seed production was abundant." It is parasitic on a wide range of woody plants.

Sporobolus clandestinus (7/8). In Kentucky, this widespread eastern species of dry openings is known from scattered southern regions. The only Appalachian records are from the southern Cliff Section, on roadsides adjacent to sandstone outcrops, and on some limestone clifftops. It is locally dominant, with patches up to 300 m².

Tephrosia spicata (2/7). In Kentucky, this southeastern species of sandy openings is known only from the southern Cliff Section. Most records are from open rocky banks of the Cumberland River. Two others are collections dated 1941 and 1980 from disturbed areas on ridges near Barthell (McCreary Co.).

Viola fimbriatula [= *V. sagittata* var. *ovata*] (3/3). In Kentucky, this north-central species of disturbed woods (especially on mineral soil) is known from a few Cliff Section records. The only post-1950 record is from McCreary Co., along an old eroded roadside, with at least 30 plants.

NOTES ON ASSOCIATED VEGETATION

Some of the roadsides with rare species have a relatively high diversity of native species, and a low frequency of exotics. Table 1 lists the ca. 300 vascular species found at good examples of such vegetation and some nearby grassy woods. The most abundant species include several warm-season (C4) grasses, with *Andropogon scoparius* the most frequent dominant. The only typical native cool-season (C3) grass is *Stipa avenacea*, which is locally dominant in young pine woods adjacent to the roads. Other frequent species include composites, especially *Coreopsis major*, *Helianthus* spp., *Chrysopsis* spp., *Solidago* spp., *Aster* spp. and *Eupatorium* spp., and legumes, especially *Lespedeza* spp. and *Desmodium* spp. About 10 percent of the species present are exotics, but most of these were recorded only at the Dobbs Hill site, which is the only site adjacent to houses. The only exotic found at more than 2-3 sites is *Chrysanthemum leucanthemum* (= *L. vulgare*).

One of the most extensive native grassy areas, with several rare species (especially *Aster concolor*), is along 3 km of KSR 751 between Burnside and Keno (Pulaski Co.). In addition to the typical dominants--*Andropogon scoparius*, *A. gerardii* and *Sorghastrum nutans*, frequent species here include *Tephrosia virginiana*, *Lobelia puberula*, *Helianthus hirsutus*, *Coreopsis major*, *Senecio anonymus*, *Chrysopsis mariana*, *C. graminifolia*, *Solidago erecta*, *S. nemoralis*, *S. odora*, *Aster patens*, *A. concolor*, *A. dumosus*, *Gnaphalium obtusifolium*, *Eupatorium rotundifolium*, *E. aromaticum*, *Panicum anceps* and *Andropogon virginicus*. Adjacent forest is dominated by *Pinus* spp., *Quercus* spp. and *Acer rubrum*.

Typically the soils are hapludults with fine sandy or silty loam texture, A horizon pH of 4.5-5, and a depth of 50-150 cm to the sandstone or shale. On shallower hapludults or dystrochrepts near sandstone outcrops, the vegetation generally lacks taller species such as *Andropogon gerardii*, *Sorghastrum nutans*, *Helianthus atrorubens* and *Eupatorium* spp. An unusual variant with patches of *Sporobolus clandestinus* was found on some rocky sites, especially Dobbs Hill. In addition to abundant *Pinus virginiana* at this site, the trees included much *Juniperus virginiana*, which, together with some of the other frequent species (especially *Ulmus alata*, *Celtis tenuifolia*, *Rhamnus caroliniana*, *Phlox amoena*, *Rudbeckia triloba*, *Pellaea atropurpurea* and *Woodsia obtusa*), may indicate more base-rich soils (following Campbell 1987). *S. clandestinus* itself is also frequent on some limestone sites.

Apart from these roadside remnants, there is little information on the barrens or open forest that may have existed when annual burning was a common practice before DBNF was established. However, on drier ridges in the southern Cliff Section, Braun (1950, p. 102) noted: "Instead of this pine-heath or pine-oak-heath community, some of the promontaries are occupied by open pine woods (the three species of pine) with a grassy layer of *Andropogon scoparius* (little bluestem), *A. glomeratus* (broom-sedge), and *Sorghastrum nutans* (Indian grass), in which are a few scattered forbs. Fires have modified most (perhaps all) of these pine summits, although the abundance of large *Cladonia* (lichen) mats is an indication that there has been no fire for many years."

Similar vegetation may have extended onto relatively moist sites, where droughts still occurred often enough to spread fires. The only direct information about such woods comes from Rogers (1941). He noted the following plants in "a moist flat of pine-oak barrens" along the road to Bauer: *Salix humilis* (vars. *humilis* and *microphylla*), *Hypericum*

punctatum, *Eryngium yuccifolium**, *Liatris scariosa* [probably *L. squarrosa*]* and *L. spicata**; and he noted *Helianthus atrorubens** in "pine-oak barrens at the Tennessee State Line." Also near the Bauer Road, he noted several species typical of openings or edges, all in "woods" unless noted: *Andropogon gerardii* ("common"), *Robinia hispida**, *Lespedeza virginica*, *L. capitata**, *Polygala verticillata*, *Oxypolis rigidior*, *Angelica villosa*, *Cuscuta campestris*, *Solidago caesia*, *Aster patens* ("var. *phlogifolius*") and *A. solidagineus*; *Pycnanthemum pycnanthemoides*, *Helianthus hirsutus* and *Coreopsis major* var. *stellata* (all "dry woods"); *Anemone virginiana* ("dry pine-oak woods"); *Lobelia puberula* ("wet woods"); *Lilium philadelphicum** ("common along road"), *Coreopsis tripteris* var. *deamii* ("by the road"); *Hypericum frondosum* [*prolificum*?] ("low, moist, shaley soil in open thicket"). In 1987, *Andropogon gerardii* is still common along the road to Bauer, but of the rarer species (shown by *), only *Helianthus atrorubens* was encountered.

Except for some of the roadsides, there are virtually no areas where a diverse native barrens vegetation remains. A few woodland-pastures today may bear some structural resemblance to presettlement barrens, and such areas were frequently burned by residents before the modern era of fire-suppression. However, grazing has been intensive, and exotic plants have often replaced the native flora in such pastures. None of the rare plants listed above have been found in actively pastured areas. A few dry, wooded areas near clifftops have an open grassy aspect, with occasional fires, but these have generally become too shady for most of the rare species noted here.

NOTES ON FIRE HISTORY

Archaeological evidence shows that, for at least 10,000 years before 1650, Indians lived in many parts of Appalachian Kentucky (e.g., Cowan 1985, Ison 1990). It is likely that they used fires extensively for managing game animals and clearing garden plots, especially on slopes near rockhouses. Lightning fires are relatively infrequent in DBNF, with only 10-15 per 1000 km² each year (Martin 1990), and they are probably not repeated often enough in the same locations to create open grassy vegetation. However, the role of Indians versus lightning in causing presettlement fires must remain an open question.

There was almost no landscape description in the pioneer literature from the southern Appalachian Plateau in Kentucky and the adjacent Highland Rim. A few accounts suggest areas disturbed by fire, Indians or buffalo (*Bison bison*). Walker (1749) described an area in Jackson County where "The woods have been burnt some years past, and are now very thick, the only timber being almost all kill'd", and an area in Morgan County with "the only fresh burnt woods we have

seen." He noted Indian trails and buffalo in several places. Near Pineville, he initially named Clear Creek as "Clover Creek", noting that "Clover and hop vines are plenty there"; the clover was probably *Trifolium stoloniferum*, which was associated with buffalo in Kentucky (Campbell and others 1988). Walker (1824), recounting his travels in 1775, noted "twenty miles, entirely covered with dead brush" in the Rockcastle and Laurel County area. This statement suggests the results of a large fire (see also McHargue 1941). Arnow (1960) noted descriptions of pioneers in the Cumberland River drainage that suggested "park-like" forests "with so little undergrowth a traveler could see a deer for 150 paces. There were, too, along the creeks and rivers, treeless glades and valleys, sometimes filled with cane...or only high grass..." Edwards (1970) described Wayne County (mostly in the eastern Highland Rim) during about 1775: "Three-fourths of the county was covered with virgin forests; the lowlands contained some cane, or tall grass as they preferred to call it...Price's Meadows [initially called the Big Meadow], near the mouth of Meadow Creek, contained very high grass. Corn could be planted without the forests being cleared."

Interviews with older residents provide a general historical view of the southern Cliff Section. Until DBNF was established in 1930-40, intentional fires were widespread, except perhaps for a few decades before 1910 when the Kentucky Landsharers Association had control over much land and restricted burning. Annual fires occurred in much of the area during 1910-1930. They were generally set in February and March to promote grass and forb growth for cattle. Also, hogs ran in the forest, with about 0.5-1 per km², and many became feral. In some years, a second set of fires were set in October or November "to keep the woods open". Fires were generally started along roadsides on ridges and allowed to burn without control, unless property was threatened. In general, ridgetop forests contained much *Quercus coccinea* (ca. 50-60 cm dbh), *Q. velutina* and *Pinus echinata*, with scattered *Q. alba* (to 100 cm dbh) and *Liriodendron*. Most woody understory on ridges was removed, except for scattered *Quercus* spp. and *Liriodendron*, creating some savanna-like areas. The ground cover of blueberries and other low ericaceous shrubs, grasses and forbs was much thicker than today. Pink ladies' slipper orchids (*Cypripedium acaule*) were more frequent, but yellow ones (*C. pubescens*) were reduced by fire. Composites were more frequent, though concentrated along roads. Birds were generally more numerous, though wild turkey (*Meleagris gallopavo*), like deer (*Odocoileus virginianus*), had been much reduced by hunting.

By some accounts, fire would generally stop near the top of east and north slopes, but it would creep down west and south slopes, creating a scrub forest with such species as *Pinus rigida*, *Quercus marilandica* and *Kalmia latifolia*. However, by other accounts, the fire would often be blown onto east slopes by prevailing winds, and it would seldom move down west and south slopes. Accounts agree that north slopes seldom burned and often had thick understories of *Acer saccharum* and *A. rubrum* below canopies of *Liriodendron* and *Quercus* spp.

Acquisition of land in DBNF by USFS began about 1933, bringing with it suppression of fire. Burning for forage generally stopped about 1945, though arson increased after 1970. All accounts agree that pine is more common today than 40-60 years ago. Abandoned fields and open woods grew back with much pine and *Liriodendron*. However, soils on and near ridgetops were often so worn-out that only scrub trees, mostly pines and oaks, grew back, and were called "barrens". Fire was not generally set in this scrubby vegetation, which did not burn well. Remaining barrens of this type have much lichen (*Cladonia*) today, suggesting fire exclusion.

DISCUSSION

The restriction of several rare plants in southeastern Kentucky to roadsides and similar disturbed sites might seem paradoxical, because such artificial habitats are generally considered to be dominated by common weeds and grasses. Two general hypotheses may explain this phenomenon: (a) these species have invaded the region along roads and other disturbed ground after settlement and forest-clearance; or (b) they are relicts from natural openings that were maintained largely by fire, with old stable roadsides and adjacent areas offering them a continually open refuge.

The following two arguments favor the latter hypothesis (b), involving fire.

(1) These species generally do not appear invasive or weedy within this region, except perhaps a few of the more frequent ones (also *Digitaria violascens* and *Paspalum setaceum* var. *longepedunculatum*). Most have never been found in tree-fall gaps, clear-cuts, cropland, pastures, old-fields, artificial wildlife-openings or railroad rights-of-way. Moreover, some of them appear to have declined or disappeared in recent decades: *Aureolaria pectinata*, *Castanea pumila*, *Eryngium yuccifolium*, *Leiophyllum buxifolium*, *Lespedeza capitata*, *Lilium philadelphicum*, *Muhlenbergia torreyana*, *Oenothera perennis*, *Rhynchosia tomentosa* and *Schwalbea americana*. It seems most unlikely that the rarest species, especially those with disjunct records 100 miles or more further south (*Muhlenbergia torreyana*, *Schwalbea americana*) dispersed into Kentucky in the 200 years since settlement.

(2) As noted above, there is considerable evidence that fire has played an important role in the upland forests of this region within the past 100-200 years, before the modern era of fire-suppression. It is possible that death of large trees due to other factors in the presettlement forest created temporary gaps suitable for some of these species. However, rapid dispersal into such gaps would still be required, and, as already noted, these species generally have not dispersed into newly created openings.

Further support for the "fire hypothesis" comes from evidence in other southeastern regions. Even in the Appalachians, fire, mostly set by Indians, was probably a widespread factor maintaining open vegetation before European settlement (Devivo 1990), and early settlers continued frequent burning (Pyne 1982, Otto 1983). On the Coastal Plain, there is evidence of widespread prehistoric, anthropogenic fire (Myers and Peroni 1983), and several of the rare species noted above are typical of fire-maintained vegetation in addition to rights-of-way (S. Orzell, Florida Natural Areas Inventory, pers. comm.). Experimental use of fire in the Southeast has confirmed that barrens or savanna vegetation can be restored and maintained by decades of annual burning (Komarek 1974; Kulhavy and Connor 1986; DeSelm and Clebsch 1990).

One of the closest areas to southeastern Kentucky where extensive fire-maintained areas existed before settlement, and where substantial pieces still survive, is the "oak-barrens" region centered on Coffee County, Tennessee (Svenson 1941; Patrick 1979; DeSelm 1989; DeSelm and Clebsch 1990). The open grassy vegetation there is typically found in relatively flat areas, locally with fragipan soils, on the Appalachian Plateau and its residuum overlying the eastern Highland Rim. Almost all the rare species noted above in southeastern Kentucky occur in that region, plus several rare species of seasonal wetlands. Some species have no records in between, but there are a few well-known barrens sites with rare species on the Appalachian Plateau in northeast Tennessee (Patrick 1979; DeSelm 1989, and unpublished).

Other circumstantial evidence concerns the habitat of the red-cockaded woodpecker (*Picoides borealis*), a Federally Endangered Species. This species has declined drastically in Kentucky within the past 50-100 years, and only 10-15 birds are currently known (S. Phillips, pers. comm.). Optimal habitat for this southeastern species appears to be dry, open forest with large pine trees at least 75-100 years old. Given the admixture of hardwoods in DBNF, it is estimated that 400 ha may be required for a stable colony. In Kentucky, logging of large pines has probably been the major cause of the species' decline, rather than understory encroachment, and the birds may be more tolerant of closed forest than those on the Coastal Plain (P. Kalisz, pers. comm.).

Much of the older pine today, including most trees used by the woodpeckers, grew up during the period of frequent burning for woodland-pastures. During the last century (from County Court Deed Books; and Barton 1919), about 5-10 percent of the southern Cliff Section forest was composed of pine, mostly *Pinus echinata*. This percentage is probably much higher than which would exist without any fire. Without fire, current patterns of succession suggest that pine would be largely confined to the driest ridges and clifftops, where, despite extensive recent searches, signs of the red-cockaded woodpecker remain extremely rare. Therefore, before settlement, it seems likely that this species was largely dependent on fires to regenerate extensive areas of pine, especially the relatively fire-tolerant *Pinus echinata* (Martin 1990).

Although this paper focuses on the rare species of moderately dry soils in open habitats, several other uncommon or rare species in this region of Kentucky may have benefited from fire. Some of these are restricted to thin soil around rock outcrops with little or no woody cover, especially *Arenaria glabra*, *Crotonopsis elliptica*, *Oenothera linifolia* and *Talinum teretifolium*. Fires may have increased the openness of such places. Some more widespread species can persist in the shade of relatively undisturbed pine-oak forests, but clearly do better in the open. Such species persist mostly along trails and logging roads through the forest, but they are locally frequent in small clearings and burned areas. They include *Cleistes divaricata* (see also Komarek 1974; Gregg 1989), *Danthonia compressa* (see also Lindsay and Bratton 1979), *Isotria verticillata* (see also Baldwin and Wieboldt 1969) and *Porteranthus trifoliatius*. Such species are probably too widespread, well-dispersed and persistent in shade to be good indicators of presettlement barrens, though they may well have occurred in relatively moist or shady variants of such vegetation.

The "fire hypothesis" may also be extended to some uncommon or rare species of seasonally wet, flat ground in thin-canopied forest, thickets, small natural openings or adjacent old-fields. In Kentucky, some are largely restricted to streamheads in the southern Cliff Section: *Carex jooirii*, *Calamagrostis cinnoides*, *Calopogon tuberosus*, *Gratiola pilosa*, *Lobelia nuttallii*, *Platanthera cristata*, *P. integrilabia* and *Vernonia noveboracensis*. Others are mostly in broader valleys adjacent to, and in a few cases within, the Cliff Section, mostly in full-sun: *Bartonia virginica*, *Drosera brevifolia*, *Eryngium prostratum*, *Gratiola viscidula*, *Gymnopogon brevifolius*, *Hypericum canadense*, *Hypericum crux-andrewsii* (*Ascyrum stans*), *Platanthera lacera*, *P. ciliaris*, *Polygala cruciata*, *Sabatia campanulata*, *Stenanthium gramineum* var. *micranthum*, *Trichostema setaceum* and *Xyris torta*. Although the wetness of these sites is probably

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