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THE FLORA AND VEGETATION OF RAVEN RUN NATURE SANCTUARY, FAYETTE COUNTY, KENTUCKY

Julian Campbell
The Nature Conservancy
642 West Main Street
Lexington, Kentucky 40508

Donald G. Ruch
Department of Biology
Ball State University
Muncie, Indiana 47306

and

Willem Meijer
School of Biological Sciences
University of Kentucky
Lexington, Kentucky 40506

ABSTRACT: The vascular flora of Raven Run Nature Sanctuary, Fayette County, Kentucky, is described, and the significance of this natural area in the Inner Bluegrass Region is discussed. A total of 541 vascular plant species have been documented, including 112 non-native species and 23 rare native species. The forest is divisible into four intergrading types largely defined by dominant species: 1) *Juniperus* on dry or eroded, successional sites; 2) *Juglans-Celtis-Fraxinus* or *Robinia-Prunus* on moist, successional sites; 3) *Quercus-Fraxinus* on relatively dry, undisturbed sites; and 4) *Acer saccharum* or *A. nigrum* on relatively moist, undisturbed sites. Old fields on the broader ridges with deeper soil are divisible into (1) recently plowed or disked areas with weedy species, (2) former pastures or grassy mowed areas, and (3) brushy disturbed areas. Species in the Sanctuary which are rare in Kentucky include *Allium burdickii, Malvastrum hispidum, Onosmodium hispidissimum, Prenanthes crepidinea, Prunus virginiana, Solidago harrisii,* and *Viburnum molle.* Rare species in the Bluegrass Region that are more frequent elsewhere in the State include *Aplectrum hyemale, Aureolaria flava, Carex laxiculmis, C. plantaginea, Chimaphila maculata, Goodyera pubescens, Monotropa uniflora, Pachysandra procumbens, Panicum anceps,* and *Tipularia discolor.* Most rare species are present in the less disturbed forest of more rugged areas, except for *M. hispidum* and *O. hispidissimum,* which occur in rocky, old fields. Non-native species are mostly confined to old fields. A few exotic shrubs and vines, *Lonicera maackii, L. japonica, Hedera helix,* and *Euonymus fortunei,* occur mostly in the woods.

KEYWORDS: Fayette County, Kentucky records — vascular plants, flora, forest types, introduced species, old field succession, rare species, Raven Run Nature Sanctuary — flora.

INTRODUCTION

The Palisades section of the Kentucky River Valley is centered between Camp Nelson and High Bridge with an outlying eastern area centered near Clays Ferry. The vascular flora of this area is relatively diverse compared to other sections of the Bluegrass Region. This diversity was described as a whole by Martin, *et al.* (1979), but only two intensive surveys of specific sites (Panther

Rock near the downstream end of the Palisades (Bryant, 1973) and Jessamine Creek Gorge in the central Palisades (Campbell and Meijer, 1989)) have been carried out. The botanical features of a third area, Raven Run, within the outlying eastern part of the Palisades is the focus of this study.

Raven Run Nature Sanctuary, a 375 acre tract located in southeastern Fayette County (Figure 1), is owned by the Lexington-Fayette Urban-County Government and is managed for biological conservation and passive recreation by the Division of Parks and Recreation. One hundred of these acres were incorporated into the Sanctuary following the completion of this study and are not detailed in this report. The Sanctuary was established during 1977-1982 and is registered as a Natural Area by the Kentucky State Nature Preserves Commission.

This study was initiated at the request of the Raven Run Advisory Board in order to update the flora and describe the distribution of plant communities in the Sanctuary for educational programs and management considerations. The objectives were to: 1) identify areas with rare species; 2) update existing lists of the vascular flora; 3) produce a vegetation map of the Sanctuary; 4) advise on management plans and on the potential impacts involving mowing regimes in the fields, promotion of attractive wild flowers, release of some fields from mowing, forest succession on ridgetops, location of trails, and possible effects of a Kentucky River impoundment. Details of the management applications are excluded here but were part of the report to the Department of Parks and Recreation (Campbell and Ruch, 1990). In addition to botanical description, the regional significance of the Raven Run area as a site for the long-term study of succession and the spread of exotic species is addressed in this paper.

THE STUDY AREA

The Raven Run Sanctuary lies in the Inner Bluegrass Region of north-central Kentucky, which is underlain by Middle Ordovician bedrock (450-480 million years old). Most bedrock on the uplands is the Lexington Limestone, containing phosphatic beds that have weathered to produce some highly fertile soils. Deeper ravines along the Kentucky River, including Raven Run, expose the older High Bridge Group of rocks, mostly non-phosphatic limestones and dolomites. The Upper Ordovician Eden Shale is virtually absent at Raven Run, although some of the soils on ridges may have a minor residual component derived from this rock unit, and a few vegetational features may be related to it. For example, the northern area, which is underlain by the Salvisa soil series (Sims, *et al.,* 1968), has the only *Sassafras* in the Sanctuary.

Within the Inner Bluegrass, two major types of topography are found: the largely agricultural, gentler slopes, including the Lexington Plain; and the narrow, forested zone on steeper slopes near the Kentucky River, including the Palisades. A gradual transition occurs in soils between these two topographic regions (Sims, *et al.,* 1968) from the deeper Maury soil series on gentler (2-6%) slopes, to the McAfee soil series on intermediate (6-12%) slopes, to the shallower Fairmount soil series on steeper (12-30%) slopes. Steep and intermediate slopes are predominant at Raven Run. The Sanctuary is bounded by Chandler Creek and the forks of Raven Run Creek. The seasonal Collinsia Creek (formerly known as Rabbit Town Branch) runs through the center of the Sanctuary.

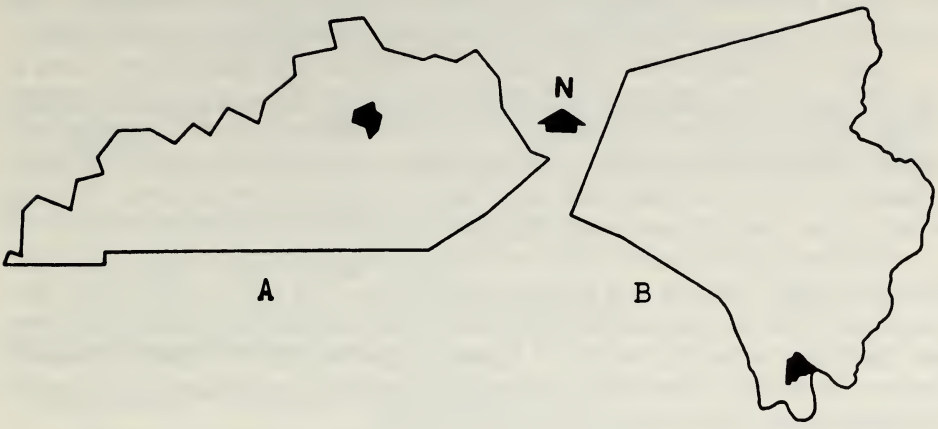

Figure 1. **A.** Map of Kentucky showing the location of Fayette County (darkened). **B.** Fayette County enlarged showing the location of the Raven Run Nature Sanctuary (darkened).

The Sanctuary has been greatly disturbed in the past and is now recovering. The Raven Run Sanctuary contains areas of mixed hardwood forest, successional red cedar forest, old fields, and mowed fields. After 1810-1830, three farms existed in the area (Prather near Jack's Creek Pike; Moore in the center; and Brink in the northern section). Several homes (including Rabbit Town), a mill (Evan's Mill), and a lime kiln were formerly located here. Mature forest, with a composition similar to the presettlement state (Campbell 1980, 1989), is mostly confined to steeper slopes near the Kentucky River. The fields remaining today on the broader ridges were farmed until the 1960s. At that time, the City of Lexington acquired the area and used part as a land-fill for several years.

MATERIALS AND METHODS

Over the past fifty years, the plants of Raven Run have been studied by several botanists, including Mary Wharton, Edward Browne, and Willem Meijer. These investigators began compiling lists and documenting the vascular flora of the area. Additionally, members of the Thursday Morning Hiking Group (TMHG), an amateur botanical group, have surveyed Raven Run nearly every week for the past 15 years, recording many important botanical observations.

During the 1989 growing season, biweekly forays were made in the Sanctuary and on adjacent slopes to verify previous floral records and to add new ones. This effort was continued on a less intensive basis during the 1990 and 1991 seasons. Simultaneously, collections stored at the University of Kentucky herbarium were re-examined. Vegetation in each section of the Sanctuary was described and related to shifts in topography and relative abundance of species (Figure 2). Aerial photographs were helpful in determining these delineations. Additionally, the soil survey of Fayette County (Sims, *et al.,* 1968) was used to help interpret the vegetation patterns. Notes on vegetation consisted of species lists, with visual estimates of their abundance (see catalog of vascular plants below). Lists were sorted into vegetation types based on common dominant species and species composition. A special effort

was made to document populations and environments of the rarer species and some exotic species. More detailed maps are available from the senior author.

Quantitative data from 17 circular plots were gathered from forested areas in 1977-78 and are presented here to illustrate the variation in tree species composition. These plots were placed systematically in different forest types. Trees having a diameter equal to or greater than 10 cm at breast height (dbh) were recorded within a radius of 15 m, and these data were used to determine basal areas. Smaller woody stems and herbaceous species were listed within a radius of 10 m.

Gleason and Cronquist (1991) was used as the primary taxonomic reference. Fernald (1950), Kartesz and Kartesz (1980), and Voss (1972, 1985) were also consulted for a few taxa and other details of identification. Herbarium specimens are deposited in the University of Kentucky herbarium. In 1989, the authors observed over 95% of the listed species at Raven Run or on adjacent slopes (north of Raven Run Creek, south of Chandler Branch).

RESULTS

The following catalog of the vascular plants found in the Raven Run Nature Sanctuary is arranged alphabeticllay by family. The ecological codes on the right margin are as follows:

Flowering or sporulating date (Flw): 3-10 = months March to October (along this sequence, peak months for white/cream flowered herbaceous species are distributed 10/25/13/8/6/8/6/0; yellowish/greenish ones are 0/14/5/2/22/12/5/0; blue ones are 0/10/7/4/4/2/2/2; purple/pink/red ones are 1/4/7/6/9/11/1/1; wind pollinated ones are 1/7/30/13/18/16/0/0; and woody species (mostly white/greenish or wind-pollinated) are 5/26/36/14/4/3/0/0).

Typical habitat (Hab): A-G = vegetation types as listed in the text; in addition, GA = streams or other wet spots in or near fields; X = largely restricted to rock outcrops; and Y = under rock overhangs.

Relative abundance (Rel): r = rare (< 10 sites); o = occasional, not widespread throughout the Sanctuary, even in suitable habitat; c = common (or frequent) throughout the Sanctuary, typically not in great numbers (although occasionally a species may be locally abundant); and d = abundant throughout the Sanctuary, often locally abundant in suitable habitat.

Superscripts (1 to 4) refer to the following notes: 1 = collected by Robert Peter in 1834 from the bank of the Kentucky River at or near "Raven Creek" (MacFarlane, 1979); 2 = found on the point north of the mouth of Raven Run Creek; 3 = found on other slopes north of the Sanctuary; and 4 = found on other slopes just outside the Sanctuary (see text). The "§" in the left column indicates naturalized, non-native plant species. The "?" in the left column indicates that the record is uncertain. These species were reported from the Sanctuary by other botanists, but no adequate voucher specimens were taken. Common synonyms are in parentheses.

CATALOG OF THE VASCULAR PLANTS OF THE RAVEN RUN NATURE SANCTUARY ARRANGED ALPHABETICALLY BY FAMILY

Species	Flw	Hab	Rel
DIVISION EQUISETOPHYTA (Scouring Rushes)			
Equisetaceae — Horsetail Family			
Equisetum hyemale L.; Common scouring rush		GA	r
DIVISION POLYPODIOPHYTA (Ferns)			
Adiantaceae — Maidenhair Fern Family			
Adiantum pedatum L.; Northern maidenhair fern	6-8	F	o
Aspleniaceae — Spleenwort Family			
Asplenium platyneuron (L.) Oakes; Ebony spleenwort	4-10	C	d
Asplenium rhizophyllum L.; Walking fern	5-9	FX	o
Athyrium pycnocarpon (Spreng.) Tidestrom; Glade fern	7-9	F	o
Cystopteris bulbifera (L.) Bernh.; Bulblet bladder fern	6-9	FX	d
Cystopteris protrusa (Weatherby) Blasdell; Lowland bladder fern	6-9	F	d
Dryopteris marginalis (L.) Gray; Marginal woodfern	6-9	F	c
Polystichum acrostichoides (Michx.) Schott; Christmas fern	6-10	C	r
Woodsia obtusa (Spreng.) Torr.; Blunt cliff-fern	5-10	EX	o
Ophioglossaceae — Adder's Tongue Family			
Botrychium dissectum Spreng. var. *obliquum* (Muhl.) Clute; Lace-frond grape fern	9-10	C	o
Botrychium virginianum (L.) Swartz; Rattlesnake fern	5	D	o
Ophioglossum vulgatum L. var. *pycnostichum* Fern; Southern adder's tongue	5	C	r
DIVISION PINOPHYTA (Gymnosperms)			
Cupressaceae — Cypress Family			
Juniperus virginiana L.; Eastern red cedar		C	d
Pinaceae — Pine Family			
§ *Pinus strobus* L.; White pine	5	E	r

Species	Flw	Hab	Rel
DIVISION MAGNOLIOPHYTA (Flowering Plants)			
DICOTYLEDONAE (Dicotyledons)			
Acanthaceae — Acanthus Family			
Justicia americana (L.) Vahl; American water-willow	7-8	GF	o-d
Ruellia strepens L.; Rustling ruellia	6-7	A	o
Aceraceae — Maple Family			
Acer negundo L.; Boxelder	4	G	d
Acer nigrum Michx. f.; Black maple	5-6	F	d
Acer saccharinum L.; Silver maple	2-4	GR	o
Acer saccharum Marsh.; Sugar maple	4-5	F	d
Anacardiaceae — Cashew Family			
Rhus aromatica Ait.; Squaw-bush or fragrant sumac	4	E	c
? *Rhus copallina* L.; Shining sumac	7	A	r
Rhus glabra L.; Smooth sumac	6-7	A	d
Toxicodendron radicans (L.) Kuntze; Common poison-ivy	6	C	d
Annonaceae — Custard-Apple Family			
Asimina triloba (L.) Dunal; Pawpaw	4	F	c
Apiaceae — Carrot Family			
Chaerophyllum procumbens (L.) Crantz; Spreading chervil	4-5	D	d
Chaerophyllum tainturieri Hook.; Southern chervil	4-5	A	o
§ *Conium maculatum* L.; Poison hemlock	6-7	A	o
Cryptotaenia canadensis (L.) DC.; Honewort	6-8	GD	c
§ *Daucus carota* L.; Wild carrot or Queen Anne's lace	7-8	A	c
Erigenia bulbosa (Michx.) Nutt.; Harbinger of spring	2-4	F	o
Osmorhiza claytonii (Michx.) Clarke; Bland sweet cicely	5	F	c
Osmorhiza longistylis (Torr.) DC.; Long-styled sweet cicely	5	D	c
§ *Pastinaca sativa* L.; Parsnip	6	A	o
Sanicula canadensis L.; Canada sanicle	5-6	D	o
Sanicula gregaria Bickn.; Cluster sanicle	4-6	C	o
Sanicula trifoliata Bickn.; Beaked sanicle	6	F	o

	Species	Flw	Hab	Rel
	Taenidia integerrima (L.) Drude; Yellow pimpernel	5	E	o
	Thaspium barbinode (Michx.) Nutt.; Bearded meadow-parsnip	5-6	F	c
	Thaspium trifoliatum (L.) Gray var. *flavum* Blake; Smooth meadow-parsnip	4-5	F	r
§	*Torilis arvensis* (Hudson) Link. (*T. japonica*); Field hedge-parsley	7	C	o
	Zizia aptera (Gray) Fern.; Heart-leaved golden alexanders	5	E	o
	Apocynaceae — Dogbane Family			
	Apocynum cannabinum L.; Hemp-dogbane	6-7	A	c
	Aquifoliaceae — Holly Family			
§	*Ilex opaca* Ait.; American holly	5	C	r
	Araliaceae — Ginseng Family			
§	*Hedera helix* L.; English ivy	9-3?	F	d
	Panax quinquefolium L.; American ginseng	6-7	F[4]	r
	Aristolochiaceae — Birthwort Family			
	Aristolochia serpentaria L.; Virginia snakeroot	5-7	E	o
	Asarum canadense L.; Wild ginger	4	F	d
	Asclepiadaceae — Milkweed Family			
	Asclepias quadrifolia Jacq.; Four-leaved milkweed	5-6	E	o
	Asclepias syriaca L.; Common milkweed	6-7	A	c
	Ampelamus albidus (Nutt.) Britt. (*Cynanchum laeve*); Sandvine	7-9	A	o
	Asteraceae — Aster Family			
§	*Achillea millefolium* L.; Common yarrow	6-7	A	c
	Ambrosia artemisiifolia L. var. *elatior* (L.) Descourt; Common ragweed	7-9	A	c
	Ambrosia trifida L.; Giant ragweed	7-8	G	o
	Antennaria plantaginifolia (L.) Richardson; Plantain pussytoes	4-5	E	r
§	*Arctium minus* Schk.; Common burdock	7-9	A	o
§	*Artemisia annua* L.; Annual wormwood	8-9	A	o
	Aster cordifolius L.; Common blue heart-leaved aster	10	F	c
?	*Aster lanceolatus* Willd. var. *simplex* (Willd.) Jones; Eastern lined aster	9-10	G	o

	Species	Flw	Hab	Rel
	Aster lateriflorus (L.) Britt.; Goblet aster	9-10	C	o
	Aster novae-angliae L.; New England aster	10	A	o
	Aster oblongifolius Nutt.; Aromatic aster	10	E	o
	Aster ontarionis Wieg.; Bottomland aster	9-10	G	d
	Aster pilosus Willd.; Awl aster	9-10	A	d
	Aster shortii Lindley; Midwestern blue heart-leaved aster	9-10	E	d
	Bidens aristosa (Michx.) Britt.; Midwestern tickseed-sunflower	9-10	G	o
	Bidens bipinnata L.; Spanish needles	8-10	A	o
	Bidens frondosa L.; Devil's beggar-ticks	8-10	G	o
§	*Carduus nutans* L.; Musk thistle	6-8	A	o
§	*Chrysanthemum leucanthemum* L. (*Leucanthemum vulgare* L. var. *pinnatifidum*); Ox-eye daisy	6-7	A	c
§	*Cichorium intybus* L.; Chickory	6-9	C	o
	Cirsium discolor (Muhl.) Spreng.; Field thistle	8-9	A	c
§	*Crepis pulchra* L.; Hawk's beard	2-6?	A	o
	Eclipta prostrata L. (*E. alba*); Yerba-de-tajo	8-9	G	r
	Erigeron annuus (L.) Pers.; Annual fleabane	6-7	D	d
	Erigeron canadensis L. *(Conyza canadensis)*; Horseweed	7-10	A	d
	Erigeron philadelphicus L.; Philadelphia daisy	5	D	c
	Eupatorium coelestinum L.; Mistflower	8-10	G	o
	Eupatorium incarnatum Walter; Pink eupatorium	9	C	r
	Eupatorium perfoliatum L.; Boneset	8	G	o
	Eupatorium purpureum L.; Purple-node joe-pye-weed	7-9	F	o
	Eupatorium rugosum Houtt.; White snakeroot	8-9	D	c
	Gnaphalium obtusifolium L.; Fragrant cudweed	9-10	A	o
	Helianthus decapetalus L.; Forest sunflower	7-8	F	r
	Helianthus microcephalus T. & G.; Small-headed sunflower	8-9	E^2	r
	Heliopsis helianthoides (L.) Sweet var. *scabra* (Dunal) Fern.; Sunflower everlasting	7-8	A	r
§	*Hypochoeris radicata* L.; Spotted cat's ear	6-7	A	r
	Kuhnia eupatorioides L. (*Brickellia eupatorioides*); False boneset	8-9	A	o

	Species	Flw	Hab	Rel
	Lactuca canadensis L.; Tall lettuce	7-9	A	o
	Lactuca floridana (L.) Gaertn.; Woodland lettuce	8-9	C	o
§	*Lactuca serriola* L.; Prickly lettuce	7-9	A	o
§	*Matricaria matricarioides* (Lessing) Porter; Pineapple-weed	6-9	A	o
	Polymnia canadensis L.; Pale-flowered leafcup	7-9	F	d
	Polymnia uvedalia L.; Yellow-flowered leafcup	7-8	D	o
	Prenanthes altissima L.; Tall white lettuce	8-9	F	o
	Prenanthes crepidinea Michx.; Midwestern white lettuce	8-10	FD	r
	Rudbeckia fulgida Ait.; Eastern coneflower	8-9	A	o
	Rudbeckia hirta L. var. *pulcherrima* Farw. (*R. serotina*); Black-eyed Susan	7-8	A	c
	Rudbeckia triloba L.; Three-lobed coneflower	7-8	A	d
	Senecio aureus L.; Heart-leaved groundsel	4-5	GF	o
	Senecio obovatus Muhl.; Running groundsel	4	CE	c
	Solidago altissima L. (*S. canadensis* L. var. *scabra*); Common goldenrod	9	A	d
	Solidago caesia L.; Axillary goldenrod	9-10	E	d
	Solidago flexicaulis L.; Zigzag goldenrod	9	F	d
?	*Solidago gigantea* Ait.; Smooth goldenrod	8-9	A	o
	Solidago harrisii Steele: Forest goldenrod	8-9	E[2]	r
	Solidago rupestris Raf.; Riverbank goldenrod	8-9	B	o
	Solidago sphacelata Raf.; Short-pappus goldenrod	9	E	c
	Solidago ulmifolia Muhl.; Elm-leaved goldenrod	8-9	E	d
§	*Taraxacum officinale* Weber; Common dandelion	2-10	A	o
§	*Tragopogon dubius* Scop. (*T. major*); Fistulous goat's beard	5-7	A	o
	Verbesina alternifolia (L.) Britt *(Actinomeris alternifolia*); Wingstem	8-9	G	o
	Verbesina occidentalis (L.) Walt.; Southern flatseed sunflower	8-10	A	d
	Vernonia gigantea (Walt.) Trel. (*V. altissima*); Tall ironweed	8-9	A	d
§	*Xanthium strumarium* L.; Common cocklebur	7-9	A	r

Species	Flw	Hab	Rel
Balsaminaceae — Touch-Me-Not Family			
Impatiens capensis Meerb.; Orange touch-me-not	7-8	G	d
Impatiens pallida Nutt.; Yellow touch-me-not	7-8	FG	d
Berberidaceae — Barberry Family			
Caulophyllum thalictroides (L.) Michx.; Blue cohosh	4	F	o
Jeffersonia diphylla (L.) Pers.; Twinleaf	3-4	E	d
Podophyllum peltatum L.; Mayapple or mandrake	4-5	F	d
Betulaceae — Birch Family			
Carpinus caroliniana Walt.; Hornbeam or blue beech	4-5	F	c
Ostrya virginiana (Miller) Koch; Hop-hornbeam	4-5	E	d
Bignoniaceae — Trumpet-Creeper Family			
Bignonia capreolata L. (*Anisostichus capreolata*); Crossvine	5	F	c
Campsis radicans (L.) Seemann; Trumpet-creeper	7	A	c
Boraginaceae — Borage Family			
§ *Echium vulgare* L.; Blue-weed	6-8	AX	o
§ *Lithospermum arvense* L.; Corn gromwell	4-5	A	o
Mertensia virginica (L.) Pers.; Eastern bluebell	4	F	o
Myosotis macrosperma Engelm.; Big-seed scorpion-grass	4-5	D	r
Onosmodium hispidissimum Mack. (*O. molle* var. *hispidissimum*); Western false gromwell	6-7	A	r
Brassicaceae — Mustard Family			
§ *Alliaria petiolata* (Bieb.) Cavara & Grande; Garlic mustard	5	D	r
Arabis laevigata (Muhl.) Poiret; Rock-cress	4-5	E	c
§ *Barbarea vulgaris* R. Brown; Yellow rocket	4-5	A	c
§ *Capsella bursa-pastoris* (L.) Medikus; Shepherd's purse	3-11	A	o
Cardamine douglassii Britt.; Pink springcress	3-4	F	c
§ *Cardamine hirsuta* L.; Hoary bittercress	2-4	A	c
? *Cardamine pensylvanica* Muhl.; Pennsylvania bittercress	3-7	G	o
Dentaria diphylla (Michx.) Wood (*Cardamine diphylla*); Broad-leaved toothwort	4	F	c
Dentaria laciniata Muhl. (*Cardamine concatenata*); Five-parted toothwort	3-4	F	c

	Species	Flw	Hab	Rel
	Draba ramosissima Desv.; Branched rock-cress	4-5	E	r
	Draba verna L.; Whitlow-grass	2-4	A	c
§	*Erysimum repandum* L.; Treacle mustard or bushy wallflower	5-6	A	r
	Iodanthus pinnatifidus (Michx.) Steud.; Purple rocket	5	G	r
§	*Lepidium campestre* (L.) R. Brown; Field cress	4-8	A	c
	Lepidium virginicum L.; Poor-man's pepper	5-6	A	c
§	*Rorippa nasturtium-aquaticum* (L.) Hayek. (*Nasturtium officinale*); Water-cress	5-7	GA	o
	Sibara virginica (L.) Rollins; Little field cress	3-5	A	r
§	*Thlaspi perfoliatum* L.; Thoroughwort pennycress	3	A	o
	Buxaceae — Boxwood Family			
	Pachysandra procumbens Michx.; Allegheny spurge	4	F	o
	Caesalpiniaceae — Caesalpinia Family			
	Cercis canadensis L.; Redbud	4	C	c
	Gleditsia triacanthos L.; Honeylocust	5-6	C	c
	Gymnocladus dioicus (L.) Koch; Kentucky coffeetree	5-6	D	o
	Senna marilandica (L.) Link (*Cassia marilandica*); Southern wild senna	7-8	A	o
	Campanulaceae — Bellflower Family			
	Campanula americana L.; Tall bellflower	6-8	CD	c
	Lobelia inflata L.; Indian tobacco	7-8	A	c
	Lobelia siphilitica L.; Great lobelia	8-9	G	o
	Triodanis perfoliata (L.) Nieuwl. (*Specularia perfoliata*); Round-leaved triodanis	5-6	A	c
	Caprifoliaceae — Honeysuckle Family			
	Lonicera dioica L.; Wild honeysuckle	5	FX	o
§	*Lonicera japonica* Thunb.; Japanese honeysuckle	5-7	AC	d
§	*Lonicera maackii* (Rupr.) Maxim; Manchurian bush honeysuckle	5-6?	CD	d
	Sambucus canadensis L.; Common elderberry	6	G	o
	Symphoricarpos orbiculatus Moench; Coralberry	7-8	A	d
	Triosteum aurantiacum Bickn.; Perfoliate horsegentian	5	E	o
	Viburnum molle Michx.; Missouri arrow-wood	6-7	F	r
	Viburnum prunifolium L.; Black haw	4	D	o

	Species	Flw	Hab	Rel
	Viburnum rafinesquianum Schultes var. *affine* (Bush) House; Downy arrow-wood	5	E	o
	Viburnum rufidulum Raf.; Southern black haw	5	C	c
	Caryophyllaceae — Pink Family			
	Arenaria patula Michx. var. *robusta* (Steyerm.) Maguire; Limestone stitchwort	4-5	EX	c
§	*Arenaria serpyllifolia* L.; Thymeleaf sandwort	5-7	A	r
§	*Cerastium fontanum* ssp. *triviale* Baumg. (*C. vulgatum*); Mouse-ear chickweed	3-10	A	o
§	*Cerastium glomeratum* Thuillier (*C. viscosum*); Clammy chickweed	3-7	A	c
§	*Dianthus armeria* L.; Deptford-pink	6-7	A	c
§	*Holosteum umbellatum* L.; Jagged chickweed	3-5	A	o
§	*Saponaria officinalis* L.; Soapwort	6-9	A	c
	Silene caroliniana Walt. var. *wherryi* (Small) Fern.; Wild pink	5	E	o
	Silene rotundifolia Nutt.; Round-leafed fire-pink	5-7	EY	r
	Silene stellata (L.) Ait. f.; Starry campion	7	C	o
	Silene virginica L.; Fire-pink	4-6	E	o
	Stellaria corei Shinners (*S. pubera* var. *silvatica*); Star chickweed	4	F	d
§	*Stellaria graminea* L.; Common stitchwort	5-9	A	o
§	*Stellaria media* (L.) Villars; Common chickweed	3-10	D	d
	Stellaria pubera Michx.; Star chickweed	4	E	o
	Celastraceae — Staff-Tree Family			
	Celastrus scandens L.; American bittersweet	5-6	C	o
§	*Euonymus alatus* (Thunb.) Siebold; Winged burning bush	5-6	C	r
	Euonymus americanus L.; Strawberry-bush	5	F	r
	Euonymus atropurpureus Jacq.; Wahoo	5-6	D	o
§	*Euonymus fortunei* (Turzc.) Hand.-Mazz.; Japanese running strawberry-bush	5-6	D	o-d
	Euonymus obovatus Nutt.; Running strawberry-bush	5	E	o
	Chenopodiaceae — Goosefoot Family			
§	*Chenopodium album* L.; Lamb's quarters	7-9	A	o

Species	Flw	Hab	Rel
Chenopodium standleyanum Aellen; Woodland goosefoot	7-9	EY[3]	r
Clusiaceae — Mangosteen Family			
§ *Hypericum perforatum* L.; Common St. John's-wort	7-8	A	o
Hypericum punctatum Lam.; Spotted St. John's-wort	7-8	C	o
Convolvulaceae — Morning-Glory Family			
§ *Convolvulus sepium* (L.) R. Brown (*Calystegia sepium*); Hedge-bindweed	5-8	A	r
Ipomoea pandurata (L.) Meyer; Wild potato	7-8	A	o
Cornaceae — Dogwood Family			
Cornus alternifolia L. f.; Pagoda dogwood	5	F	r
Cornus drummondii Meyer; Rough-leaved dogwood	6	A	o
Cornus florida L.; Flowering dogwood	4	E	r
Crassulaceae — Stonecrop Family			
Sedum pulchellum Michx.; Pink stonecrop	6	AX	o
§ *Sedum sarmentosum* Bunge; Yellow stonecrop	6	AX	r
Sedum ternatum Michx.; White stonecrop	4-5	FX	c
Cucurbitaceae — Gourd Family			
Sicyos angulatus L.; Bur cucumber	7-8	G	o
Dipsacaceae — Teasel Family			
§ *Dipsacus fullonum* L.; Common teasel	7-9	A	o
§ *Dipsacus laciniatus* L.; Cut-leaf teasel	7-9	A	r
Euphorbiaceae — Spurge Family			
Croton capitatus Michx.; Wooly croton	7-8	A	r
Croton monanthogynus Michx.; Prairie tea or one-seed croton	7-8	AX	c
Euphorbia commutata Engelm.; Tinted spurge	4-5	E	o
Euphorbia nutans Lag.; Eyebane	7-8	A	o
Fabaceae — Pea Family			
Amphicarpaea bracteata (L.) Fern.; Hog peanut	8	CG	o
Desmodium glutinosum (Muhl.) Wood; Cluster-leaf tick-trefoil	7-8	A	o
Desmodium perplexum Schubert; Common tick-trefoil	8-9	A	c
§ *Lathyrus latifolius* L.; Everlasting pea	6-8	A	r

	Species	Flw	Hab	Rel
§	*Lathyrus sylvestris* L.; Narrow-leaved everlasting pea	6-7	A	r
§	*Lespedeza stipulacea* Maxim.; Korean clover	8-9	A	o
	Lespedeza violacea (L.) Pers.; Violet lespedeza	7-8	E	o
§	*Medicago lupulina* L.; Black medick	4-10	A	o
§	*Medicago sativa* L.; Alfalfa	5-8	A	o
§	*Melilotus alba* Medikus; White sweet clover	5-8	A	o
§	*Melilotus officinalis* (L.) Pallas; Yellow sweet clover	5-8	A	o
	Robinia pseudoacacia L.; Black locust	5	C	d
§	*Trifolium campestre* Schreber; Pinnate hop clover	5-8	A	d
§	*Trifolium hybridum* L.; Alsike clover	6-8	A	r
§	*Trifolium pratense* L.; Red clover	5-8	A	o
§	*Trifolium repens* L.; White clover	5-8	A	o
	Vicia caroliniana Walt.; Pale vetch	4	F	r
§	*Vicia villosa* Roth ssp. *varia* (Host) Corb. (*V. dasycarpa*); Woolly-pod vetch	6	A	c
Fagaceae — Beech Family				
	Fagus grandifolia Ehrh.; American beech	4	F	r
	Quercus alba L.; White oak	5	E[3]	r
	Quercus imbricaria Michx.; Shingle or jack oak	5	E	r
	Quercus macrocarpa Michx.; Bur oak	5	AD[4]	r
	Quercus muehlenbergii Engelm.; Yellow oak	5	E	d
	Quercus rubra L. var. *borealis* (Michx. f.) Farw.; Northern red oak	5	F	c
	Quercus shumardii Buckley; Shumard oak	5	E	d
Fumariaceae — Fumitory Family				
	Corydalis flavula (Raf.) DC.; Short-spurred corydalis	4	D	o
	Dicentra canadensis (Goldie) Walp.; Squirrel corn	4	FG	c
	Dicentra cucullaria (L.) Bernh.; Dutchman's breeches	4	F	c
Gentianaceae — Gentian Family				
	Frasera caroliniensis Walter (*Swertia caroliniensis*); American columbo	6	E[2]	o
Geraniaceae — Geranium Family				
	Geranium carolinianum L.; Carolina crane's bill	5-7	A	o
	Geranium maculatum L.; Wild geranium	4-5	F	o

Species	Flw	Hab	Rel
Grossulariaceae — Gooseberry Family			
Ribes cynosbati L.; Dogberry	4-5	FEX	o
Ribes missouriense Nutt.; Missouri gooseberry	5-6	E	r
Hamamelidaceae — Witch-Hazel Family			
? *Hamamelis virginiana* L.; Witch-hazel	10-11	F	r?
Hippocastanaceae — Horse-Chestnut Family			
Aesculus flava Ait. (*A. octandra*); Sweet or yellow buckeye	4-5	F	c
Aesculus glabra Willd.; Ohio buckeye	4	D	c
Hydrangeaceae — Hydrangea Family			
Hydrangea arborescens L.; American hydrangea	6	FG	d
Hydrophyllaceae — Waterleaf Family			
Hydrophyllum appendiculatum Michx.; Biennial waterleaf	5	G	c
Hydrophyllum canadense L.; Maple-leafed waterleaf	6	F	o
Hydrophyllum macrophyllum Nutt.; Hairy waterleaf	5-6	F	d
Phacelia bipinnatifida Michx.; Forest phacelia	4-5	FX	c
Phacelia purshii Buckley; Miami mist	4-5	D	d
Juglandaceae — Walnut Family			
Carya cordiformis (Wang.) Koch; Bitternut hickory	4-5	DF	d
Carya glabra (Miller) Sweet; Pignut hickory	5	E	r
Carya laciniosa (Michx. f.) Loudon; Shellbark hickory	4-5	DG	c
Carya ovata (Miller) Koch; Shagbark hickory	5	E	o
Juglans cinerea L.; Butternut	4-5	DC	r
Juglans nigra L.; Black walnut	4-5	D	d
Lamiaceae — Mint Family			
Agastache nepetoides (L.) Kuntze; Catnip giant hyssop	8	AC	o
§ *Ajuga reptans* L.; Carpet bugle	5-6	D	r
Blephilia ciliata (L.) Benth.; Downy wood-mint	6	CE	c
Collinsonia canadensis L.; Northern horse-balm	8	F	o
§ *Glecoma hederacea* L.; Gill-over-the-ground	4-5	D	c
§ *Lamium amplexicaule* L.; Henbit	3-4	A	o

	Species	Flw	Hab	Rel
§	*Lamium purpureum* L.; Red dead nettle	3	D	d
§	*Leonurus cardiaca* L.; Motherwort	6-7	A	o
§	*Mentha spicata* L.; Spearmint	7-8	GA	o
	Monarda fistulosa L. var. *mollis* (L.) Benth.; Wild bergamot	7-8	A	c
	Prunella vulgaris L. var. *lanceolata* (Barton) Fern.; Selfheal	7-8	D	o
	Salvia lyrata L.; Lyre-leaved sage	5	A	o
	Scutellaria elliptica Muhl. var. *hirsuta* (Short) Fern.; Common hairy skullcap	6	CE	o
	Scutellaria nervosa Pursh; Smooth creeping skullcap	5	F	r
	Scutellaria ovata Hill var. *versicolor* (Nutt.) Fern.; Forest skullcap	6-7	E	o
	Stachys tenuifolia Willd.; Smooth hedge nettle	7	DG	r
	Synandra hispidula (Michx.) Britt.; White dragonhead	5	F	r
	Teucrium canadense L. var. *virginicum* (L.) Eaton; American germander	7	A	r
Lauraceae — Laurel Family				
	Lindera benzoin (L.) Blume; Spicebush	3	F	d
	Sassafras albidum (Nutt.) Nees; Sassafras	4	A	r
Lythraceae — Loosestrife Family				
	Cuphea viscosissima Jacq.; Blue waxweed	7-9	A	o
Magnoliaceae — Magnolia Family				
	Liriodendron tulipifera L.; Tulip tree	5	F	o
Malvaceae — Mallow Family				
	Malvastrum hispidum (Pursh) Hochr. (*Sphaeralcea angusta*); Yellow globe-mallow	7-8	A	r
§	*Sida spinosa* L.; Prickly sida	6-9	A	o
Menispermaceae — Moonseed Family				
	Menispermum canadense L.; Moonseed	6-7	D	o
Molluginaceae — Carpet-Weed Family				
§	*Mollugo verticillata* L.; Carpet-weed	7-10	A	r
Monotropaceae — Indian Pipe Family				
	Monotropa uniflora L.; Indian pipe	7	FE	r

Species	Flw	Hab	Rel
Moraceae — Mulberry Family			
Morus rubra L.; Red mulberry	4-5	D	o
Oleaceae — Olive Family			
Fraxinus americana L.; White ash	4-5	DE	c
Fraxinus americana L. var. *blitmoreana* (Beadle) J. Wright *ex* Fern.; Hairy white ash	4-5	E	o
Fraxinus pennsylvanica Marsh. var. *subintegerrima* (Vahl) Fern.; Green ash	5	G	o
Fraxinus quadrangulata Michx.; Blue ash	3-4	E	d
Onagraceae — Evening-Primrose Family			
Circaea quadrisulcata (Maxim.) Franch. & Sav. (*C. canadensis*); Common enchanter's nightshade	6-7	F	o
Epilobium coloratum Biehler; Eastern willowherb	7-9	G	r
Oenothera biennis L.; Common evening-primrose	7-9	A	o
Orobanchaceae — Broom-Rape Family			
Orobanche uniflora L.; Cancer-root	4-5	F	r
Oxalidaceae — Wood Sorrel Family			
Oxalis dillenii Jacq.; Southern yellow wood sorrel	5-9	A	o
Oxalis fontana Bunge var. *bushii* (Small) Hara; Weedy wood sorrel	6-9	A	o
Oxalis grandis Small; Big yellow wood sorrel	6	E	o
Oxalis violacea L.; Violet wood sorrel	4-5	E	r
Papaveraceae — Poppy Family			
Sanguinaria canadensis L.; Bloodroot	3-4	E	c
Stylophorum diphyllum (Michx.) Nutt.; Celandine-poppy	4	F	c
Passifloraceae — Passion-Flower Family			
Passiflora lutea L. var. *glabriflora* Fern.; Passionflower	6-8	C	o
Phytolaccaceae — Pokeweed Family			
Phytolacca americana L.; Pokeberry or pokeweed	7-9	D	c
Plantaginaceae — Plantain Family			
§ *Plantago lanceolata* L.; English plantain	5-9	A	o
Plantago rugelii Decne.; American plantain	7-9	A	o
Plantago virginica L.; Hoary plantain	4-6	A	r

Species	Flw	Hab	Rel
Platanaceae — Plane-Tree Family			
Platanus occidentalis L.; Sycamore	4-5	G	c
Polemoniaceae — Phlox Family			
Phlox divaricata L.; Forest phlox	4-5	F	c
Phlox paniculata L.; Summer phlox	7-9	G	o
Polemonium reptans L.; Spreading Jacob's ladder	4	F	c
Polygalaceae — Milkwort Family			
Polygala senega L. var. *latifolia* T. & G.; Broad-leaved seneca snakeroot	5-7	E	o
Polygonaceae — Smartweed Family			
§ *Polygonum cespitosum* Blume var. *longisetum* (DeBruyn) Stewart; Smartweed	7-9	G	c
Polygonum lapathifolium L.; Dock-leaved smartweed	7-10	G[1]	r
Polygonum aviculare L.; Knotweed	6-10	A	o
Polygonum pensylvanicum L.; Pennsylvania smartweed	6-9	A	o
Polygonum punctatum Ell.; Dotted smartweed	7-9	G	c
Polygonum scandens var. *cristatum* (Engelm. & A. Gray) Gleason; False buckwheat	9-10	C	r
Polygonum scandens var. *scandens* L.; False buckwheat	9-10	G	r
Polygonum virginianum L.; Jumpseed	7-9	D	o
§ *Rumex acetosella* L.; Red sorrell	5-6	A	r
§ *Rumex crispus* L.; Curly dock	5-6	A	o
§ *Rumex obtusifolius* L.; Bitter dock	5-6	A	o
Portulacaceae — Purslane Family			
Claytonia virginica L.; Spring beauty	3-4	F	d
§ *Portulaca oleracea* L.; Common purslane	7-10	A	o
Primulaceae — Primrose Family			
Dodecatheon meadia L.; Eastern shooting star	4-5	EX	o
Samolus valerandi L. ssp. *parviflorus* Raf.; Water pimpernel	6-8	G	o
Pyrolaceae — Shinleaf Family			
Chimaphila maculata (L.) Pursh; Spotted wintergreen	7	C	r

	Species	Flw	Hab	Rel
	Ranunculaceae — Buttercup Family			
	Actaea alba (L.) Miller (*A. pachypoda*); Doll's eyes	5	F	o
	Anemone virginiana L.; Tall anemone	7	C	o
	Anemonella thalictroides (L.) Spach (*T. thalictroides*); Rue anemone	4	F	c
	Aquilegia canadensis L.; Canada columbine	5	E	o
§	*Clematis terniflora* DC. (*C. dioscoreifolia*); Yam-leaved clematis	8-9	A	r
	Clematis viorna L.; Hairy leatherflower	6-7	E	r
	Clematis virginiana L.; Virgin's bower	8-9	A	r
	Delphinium tricorne Michx.; Dwarf larkspur	4	F	c
	Hepatica acutiloba DC.; Shape-lobed hepatica	2-4	C	d
	Isopyrum biternatum (Raf.) T. & G. (*Enemion biternatum*); False rue anemone	4	F	d
	Ranunculus abortivus L.; Small-flowered crowfoot	4	G	o
	Ranunculus hispidus Michx.; Hispid buttercup	4	F	o
	Ranunculus micranthus Nutt.; Small-flowered crowfoot	4	F	o
	Ranunculus recurvatus Poiret; Hooked crowfoot	5	G	o
	Thalictrum dioicum L.; Early meadow rue	4	E	c
	Rhamnaceae — Buckthorn Family			
	Ceanothus americanus L.; New Jersey tea	6	E[2]	r
	Rhamnus caroliniana Walt. var. *mollis* Fern.; Carolina buckthorn	6	C	o
§	*Rhamnus cathartica* L.; Common buckthorn	5-6	C	r
§	*Rhamnus citrifolia* (Weston) Hess & Stearn (*R. davurica*); Buckthorn	5-6?	C	r
	Rhamnus lanceolata Pursh; Lance-leaved buckthorn	5	CA	o
	Rosaceae — Rose Family			
	Agrimonia pubescens Wallr.; Downy agrimony	7-8	E	c
	Agrimonia rostellata Wallr.; Woodland agrimony	7-8	F	o
§	*Crataegus monogyna* Jacq.; Oneseed hawthorn	5	A	r
§	*Duchesnea indica* (Andrews) Focke; Indian strawberry	4-9	D	o
	Fragaria virginiana Duchesne; Thick-leaved wild strawberry	4	A	d

	Species	Flw	Hab	Rel
	Geum canadense Jacq.; White avens	6-7	D	c
	Geum vernum (Raf.) T. & G.; Spring avens	4-6	D	o
	Physocarpus opulifolius (L.) Maxim.; Ninebark	6	EX[2]	r
§	*Potentilla norvegica* L.; Strawberry weed	6-8	A	o
§	*Potentilla recta* L.; Sulphur-five-fingers	5-6	A	d
	Prunus americana Marsh. var *lanata* Sudw.; Wild plum	4	A	o
	Prunus angustifolia Marsh.; Chickasaw plum	4	A	r
§	*Prunus avium* L.; Sweet cherry	4-5	E	r
	Prunus serotina Ehrh.; Wild black cherry	5	D	d
	Prunus virginiana L.; Chokecherry	5	B	o
§	*Rosa canina* L.; Dog rose	5-6	A	r
	Rosa carolina L.; Pasture rose	6	E	c
§	*Rosa multiflora* Thunb.; Multiflora rose	5	D	c
	Rosa setigera Michx.; Climbing prairie rose	6	A	o
	Rubus pensilvanicus Poiret (*sensu lato*); Pennsylvania blackberry	5-6	A	d
	Rubus occidentalis L.; Black raspberry	4-6	A	c
	Rubiaceae — Madder Family			
	Galium aparine L.; Cleavers	5-6	D	d
	Galium circaezans Michx.; Forest bedstraw	6	E	c
	Galium triflorum Michx.; Sweet-scented bedstraw	5-8	F	c
	Hedyotis purpurea (L.) T. & G. var. *calycosa* (A. Gray) Fosb. (*Houstonia lanceolata*); Purple sweet-ear	6-7	D	o
	Rutaceae — Rue Family			
	Ptelea trifoliata L.; Common hoptree	5-6	E	o
	Zanthoxylum americanum Miller; Common prickly ash	4-5	A	r
	Salicaceae — Willow Family			
§	*Populus alba* L.; White or silver poplar	4	D	r
	Salix exigua Nutt.; Sandbar willow	4	GA	r
	Salix nigra Marsh.; Black willow	4	GA	o
	Saxifragaceae — Saxifrage Family			
	Heuchera americana L.; Common alumroot	5-7	E	o

Species	Flw	Hab	Rel
Heuchera villosa Michx. var. *macrorhiza* (Small) C. Rosend.; Maple-leaved alumroot	7-9	EFX	c
Mitella diphylla L.; Bishop's cap	4-5	F	o
Saxifraga virginiensis Michx.; Early saxifrage	3-4	FX	c
Scrophulariaceae — Figwort Family			
Aureolaria flava (L.) Farw.; Smooth false foxglove	7-8	E[2]	r
Collinsia verna Nutt.; Eastern blue-eyed Mary	5	FD	c
Dasystoma macrophylla (Nutt.) Raf.; Mullein foxglove	7	C	r
Mimulus alatus Ait.; Sharpwing monkeyflower	7-8	G	o
Penstemon calycosus Small; Eastern beard-tongue	5-6	D	o
Penstemon hirsutus (L.) Willd.; Northeastern beard-tongue	5	EX	o
§ *Verbascum blattaria* L.; Moth mullein	6-8	A	o
§ *Verbascum thapsus* L.; Common mullein	6-8	A	o
§ *Veronica arvensis* L.; Corn speedwell	3-7	A	c
§ *Veronica serpyllifolia* L.; Thyme-leaved speedwell	4-6	A	o
Solanaceae — Nightshade Family			
§ *Datura stramonium* L.; Jimson-weed	7-9	A	r
Physalis heterophylla Nees.; Clammy ground cherry	6-8	A	o
Physalis longifolia Nutt. var. *subglabrata* (Mack. & Bush) Cronq.; Longleaf ground cherry	6-8	A	o
§ *Solanum nigrum* var. *virginicum* L.; Black nightshade	6-9	A	o
Staphyleaceae — Bladder-Nut Family			
Staphylea trifolia L.; Bladdernut	4	F	d
Thymelaeaceae — Mezereum Family			
Dirca palustris L.; Leatherwood	3	GF	r
Tiliaceae — Linden Family			
Tilia americana L.; Basswood	6-7	F	c
Tilia heterophylla Vent.; White basswood	6-7	F	o
Ulmaceae — Elm Family			
Celtis occidentalis L.; Northern hackberry	5?	D	d
Celtis tenuifolia Nutt.; Dwarf hackberry	5?	C	o
Celtis tenuifolia x *occidentalis*; Dwarf hackberry and northern hackberry hybrid	5?	C	o

Species	Flw	Hab	Rel
Ulmus americana L.; American or white elm	2-3	G	c
Ulmus rubra Muhl.; Slippery or red elm	3	F	c
Ulmus thomasii Sargent; Rock elm	5	E	c
Urticaceae — Nettle Family			
Boehmeria cylindrica (L.) Swartz; False nettle	7-9	G	c
Laportea canadensis (L.) Weddell; Wood nettle	7	G	o
Parietaria pensylvanica Muhl.; Pillitory	5-8	EY	o
Pilea pumila (L.) A. Gray; Clearweed	7-9	G	c
Urtica chamaedryoides Pursh; Stinging nettle	3-5	F	o
Valerianaceae — Valerian Family			
Valeriana pauciflora Michx.; Long-tube valerian	5	F	o
§ *Valerianella locusta* (L.) Betcke (*V. olitoria*); European cornsalad	4-5	A	r
Verbenaceae — Vervain Family			
Phryma leptostachya L.; Lopseed	7	F	o
Verbena simplex Lehm.; Narrow-leaved vervain	5-6	A	o
Verbena urticifolia L.; White vervain	6-8	A	o
Violaceae — Violet Family			
Hybanthus concolor (T. Forster) Spreng.; Green violet	4-5	F	o
? *Viola canadensis* L.; Tall white violet	4-5	F	r
Viola papilionacea Pursh; Smooth blue stemless violet	4	D	c
Viola pubescens var. *pubescens* Ait.; Yellow forest violet	4	F	o
Viola pubescens var. *eriocarpa* (Schwein.) Russell (*V. eriocarpa*); Smooth yellow-stemmed violet	4	F	o
Viola rafinesquii Greene; Wild pansy	4	A	o
Viola sororia Willd.; Dooryard violet	4	F	c
Viola striata Ait.; Creamy violet	4-5	D	d
Viscaceae — Christmas-Mistletoe Family			
Phoradendron serotinum (Raf.) Johnston (*P. flavescens*); American Christmas-mistletoe	9	D	r
Vitaceae — Grape Family			
Parthenocissus quinquefolia (L.) Planchon; Virginia creeper	5-6?	DF	d

Species	Flw	Hab	Rel
Vitis vulpina L.; Frost grape	5-6	DF	c
MONOCOTYLEDONAE (Monocotyledons)			
Alismataceae — Water-Plantain Family			
? *Sagittaria australis* (Smith) Small; Appalachian arrowhead	7-8	G	r
Araceae — Arum Family			
Arisaema dracontium (L.) Schott; Green dragon	5-6	D	r
Arisaema triphyllum var. *triphyllum* (L.) Schott (*A. atrorubens*); Jack-in-the-pulpit	5	F	o
Commelinaceae — Spiderwort Family			
§ *Commelina communis* L.; Common dayflower	7-9	AG	o
Tradescantia subaspera Ker Gawler; Wide-leaved spiderwort	6	DF	c
Cyperaceae — Sedge Family			
Carex albicans Willd. var. *emmonsii* (Dewey) Rettig.; Sedge	4-6	E	o
Carex albursina Sheldon; Sedge	4-6	F	c
Carex amphibola var. *amphibola* Steud.; Sedge	5-6	D	o
Carex amphibola var. *turgida* Fern. (*C. grisea*); Sedge	5-6	G	o
Carex annectens var. *annectens* Bickn.; Sedge	6-7	A	o
Carex blanda Dewey; Sedge	4-6	D	c
Carex careyana Torr.; Sedge	5-6	F	o
Carex cephalophora Muhl. var. *mesochorea* (Mack.) Gleason; Sedge	5-6	A	o
Carex communis Bailey; Sedge	5-6	F	o
Carex complanata Torr. & Hook. var. *hirsuta* (Bailey) Gleason (*C. hirsutella*); Sedge	5-7	A	o
Carex conjuncta F. Boott; Sedge	6	GA	r
Carex eburnea F. Boott; Sedge	5-7	EX	o
Carex frankii Kunth; Sedge	6-8	GA	o
Carex granularis Muhl.; Sedge	5-6	GA	r
? *Carex hitchcockiana* Dewey; Sedge	5-6	E	r
Carex jamesii Schw.; Sedge	5-6	D	d
Carex laevivaginata (Kuken.) Mack.; Sedge	5-6	GA	r
Carex laxiculmis Schw.; Sedge	5-6	GF	r

	Species	Flw	Hab	Rel
	Carex laxiflora Lam.; Sedge	4-6	F	c
	Carex molesta (Dewey) Mack.; Sedge	6-7	GA	r
	Carex muhlenbergii Schk. var. *enervis* Boott; Sedge	6-7	A	o
	Carex oligocarpa Schk.; Sedge	5-6	D	d
	Carex pensylvanica var. *pensylvanica* Lam.; Sedge	4-6	E	c
	Carex plantaginea Lam.; Sedge	4-6	F	r
	Carex platyphylla Carey; Sedge	4-6	E	o
	Carex retroflexa var. *retroflexa* Muhl.; Sedge	5-6	C	o
	Carex rosea Schk. *ex* Willd. (*C. convoluta*); Sedge	5-6	F	o
	Carex sparganioides var. *sparganioides* Muhl.; Sedge	6-7	D	o
?	*Carex striatula* Michx.; Sedge	5-6	E	o
	Carex vulpinoidea Michx.; Sedge	6-7	GA	o
	Cyperus strigosus L.; False nutsedge	8-9	A	o
	Scirpus atrovirens var. *atrovirens* Willd.; Black bulrush	5-6	G	o
	Dioscoreaceae — Yam Family			
§	*Dioscorea batatas* Decne.; Cinnamon-vine		G	o
	Dioscorea quaternata (Walt.) Gmelin; Colic-root	5	F	c
	Iridaceae — Iris Family			
§	*Belamcanda chinensis* (L.) DC.; Blackberry lily	6-7	A	r
	Sisyrinchium angustifolium Miller (*S. graminoides*); Blue-eyed grass	5-6	A	o
	Juncaceae — Rush Family			
	Juncus tenuis var. *tenuis* Willd.; Path rush	6-8	D	o
	Liliaceae — Lily Family			
	Allium burdickii (Hanes) A.G. Jones (*A. tricoccum* var. *burdickii*); Ramps or wild leek	5-6	F	o
	Allium canadense L.; Onion	5-7	A	c
	Allium cernuum Roth; Nodding onion	5-6	GEX	o
	Allium tricoccum Ait.; Ramps or wild leek	6-7	F	d
§	*Allium vineale* L.; Field-garlic	5-7	AD	o
	Camassia scilloides (Raf.) Corey; Wild hyacinth	5	F	c
	Erythronium albidum Nutt.; White trout lily	3	E	o
	Erythronium americanum Ker Gawler; Yellow trout lily	4	F	d

	Species	Flw	Hab	Rel
	Lilium michiganense Farw.; Michigan lily	6-7	G[3]	r
§	*Ornithogalum umbellatum* L.; Star-of-Bethlehem	5	F	o
	Polygonatum biflorum var. *biflorum* (Walt.) Ell.; Solomon's seal	5	F	c
	Polygonatum biflorum var. *commutatum* (R. & S.) Dietr.; Solomon's seal	6	D	o
	Polygonatum pubescens (Willd.) Pursh; Solomon's seal	5	F	c
	Smilacina racemosa (L.) Desf.; False Solomon's seal	5	F	c
	Trillium flexipes Raf.; Bent trillium	4	F	o
	Trillium sessile L.; Toadshade	4	D	c
	Uvularia grandiflora Smith; Large bellwort	4	F	c
	Uvularia perfoliata L.; Small bellwort	4-5	E	o
	Orchidaceae — Orchid Family			
	Aplectrum hyemale (Muhl.) Torr.; Puttyroot	5-6	C	r
	Corallorhiza odontorhiza (Willd.) Nutt.; Autumn coral-root	8-9	D[3]	r
	Goodyera pubescens (Willd.) R. Brown; Downy rattlesnake plantain	7	F	r
	Liparis liliifolia (L.) Richard; Large twayblade	6	C	r
	Spiranthes ovalis Lindley; Oval ladies'-tresses	9-10	C	r
	Tipularia discolor (Pursh) Nutt.; Crane-fly orchid	8	F	r
	Poaceae — Grass Family			
	Andropogon gerardii Vitman; Big bluestem	8-9	B	d
	Andropogon virginicus L.; Broom sedge	8-9	A	o
§	*Arrhenatherum elatius* (L.) J. & C. Presl; Tall oatgrass	5	A	o
	Brachyelytrum erectum (Schreber) Beauv.; Little-glume wood-grass	6-8	F	o
	Bromus pubescens Muhl.; Bromegrass	6-7	E	c
§	*Bromus inermis* Leysser; Smooth brome	5-6	A	o
§	*Bromus japonicus* Thunb.; Japanese chess	6-7	A	d
	Chasmanthium latifolium (Michx.) Yates (*Uniola latifolium*); Wild oats	6-8	BE	d
	Cinna arundinacea L.; Common woodreed	7-9	G	c
§	*Dactylis glomerata* L.; Orchard grass	5-6	A	c
	Danthonia spicata (L.) Beauv.; Poverty oats	5-6	E	c

	Species	Flw	Hab	Rel
	Diarrhena americana P. Beauv.; Two-stamen wood-grass	7-8	E	c
§	*Digitaria sanguinalis* (L.) Scop.; Northern crabgrass	6-9	A	o
§	*Echinochloa crusgalli* (L.) Beauv.; Barnyard grass	6-9	AG	o
§	*Eleusine indica* (L.) Gaertn.; Yard-grass	7-9	A	o
	Elymus hystrix var. *bigeloviana* (Fern.) Gl.; Hairy bottlebrush grass	6-8	E	r
	Elymus hystrix var. *hystrix* L. (*Hystrix patula*); Bottlebrush grass	6-8	E	d
	Elymus hystrix x *virginicus*; Bottlebrush grass and wild rye hybrid	6-7	DA	r
	Elymus sp. nov. (R. Brooks, in prep.); Early wild rye	5-6	DG	o
	Elymus villosus Muhl.; Downy wild rye	6-7	DC	d
	Elymus virginicus var. *hirsutiglumis* (Scribner) Fern.; Hirsute wild rye	7-8	B	o
	Elymus virginicus var. *virginicus* L.; Virginia wild rye	6-8	GA	c
§	*Elytrigia repens* (L.) Nevski (*Agropyron repens*); Quackgrass	6	A	r
§	*Eragrostis cilianensis* (All.) Janchen (*E. megastachya*); Stinkgrass	6-8	A	o
	Eragrostis pectinacea (Michx.) Nees; Carolina lovegrass	7-8	A	o
§	*Festuca elatior* L. (*F. arundinacea*); Tall or alta fescue	5-6	A	d
	Festuca subverticillata (Pers.) Alexeev. (*F. obtusa*); Nodding fescue	5-6	DF	c
	Glyceria striata (Lam.) Hitchc.; Fowl mannagrass	5-6	G	d
	Hordeum pusillum L.; Little barley	5	A	o
	Leersia oryzoides (L.) Swartz; Rice cutgrass	8-9	G[1]	o
	Leersia virginica Willd.; White grass	7-8	D	c
	Melica mutica Walt.; Two-flower melic grass	4-5	E	o
§	*Microstegium vimineum* (Trin.) Camus (*Eulalia viminea*); Japanese grass	9-10	CG	c
	Muhlenbergia frondosa (Poiret) Fern.; Muhly	7-9	GB	o
?	*Muhlenbergia schreberi* Gmelin; Nimblewill	7-10	A	r?
	Muhlenbergia sobolifera (Muhl.) Trin.; Muhly	7-9	E	c
	Panicum anceps Michx.; Panic grass	7-8	A	r

	Species	Flw	Hab	Rel
	Panicum boscii Poiret; Panic grass	5-7	EC	c
	Panicum capillare var. *campestre* Gattinger (*P. gattingeri*); Witchgrass	8-9	A	o
	Panicum capillare var. *capillare* L.; Witchgrass	8-9	A	o
	Panicum clandestinum L.; Panic grass	5-8	AG	c
	Panicum dichotomiflorum Michx.; Panic grass	8-9	A	o
	Panicum flexile (Gattinger) Scribner; Wiry witchgrass	8-9	ACX	c
	Panicum lanuginosum Ell. var. *fasciculatum* (Torr.) Fern. (*P. acuminatum*); Panic grass	5-8	AC	o
§	*Phleum pratense* L.; Timothy	6-7	A	c
§	*Poa annua* L.; Speargrass	4-5	A	o
	Poa cuspidata Nutt.; Bluegrass	3-4	E	c
§	*Poa pratensis* L. (and *P. angustifolia* L. ?); Kentucky bluegrass	4-6	A	d
	Poa sylvestris Gray; Forest bluegrass	4-5	D	c
	Schizachyrium scoparium (Michx.) Nash (*Andropogon scoparius*); Little bluestem	8-9	B[1]	r
§	*Setaria viridis* (L.) Beauv.; Green foxtail	7-9	A	o
	Sorghastrum nutans (L.) Nash; Indian grass	8-9	B[1]	r
§	*Sorgum halepense* (L.) Pers.; Johnson grass	6-8	A	o
	Sphenopholis nitida (Biehler) Scribner; Wood wedgegrass	4-5	E	o
	Tridens flavus (L.) Hitchc. (*Triodia flava*); Purpletop	7-8	A	c
	Smilacaceae — Catbrier Family			
	Smilax bona-nox var. *bona-nox* L.; Tough-leaved greenbrier	5-6	E	o
	Smilax bona-nox var. *hederaefolia* (Beyrich) Fern.; Tough-leaved greenbrier	5-6	E	o
?	*Smilax glauca* Walt.; Glaucous greenbrier	5-6	A	r
	Smilax herbacea L. var. *lasioneura* (Small) Rydb.; Climbing carrion-flower	6	D	o
	Smilax hispida Muhl.; Bristly greenbrier	5-6	D	o
	Smilax rotundifolia L.; Catbrier	4-6	C	o
	Typhaceae — Cattail Family			
	Typha latifolia L.; Common cattail	6-8	G	o

Not listed is *Trillium recurvatum* Beck. A 1961 student collection exists with the locality given as "Raven Run." This specimen is most likely mislabelled, because this Western species is otherwise unknown from the region.

DESCRIPTION OF VEGETATION TYPES

OLD FIELDS

Species largely restricted to old fields (A in Figure 2) comprise approximately 32% of the total flora, but only 22% of the native flora. These species also include 43% of herbaceous species with post-June flowering, but only 15% of those with pre-July flowering.

Open areas on the ridges typically have the McAfee soil series and are dominated by Poaceae, Asteraceae, Fabaceae, and Rosaceae. Abundant Poaceae are *Bromus japonicus* and *Festuca elatior*; others include *Phleum pratense, Poa pratensis, Dactylis glomerata, Tridens flavus,* and *Panicum clandestinum.* Abundant Asteraceae include *Solidago altissima* and *Aster pilosus*; others include *Achillea millefolium, Chrysanthemum leucanthemum, Tragopogon dubius, Vernonia gigantea, Verbesina occidentalis, Rudbeckia* spp. (especially *R. triloba*), *Cirsium discolor,* and *Erigeron* spp. (especially *E. annuus*). Among the Fabaceae, *Trifolium campestre* is most abundant; others include *Melilotus* spp., *Vicia villosa,* and *Desmodium perplexum.* Frequent Rosaceae are *Fragaria virginiana* and *Potentilla recta.* Other frequent species are *Monarda fistulosa, Blephilia ciliata, Apocynum cannabinum, Asclepias syriaca, Geranium carolinianum, Daucus carota, Torilis arvensis,* and *Dianthus armeria.* Small areas of bare rock are colonized by *Sedum pulchellum, Arenaria serpyllifolia, Croton monanthogynus,* and *Echium vulgare.*

Common woody pioneers include *Rubus pensilvanicus, Symphoricarpos orbiculatus, Rhus glabra, Robinia pseudoacacia,* and *Vitis vulpina,* all of which are able to spread widely by root sprouts or decumbent stems. Other frequent woody pioneers include *Juniperus virginiana, Gleditsia triacanthos, Prunus serotina, Ulmus americana, Campsis radicans, Toxicodendron radicans,* and *Lonicera japonica.* Vines as well as *Juniperus virginiana* are particularly abundant in the field under the power lines, where herbicides have often been applied in the past.

Three intergrading types of old fields may be recognized though some areas are mixed or otherwise difficult to classify.

Recently Plowed or Disked Areas (A1). During 1980-1986, about half of the total field area was disked to reinitiate secondary succession, while the rest was mowed or abandoned. Disked areas now have abundant *Trifolium campestre.* Also frequent are *Melilotus officinalis, Bromus japonicus, Festuca elatior, Solidago altissima, Aster pilosus, Fragaria virginiana,* and *Potentilla recta.* Annual or biennial species are relatively frequent as a group, including *T. campestre, M. officinalis, B. japonicus,* several Asteraceae (*Ambrosia* spp., *Erigeron* spp., *Carduus nutans, Cirsium discolor,* and *Bidens* spp.), Caryophyllaceae (*Dianthus armeria, Stellaria* spp., and *Cerastium* spp.), *Daucus carota,* and *Triodanis perfoliata.* In the Raven Run area, *Ambrosia* spp. and *Erigeron* spp. are often dominant during the first 1-2 years after plowing. Among woody pioneers, *Rubus pensilvanicus* and *Prunus serotina,* both with sweet warm season

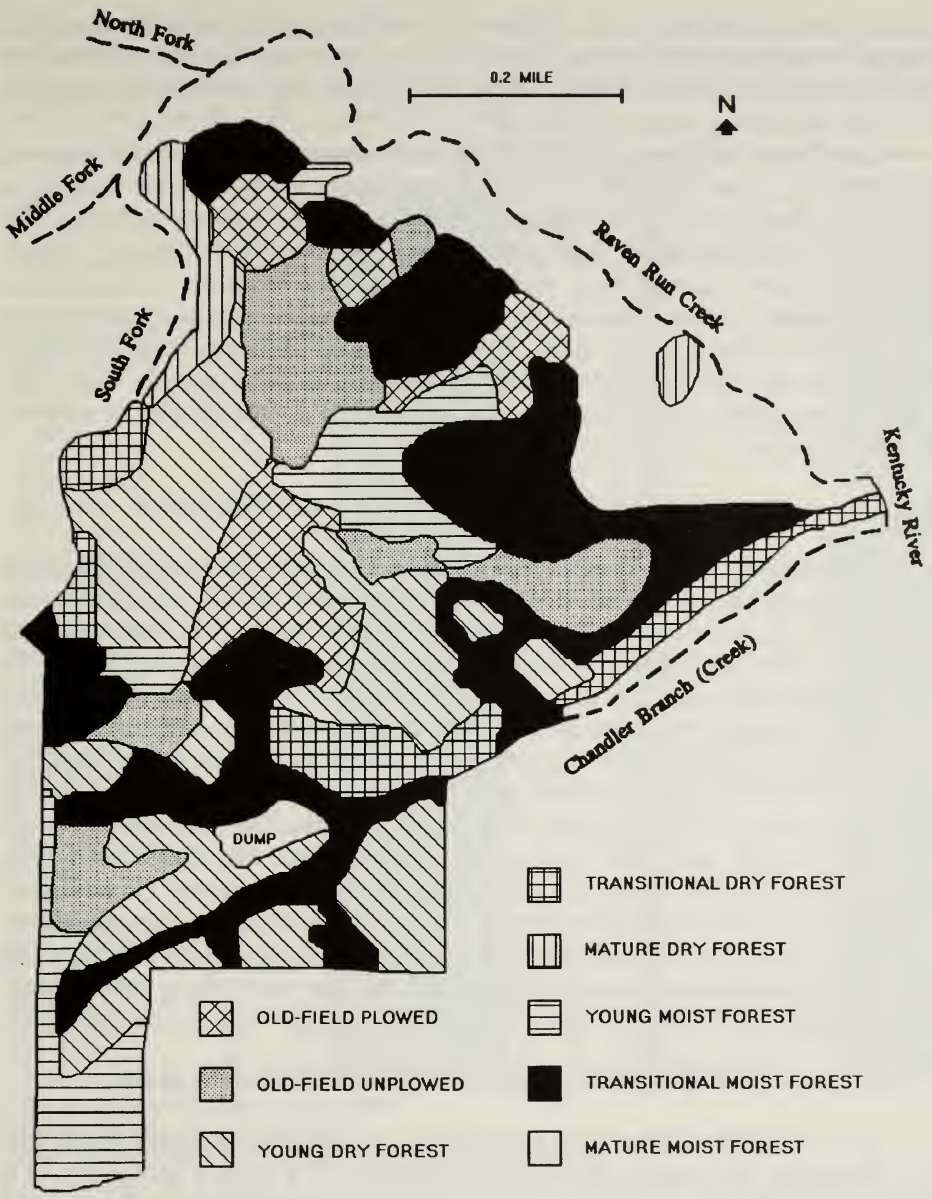

Figure 2. Raven Run Nature Sanctuary plant communities (see text for description of forest types): A1 = old-field plowed; A2-A3 = old-field unplowed; C1 = young dry forest; C2 = transitional dry forest; D1 = young moist forest; D2-D3 = transitional moist forest; E1-E2 = mature dry forest; and F1-F2 = mature moist forest.

fruit, are notably more frequent than in other areas, whereas *Symphoricarpos orbiculatus,* with relatively unrewarding fruit, is much less abundant.

Old Pastures or Mowed Grassy Areas (A2). Parts of the fields have probably been sown with various pasture grasses in the past or have become grassy because of repeated mowing, such as near the barns, parking lots, and trails

through fields. *Festuca elatior* is often dominant, and other perennial grasses are frequent. However, little or no annual *Bromus japonicus* was found. Frequent herbs include *Trifolium campestre, Monarda fistulosa, Achillea millefolium, Solidago altissima,* and *Aster pilosus.*

Less Disturbed Brushy Fields (A3). In areas abandoned for 5-10 years and with mowing at no more than 1-3 year intervals, woody species have begun to dominate. Ten to 20% of the field area is in this condition, typically with abundant *Solidago altissima* and *Poa pratensis.* Also frequent are *Festuca elatior, Tridens flavus, Panicum clandestinum, Achillea millefolium, Monarda fistulosa,* and, locally, *Blephilia ciliata. Monarda fistulosa* appears to have increased greatly during the past few years at Raven Run. Major woody invaders are *Symphoricarpos orbiculatus* and, in taller thickets, *Rhus glabra* and *Robinia pseudoacacia.* The other woody species noted above are also frequent, plus patches of *Rosa setigera, Prunus americana,* and *Cornus drummondii.*

GRASSY VEGETATION ON ROCKY RIVERBANKS

The Kentucky River floodplain (B in Figure 2) supports an unusual vegetation type that is largely restricted to steep slopes in bends of the river where rock outcrops are exposed near the water level. Instead of forest, a 1-10 m wide strip of grassy or brushy vegetation occurs. *Andropogon gerardii* is abundant in the open, and *Chasmanthium latifolium* is abundant in the brushy transition to forest above the outcrops. A rare goldenrod, *Solidago rupestris,* is locally frequent and restricted to such sites. This vegetation type occurs on the east-facing bank just north of Raven Run Creek. Frequent woody species in the brushy transition include *Rhus aromatica, Ostrya virginiana, Juniperus virginiana, Quercus muehlenbergii,* and *Acer saccharum.* This site might possibly be the one that Robert Peter described in 1834 as a "rocky bank, Raven Creek, Kentucky River" (MacFarlane, 1979). Peter collected *Sorghastrum nutans* and *Schizachyrium scoparium* here, but these species are currently unknown in Fayette County. Also notable along the river are *Justicia americana* and *Leersia oryzoides,* which form patches at the outer edge of gravel bars, including the island by the mouth of Raven Run Creek.

SUCCESSIONAL FOREST ON DRY OR ERODED SITES

Occurring primarily on west to south-facing, moderate to gentle slopes with the Fairmount soil series, this vegetation type (C in Figure 2 and Table 1) is dominated by *Juniperus virginiana,* the most common pioneering tree of abandoned pastures on dry or eroded soil. Two intergrading types can be distinguished.

Young *Juniperus* Forest (C1). Red cedar trees located in this habitat are generally no more than 10-20 cm dbh (diameter breast height) and about 30-50 years old. Frequent associates are *Gleditsia triacanthos* and, in the understory, *Fraxinus americana* and, occasionally, *F. quadrangulata.* Other trees include *Juglans nigra, Celtis occidentalis, Ulmus rubra, U. americana,* and occasional saplings of *Quercus muehlenbergii* and *Q. shumardii.* In the shrub layer, *Lonicera maackii* is abundant, while *Symphoricarpos orbiculatus* is locally abundant, especially in more open areas. In denser stands, mosses (especially *Thuidium* spp.) are abundant, and the only frequent vascular herb is *Asplenium platyneuron.*

Table 1. Basal areas and other quantitative data illustrating tree species composition from 17 circular plots. C1 and C2 are *Juniperus* dominated stands; D-F are older mesophytic stands. The species order approximates the general successional trends in the region (Campbell, 1980).

Species	Forest Type and Plot Number																
	C1		C2				D2			E1	E2				F1		
	1	6[a]	5	7[a]	3	18[a]	2[b]	10	8[b]	17	15	13	14	12	16	9	11
Platanus occidentalis	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Juniperus virginiana	112	99	19	54	24	75	24	22	—	15	44	—	—	2	6	—	—
Cercis canadensis	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
Gleditsia triacanthos	53	15	23	3	—	—	—	—	—	3	—	9	—	—	—	—	—
Robinia pseudoacacia	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
Juglans nigra	20	2	13	31	3	—	6	23	7	—	—	5	—	—	—	—	—
Prunus serotina	—	—	16	—	—	—	—	—	10	7	—	—	—	—	—	—	—
Carya laciniosa	17	—	7	12	2	—	—	—	—	9	—	20	—	2	—	—	—
Carya ovata	8	5	18	3	4	—	—	—	—	—	7	—	5	4	—	—	—
Ulmus americana	—	—	—	12	—	—	5	17	—	—	—	—	—	—	—	—	—
Ulmus rubra	—	—	11	13	1	—	2	—	2	—	—	10	15	2	—	—	9
Ulmus thomasii	—	—	—	—	—	9	—	—	18	—	—	—	2	—	—	—	—
Fraxinus americana	—	—	11	9	56	28	28	35	19	—	—	9	24	—	59	—	7
Fraxinus quadrangulata	—	—	—	—	2	13	6	—	9	46	4	26	26	5	—	—	—
Quercus muehlenbergii	3	1	12	25	26	29	28	—	—	61	22	33	20	64	15	16	—
Gymnocladus dioica	—	—	—	—	—	—	—	23	—	—	—	—	—	—	—	—	—
Aesculus glabra	—	—	7	5	2	—	9	55	—	5	2	10	15	1	8	—	—
Celtis occidentalis	—	—	—	—	—	—	10	4	42	22	—	—	—	—	—	—	18
Carya cordiformis	—	—	—	4	22	—	40	—	6	37	—	—	—	50	—	33	—
Acer saccharum/nigrum	—	10	23	40	30	11	11	—	35	2	37	32	30	28	60	52	70
Quercus shumardii	—	—	—	—	1	—	—	—	26	30	19	—	85	12	55	—	—
Quercus velutina	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—
Liriodendron tulipifera	—	—	—	—	—	—	—	—	—	—	26	—	—	—	—	—	—
Ostrya virginiana	—	—	—	—	—	7	1	—	1	—	—	3	6	—	2	1	—
Carpinus caroliniana	—	—	—	—	—	—	1	—	—	—	—	—	—	3	1	—	—
Tilia spp.	—	—	—	—	—	1	9	—	5	—	12	15	—	—	16	65	7
Aesculus flava	—	—	—	—	—	4	—	—	—	—	—	8	—	—	10	20	5
Quercus rubra	—	—	5	—	—	—	—	—	—	—	—	—	—	—	—	28	111
Fagus grandifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Total Basal Area[c]	213	142	165	208	173	178	182	181	180	240	173	180	228	173	232	215	229
Tree Density[c]	863	637	622	722	693	440	651	622	400	693	651	651	566	566	523	439	509
Approx. Age (years)	40s	40s	40s	40s	40s	50s	50s	50s	40s	50s	40s	50s	50s	50s	90s	60s	90s
Slope Aspect[c]	NW	WNW	WNW	SE	SSE	NNE	SW	B	B	ENE	NNE	NE	ENE	SE	NNE	B	NNE

[a] Plot on relatively xeric upper slope position.
[b] Plot on relatively gentle slope position.
[c] Basal area is in units of dm^2/ha; density is in stems/ha; B=bottom.

In more open areas, frequent species include *Toxicodendron radicans, Campanula americana, Glechoma hederacea,* and *Elymus villosus.* Minor species include *Sedum* spp., *Torilis arvensis,* and *Eupatorium rugosum.*

Older *Juniperus* Forest and Transition to *Quercus* (C2). This vegetation type generally has canopy trees of 20-40 cm dbh. Although *Juniperus virginiana* is still dominant, and *Gleditsia triacanthos* often remains, frequent invading trees of *Quercus muehlenbergii* (and an occasional *Q. shumardii*), *Fraxinus americana* (with some *F. quadrangulata*), *Ulmus rubra,* and *Acer saccharum* also occur. Other trees are *Juglans nigra, Carya ovata,* and, less often, *C. laciniosa. Cercis canadensis* and *Ostrya virginiana* occur in the understory. *Lonicera maackii*

remains frequent, though less than in younger stands, and *L. japonica* patches occur in more open areas. Herb cover is greater than in young red cedar stands and is highly variable in composition. Locally abundant species include *Delphinium tricorne, Senecio obovatus, Aster shortii,* and *Elymus villosus.* Other species present are *Anemonella thalictroides, Ranunculus micranthus, Claytonia virginica, Viola sororia, Geum canadense, Trillium sessile,* and *Liparis liliifolia.*

SUCCESSIONAL FOREST ON MOIST SITES WITH GENTLER SLOPES

This habitat (D in Figure 2 and Table 1) occurs widely on deeper soils in the McAfee series and locally on shallower soils of north- to east-facing slopes. Most canopy trees are only 25-75 years old, and the forest has probably been much disturbed by partial cutting and grazing. Three types can be distinguished.

***Robinia-Prunus* Forest and Transitions (D1).** This vegetation type generally has canopy trees no more than 20-40 cm dbh and about 30-50 years old. *Robinia pseudoacacia* is an abundant invader, both by seed and by root sprouts from forest edges and isolated trees. *Prunus serotina* is generally present though rarely abundant. Also common in some areas are *Juglans nigra, Ulmus americana, Celtis occidentalis, Fraxinus americana,* and *Gleditsia triacanthos. Aesculus glabra* is scattered in the understory. The smaller shrubs, *Symphoricarpos orbiculatus* and *Rubus* spp., and the vines, *Parthenocissus quinquefolia* and *Vitis vulpina,* are common in places. *Elymus villosus* is generally abundant. Also frequent are *Phytolacca americana, Stellaria media, Geum canadense, G. vernum, Viola papilionacea, V. striata, Lamium purpureum, Phacelia purshii, Galium aparine, Aster ontarionis,* and *Panicum clandestinum.*

***Juglans-Celtis-Fraxinus* Forest (D2).** This forest generally has larger trees, up to 50-70 cm dbh, and appears older or less frequently disturbed than the preceding type (D1). While *Juglans nigra* and *Celtis occidentalis* are the dominant trees, other frequent trees include *Fraxinus americana, Ulmus rubra, U. americana, Quercus muehlenbergii, Q. shumardii, Carya laciniosa, Prunus serotina, Robinia pseudoacacia,* and *Acer negundo. Aesculus glabra* and *Gymnocladus dioicus* are occasionally present. *Acer nigrum* and *A. saccharum* are generally absent in the canopy but often common in the understory. The exotic shrub, *Lonicera maackii,* is frequent in some areas, more so than in the *Robinia-Prunus* forest. *Symphoricarpos orbiculatus* is less abundant, and *Rubus* spp. are generally absent. The herb layer is generally dominated by *Elymus* spp., especially *E. villosus. Chaerophyllum procumbens, Cryptotaenia canadensis,* and *Osmorhiza longistylis* are also frequent. The flora combines several species characteristic of both *Robinia-Prunus* (D1) and *Acer nigrum* (F1) forest types.

Mixture with *Juniperus* Forest (D3). In several areas, successional forest with *Robinia, Prunus, Juglans,* and *Celtis* has an admixture of *Juniperus* and *Gleditsia,* the latter two being common, grazing-resistant pioneers in abandoned pastures of this region. *Lonicera* spp. are frequent, as in stands dominated by *J. virginiana. Elymus villosus* remains abundant, but in some areas, *Eupatorium rugosum,* a grazing-resistant species (Bratton, *et al.,* 1982), is abundant, and *Campanula americana* is frequent.

MATURE FOREST ON DRY (SUBXERIC) SITES

These sites (E in Figure 2 and Table 1) are on steeper, south- to west-facing slopes and on some upper slopes or narrow ridges with other aspects. Succession on regional sites often involves shifts from subxeric to mesic forest types (Campbell, 1980, 1987). In particular, *Acer saccharum* can invade the subcanopy of some *Quercus-Fraxinus* forest within 50-100 years. The two primary types are the *Quercus-Fraxinus-Juniperus* forest (E1) and the *Quercus-Fraxinus-Acer saccharum* mixed forest (E2).

***Quercus-Fraxinus-Juniperus* Forest (E1).** On drier, southwest- to south-facing slopes, narrow ridges, and points, *Quercus muehlenbergii, Fraxinus quadrangulata,* and *Juniperus virginiana* are locally dominant. However, *Acer saccharum* is generally frequent in the understory. Other woody species include *Q. shumardii, F. americana, Ostrya virginiana,* and *Viburnum rafinesquianum.* On steeper slopes, additional woody plants include *Ulmus thomasii* and *Staphylea trifolia.* In the variable herb layer, frequent species include *Thalictrum dioicum, Solidago ulmifolia, Polygonatum biflorum, Erythronium albidum, Elymus hystrix, Diarrhena americana, Poa cuspidata, Bromus pubescens, Muhlenbergia sobolifera,* and *Carex* spp. (especially Section *Montanae*). Also typical are *Arenaria patula, Euphorbia commutata, Dodecatheon meadia, Aster shortii,* and *Solidago sphacelata.* On the dry upper slopes just north of the mouth of Raven Run Creek is *Ceanothus americanus, Zizia aptera, Frasera caroliniensis, Triosteum aurantiacum,* and *Helianthus microcephalus.* On gentler upper slopes, ridges, and points, or on ridge crests, additional woody species include *Carya ovata* and, on rocky ledges, *Lonicera dioica. Elymus hystrix* is abundant here, and more mesophytic species are often present, especially *Erythronium americanum, Hepatica acutiloba, Corydalis flavula, Saxifraga virginiensis,* and *Trillium sessile.*

Mixture of *Quercus-Fraxinus* and *Acer saccharum* Forest (E2). On many slopes, the forest is intermediate between the *Quercus-Fraxinus-Juniperus* type (E1) and the *Acer saccharum* type (F1). The variety in herbaceous composition is considerable. Typical mesophytic dominants, such as *Stellaria corei* and *Erythronium americanum,* are locally common. In some distinct areas, *Sanguinaria canadensis* and *Jeffersonia diphylla* are also frequent and appear to have spread within the past 15 years, especially upstream along the South Fork trail. Also frequent in this transition are *Hepatica acutiloba, Uvularia grandiflora, Euonymus obovatus, Silene virginica, S. caroliniana, Allium canadense* (in seeps or gullies), and species typical of drier forest. *Claytonia virginica* occurs occasionally, but virtually no *Asarum canadense, Isopyrum biternatum, Podophyllum peltatum, Sedum ternatum, Polymnia canadensis,* or *Allium tricoccum* are found.

MATURE FOREST ON MOIST (MESIC) SITES

This vegetation type (F in Figure 2 and Table 1) is concentrated on moist, steeper slopes, except for those with south- to southwest-facing aspects. Soils are shallow and mapped as rockland or the Fairmount soil series. Before settlement, similar forest may have occurred on gentler slopes above the ravines with soils of the McAfee series (see F2) and on a few bottomland terraces with soils of the Huntingdon series. However, the remaining forest on gentler slopes

has been disturbed, and most trees are less than 50 years old. The two main types are the *Acer saccharum* forest on steeper slopes (F1) and the *A. nigrum* forest on gentler slopes (F2).

***Acer saccharum* Forest on Steeper Slopes (F1).** The most mesic sites occur on north- to northeast-facing slopes below cliffs. *Acer saccharum* is generally dominant, though often intermixed with *A. nigrum.* Other woody species include *Tilia* spp., *Aesculus* spp., *Quercus rubra, Q. shumardii, Fraxinus americana, Ulmus rubra, Carya cordiformis, C. laciniosa, Celtis occidentalis, Juglans nigra, Carpinus caroliniana, Lindera benzoin,* and *Hydrangea arborescens.* Near cliffs and on drier aspects, an admixture of *Q. muehlenbergii, F. quadrangulata, U. thomasii,* and *Staphylea trifolia* often occurs. Abundant herbaceous species are generally *Stellaria corei* and *Erythronium americanum.* Frequent herbs, although occasionally locally abundant, include *Asarum canadense, Isopyrum biternatum, Dicentra canadensis, Claytonia virginica, Uvularia grandiflora, Allium tricoccum,* and *Carex albursina.* Occasional, though characteristic, herbs include *Cystopteris bulbifera, Stylophorum diphyllum, Dentaria diphylla, Cardamine douglassii, Viola pubescens, Phlox divaricata, Phacelia bipinnatifida, Erigenia bulbosa, Solidago flexicaulis, Trillium flexipes, Polygonatum pubescens, P. biflorum,* and *Smilacina racemosa.*

Within the *A. saccharum* forest on steeper slopes, the following five intergrading types may be recognized though they are often weakly defined.

1. On seeping slopes and transitions to floodplains, *Hydrangea arborescens* is particularly frequent along with patches of *Hydrophyllum canadense, Impatiens pallida,* and, occasionally, *Laportea canadensis.* More open or disturbed sites often have related species — *Hydrophyllum appendiculatum, Impatiens capensis, Boehmeria cylindrica, Pilea pumila,* and *Urtica chamaedryoides.* Also characteristic are *Athyrium pycnocarpon, Dicentra cucullaria,* and *Valeriana pauciflora.*
2. On steep, rocky sites well above seeps and floodplains, *Hepatica acutiloba* is locally abundant in addition to *Stellaria corei, Erythronium americanum, Sedum ternatum,* and other species noted in the general description (F2).
3. On steep, drier, rocky sites, especially on talus or fissured bedrock, *Quercus* spp., *Fraxinus* spp., and *Staphylea trifolia* are common. The ground layer is often dominated by *Polymnia canadensis*, with frequent *Dryopteris marginalis, Cystopteris protrusa, Hepatica acutiloba,* and *Allium tricoccum. Dentaria laciniata, Cardamine douglassii, Sedum ternatum, Saxifraga virginiensis,* and *Solidago flexicaulis* are occasional. *Erythronium* spp. are virtually absent, and less *Stellaria corei, Asarum canadense, Isopyrum biternatum,* and *Claytonia virginica* are found.
4. On gentler, convex slopes of low ridges, benches, and terraces with less unstable colluvium, occasional patches of *Podophyllum peltatum* occur, often with *Cystopteris protrusa* and *Polemonium reptans.* Other mesic species are similar except for a general absence of *Asarum canadense* and *Allium tricoccum. Fagus grandifolia* and *Liriodendron tulipifera*

may be concentrated on such sites, though these trees are infrequent to rare at Raven Run.

5. On gentler upland slopes generally in the transition to more disturbed forest on the broad ridges, *Carya cordiformis* and *Fraxinus americana* are common to locally abundant, and *Acer nigrum* is more frequent than *A. saccharum. Hydrophyllum macrophyllum* is a common to locally abundant addition to the herbaceous vegetation. Other frequent additions include grasses (especially *Elymus villosus, Bromus pubescens,* and *Poa sylvestris*), sedges (especially *Carex jamesii*), and *Bignonia capreolata.* Less *Stellaria corei* and a general absence of *Asarum canadense* and *Allium tricoccum* were noted.

***Acer nigrum* Forest (and Disturbed Variants) on Gentler Slopes (F2).** On deeper soils of the McAfee series, shade-tolerant *Acer nigrum* may be dominant, at least in the subcanopy. However, *Carya cordiformis* (and an occasional *C. laciniosa), Celtis occidentalis,* and *Juglans nigra* are frequently intermixed and probably increased due to past disturbance. Other trees include *Quercus muehlenbergii, Fraxinus americana* (and an occasional *F. quadrangulata*), *Ulmus rubra, U. americana, Aesculus glabra,* and *Gymnocladus dioica. Lindera benzoin* is frequent in less disturbed areas, and *Symphoricarpos orbiculatus* occurs in more disturbed areas. Herbaceous vegetation is highly variable, perhaps due to grazing in the past. Abundant species in less disturbed areas consist of *Stellaria corei* and *Hydrophyllum macrophyllum.* Abundant in some areas are *H. appendiculatum,* a biennial, and *Collinsia verna,* one of the few winter annuals in the mature mesic forests of eastern North America (Baskin and Baskin, 1983). In the early 1970s, *C. verna* was largely restricted to the Collinsia Creek watershed, but this species appears to have spread greatly since then. Also frequent are *Isopyrum biternatum, Delphinium tricorne, Sanguinaria canadensis, Polemonium reptans, Polygonatum biflorum, Trillium sessile,* and *Erythronium americanum.* Occasional species include *Cystopteris protrusa, Viola pubescens, V. sororia, V. striata, Tradescantia subaspera,* grasses (especially *Festuca subverticillata* and *Elymus villosus*), and sedges (especially *Carex albursina, C. laxiflora, C. blanda, C. jamesii,* and *C. oligocarpa*). Grasses and sedges are more common in disturbed areas, as are the additional annual species *Phacelia purshii, Chaerophyllum procumbens, Galium aparine,* and *Stellaria media.*

STREAMSIDE FOREST

Restricted to narrow alluvial strips on the Huntingdon soil series and its rocky variants, this community (G in Figure 2 and Table 1) includes frequent *Platanus occidentalis, Acer negundo, Lindera benzoin, Impatiens* spp., *Laportea canadensis, Boehmeria cylindrica, Pilea pumila, Polygonum* spp., and *Cryptotaenia canadensis,* usually mixed with species typical of adjacent slopes. A few creek bottoms near the river are 15-30 m wide and have many species in common with the forest on deeper upland soils. On the Kentucky River bank, *Acer saccharinum* replaces *A. negundo* among more abundant species, and less admixture of upland species occurs.

NOTES ON RARE PLANT SPECIES

Twenty-three of the species found at Raven run are rare in the Bluegrass Region, with only 1-10 records in most cases. The 10 species with "R" in parentheses after their names are rare in Kentucky as a whole (Warren, *et al.,* 1986; U.S. Department of the Interior, Fish and Wildlife Service, 1990). The additional 13 species are rare in the Bluegrass but are more frequent elsewhere in Kentucky. Some excluded species of marginal rarity still have biogeographic interest since they are restricted to the Palisades and other rocky areas near the Kentucky River in central Kentucky. These species include widespread Appalachian species at the edge of their range, such as *Aesculus flava, Poa cuspidata,* and *Silene rotundifolia,* as well as species of calcareous regions, such as *Ulmus thomasii, Ribes missouriense, Lonicera dioica,* and *Draba ramosissima* (Campbell and Meijer, 1989).

***Allium burdickii* (R).** Until Jones (1979) recognized *A. burdickii* as a species, this taxon was neglected or called a variety of the more common *A. tricoccum. Allium burdickii* has: 1) smaller overall size, with leaves averaging 2-4 cm wide versus 5-8 cm in *A. tricoccum*; 2) pedicels more erect (at about 30°-60° to the scape versus 60°-120°) and fewer (10-20 versus 30-50) in a smaller umbel; 3) earlier flowering, in late May-June when some old leaves are still present (*A. tricoccum* flowers in late June-July after the leaves have died down); and 4) a lack of anthocyanic pigmentation. Both taxa have north-central to Midwestern ranges, but *A. burdickii* is concentrated in the Midwest and in drier forest with *Quercus* in addition to *Acer saccharum.* In Kentucky, *A. burdickii* is known from at least 15 sites in seven north-central counties, all on limestone substrates. The two Raven Run sites are on moderately steep, mid-to-upper, north-facing slopes in *A. saccharum* forest with a *Quercus-Fraxinus* component, and above small cliffs south of the North Fork mouth of Raven Run Creek (near *Pachysandra procumbens,* see below). *Allium tricoccum* is much more abundant at Raven Run but occurs mostly on moister, lower slopes along larger creeks.

Aplectrum hyemale. This north-central species is infrequent on fairly moist, fertile soils in forested areas surrounding the Bluegrass. The only Bluegrass records are from Fayette (a 1990 collection, 2 km to the south, along Dry Branch) and Madison (1 mile north of Hines Creek) Counties. The single Raven Run plant was in young *Juniperus* woods on the upper, west-facing slope about 120 m northwest of the amphitheater.

Aureolaria flava. This north-central species is virtually unknown in the Bluegrass, though frequent on limestone in the surrounding Knobs Region and Mississippian Plateaus. In 1989, *A. flava* was found on dry slopes north of the mouth of Raven Run Creek.

Carex laxiculmis. This north-central species is frequent on moist, non-calcareous soils along small streams in regions surrounding the Bluegrass. The only Bluegrass collection is from the banks of Chandler Creek at Raven Run.

Carex plantaginea. The only certain Bluegrass record of this northern and Appalachian species is from Raven Run. Some 50-100 plants occur in two patches around low seeps and gullies on the cool northeast-facing slope between the Forks and Collinsia Creek in a forest with much *Acer saccharum* and *Allium tricoccum.*

Chimaphila maculata. This Appalachian species is frequent in woods on moist to dry, acid soil in Kentucky. The only Bluegrass records are from Jessamine (in cedars near the YMCA camp), Garrard (west of the US 27 bridge), and Fayette (H. Clay High School; Dry Branch; and Raven Run) Counties. At Raven Run, a few plants were found during the 1970s near the Red Trail above the South Fork in mixed *Quercus-Acer* forest. In 1989, only one plant could be found 1-2 m below a trampled area.

Goodyera pubescens. This eastern orchid is widespread in woods on dry to moist, acid soil in Kentucky. The only Bluegrass localities known to us are at Raven Run, Jessamine Gorge, and the Crawfort Farm in Anderson County. At Raven Run, plants have been seen along trails in mixed *Quercus-Fraxinus* and *Acer* forest near the Forks and at two places along Chandler Creek. No plants were found in 1989.

***Juglans cinerea* (R).** This north-central species has declined throughout much of its range during the past 100 years, apparently because of disease. Currently, *J. cinerea* is a candidate for federal protection. The species was formerly frequent in successional woods on moist soils of moderate fertility in Kentucky, but *J. cinerea* has now virtually disappeared from parts of the Bluegrass Region. At Raven Run, a few small trees had been seen since 1975 near the overlook and on the west-facing slope along the South Fork. However, these trees are now dead. A larger tree (ca. 40-50 cm dbh) was found in the 1970s along the North Fork below the solar house.

Lilium michiganense. This Midwestern species occurs infrequently in west-central Kentucky. The only Bluegrass records are from Jessamine and Fayette Counties. At Raven Run, a few plants were found in the 1970s and 1980s along the North Fork, just north of the Forks. The plants have not been relocated in recent years.

***Malvastrum hispidum* (R).** This largely Midwestern species is typical of rocky prairies and barrens and was recently made a candidate for federal protection (U.S. Department of the Interior, Fish and Wildlife Service, 1990). Kentucky records are primarily from the Inner Bluegrass. The only post-1960 Bluegrass collections known to the authors are from Raven Run in open areas with some *Juniperus,* probably near the upper trail northwest of the barn, and from Madison County opposite Clay's Ferry.

Monotropa uniflora. This non-photosynthetic species is widespread in woods on acid soils throughout most of Kentucky and much of North America. The only records from the Bluegrass Region are collections from Campbell and Grant Counties along with an observation at Raven Run. One clump of this species was seen along the main trail to the river overlook (south of the mouth of Collinsia Creek) in 1989. The forest is dominated by *Quercus-Fraxinus* and *Acer* with frequent *Carya ovata. Orobanche uniflora,* also rare within the Bluegrass Region, was observed earlier in the 1980s on this same trail closer to the overlook and on the southwest face along Raven Run Creek.

***Onosmodium hispidissimum* (R).** This largely Midwestern species has been listed as "endangered" in Kentucky (Warren, *et al.,* 1986). Five records are known from the Bluegrass Region. The population at Raven Run, discovered in 1987 (M. Bender, pers. comm.), is south of the field with powerlines near an old fencerow of *Juniperus virginiana, Prunus serotina, Ulmus americana, Quercus*

muehlenbergii, and *Vitis vulpina.* About 15 plants are scattered along 10 m of an old road bed (1-3 m southeast of the fencerow) in thin vegetation on rather dry ground that has been compacted and eroded. The dominant species is *Trifolium campestre*; others include *Poa pratensis* (ssp. *angustifolia*?), *Monarda fistulosa, Solidago altissima, Achillea millefolium, Melilotus officinalis, Chrysanthemum leucanthemum, Ipomoea pandurata, Dianthus armeria, Desmodium perplexum, Fragaria virginiana, Symphoricarpos orbiculatus,* and *Rhus aromatica.* A second patch of about 12 plants occurs in similar vegetation about 120 m to the west.

Pachysandra procumbens. This southeastern species, common in woods on moist, fertile soil (especially on limestone), reaches its northern limit on a line running from southern Indiana (Harrison County) to central Kentucky (Fayette County). Four sites are known in the southern Bluegrass and Knobs Regions (including Jefferson, Jessamine, and Garrard Counties). At Raven Run, *P. procumbens* occurs on lower north-facing slopes above the old mill site. The species is reported to sometimes escape from cultivation (Fernald, 1950). However, the plants here occur in a mature *Acer saccharum* forest with virtually no exotics. Several patches, totaling at least 100 m^2, are scattered within a zone 30 m wide and 150 m along the slope. Although some plants near the trail above the old mill were trampled out since 1980, the whole population appears larger than 10-15 years ago. Several patches of *Allium burdickii* occur near *P. procumbens.*

Panax quinquefolium. This north-central species was once widespread in woods on moist, moderately fertile soils in Kentucky before harvesting greatly reduced the population. Only three Fayette County reports are known from the past 20 years — at Henry Clay High School, Boone Creek, and Raven Run, where a plant was found in 1983 just south of the mouth of Chandler Creek.

Panicum anceps. This south-central species is widespread in fields having acid soils in Kentucky. The three Bluegrass records are from Fayette, Madison, and Shelby Counties. At Raven Run, two 1-3 m^2 patches were found along mowed paths across the central field.

***Prenanthes crepidinea* (R).** This species appears to be rare throughout its Midwestern range and deserves study for federal listing. In Kentucky, recent records occur from only five counties: Rockcastle, Estill, and Leslie (Campbell, *et al.,* 1993) as well as Graves and Fayette. C.W. Short and R. Peter collected *P. crepidinea* during the 1830s in thickets near Lexington. The species was rediscovered in 1979 at Raven Run, and 100-200 plants occur on south-to east-facing wooded slopes just above the steepest rocky section of Collinsia Creek. The mixed hardwood forest with *Acer nigrum* dominant is relatively mesic but with a few subxeric species present. A feature of this population in recent years is that all leaves and stems die down in July without flowering. However, flowering was observed in 1979. Roots transplanted in 1989 from Raven Run to rich garden soil in full sun produced 1½-2 m tall flowering stems and abundant seed in August-October of 1991.

***Prunus virginiana* (R).** In Kentucky, this widespread northern species is near its southern limit, and only about 10 localities are known, mostly along the Palisades. In Fayette County, R. Peter collected *P. virginiana* in 1834 on the banks of North Elkhorn Creek near Paris Pike (MacFarlane, 1979), but the only currently known locality is Raven Run. Ten patches were found on the crest of northwest- to northeast-facing cliffs along Raven Run Creek and its South Fork,

and one patch was found on the dry, east-facing clifftop north of the mouth of Raven Run Creek. Each patch contains 10s to 100s of stems, covers 10-100 m^2, and may be a single clone connected by roots. The forest is generally dominated by *Acer nigrum* or *A. saccharum* with *Fraxinus quadrangulata* and *Quercus muehlenbergii* on the drier sites. The ground vegetation is mostly typical for *A. saccharum* forest with abundant *Hepatica acutiloba* and *Podophyllum peltatum.*

***Solidago harrisii* (R).** This broad-leaved goldenrod occurs in open rocky woods on limestone or shale and is best known from the shale-barrens region in the Ridge and Valley Province. *Solidago harrisii* was recently discovered in Kentucky (Estill, Powell, Rowan, and Morgan Counties) on limestone at the edge of the Appalachian Plateau (Campbell, *et al.,* 1989, 1993). At Raven Run, several plants were found on the upper slopes of the southeast-facing point just north of the mouth of Raven Run Creek.

***Solidago rupestris* (R).** This east-central species, largely restricted to riverbanks with exposed limestone, is locally frequent along the Kentucky River in the Bluegrass Region. Just north of the mouth of Raven Run Creek, several plants were found on rocky banks in brushy to grassy vegetation.

Spiranthes ovalis. This orchid occurs widely in woodland on moist, fertile soil in the south-central States but has been found in only 10 Kentucky counties. Two known Bluegrass localities are at Jessamine Gorge and Raven Run, where about seven plants were found along the trail 300 m west of the river overlook in the early 1980s. In 1989, *S. ovalis* could not be found there, but one plant was found on the trail from the barn to Chandler Creek. Both sites were in relatively young *Juniperus* or *Juglans-Celtis* forest, and the plants occurred 0.2-2 m from the trail. Like some other orchids, this species may be favored by disturbance along the trail-side vegetation.

***Synandra hispidula* (R).** This east-central species has recently been dropped as a candidate for federal protection. Kentucky is at the center of its range, and a cluster of records is known from ravines along the Kentucky River. One population has been found at Raven Run on a steep north-facing slope along Raven Run Creek. About 50 flowering plants were seen in 1989. This species is biennial, and whole populations tend to flower in alternate years (Baskin, *et al.,* 1986). The forest at this site is relatively mature, dominated by *Acer nigrum,* but includes *Aesculus glabra, A. flava, Juglans nigra, Quercus shumardii, Q. rubra,* and *Lindera benzoin. Carex plantaginea* (discussed above) occurs on slopes directly below the *Synandra.*

Tipularia discolor. This south-central species is widespread on moderately dry, acid soil in Kentucky forests. The few Bluegrass records are all from the Palisades section, in Jessamine (Jessamine Gorge, Indian Falls), Madison (Hines Creek) (Martin, *et al.,* 1979), and Fayette Counties (Raven Run). At Raven Run, scattered plants (ca. 10-20 during the 1980s) have been observed along several trails on the upper north-facing slopes; i.e., 30-300 m west of the river overlook, along the mid-slope trail 100 m south of the forks (Old Mill), and in a young forest northwest of the barn.

***Viburnum molle* (R).** This Midwestern species has been reported from about 10 Kentucky counties, mostly in limestone ravines along the Kentucky River within the Inner Bluegrass Region. Population density is generally

low. At Raven Run, only one plant was found on the crest of a small, low, northeast-facing cliff along Raven Run Creek.

DISCUSSION

Floristic Comparison with Other Palisades' Areas. Raven Run is in the outlying eastern section of the Kentucky River Palisades between Valley View and Boonesboro. This section is in the strictly defined Inner Bluegrass on Lexington Limestone and High Bridge rocks. Both up- and downstream, the bedrock is primarily the Clay's Ferry Formation of the Eden Shale Belt and is without cliffs. The only other Palisades ravine, whose vascular flora has been extensively surveyed, is Jessamine Gorge (Campbell and Meijer, 1989), which lies in the central Palisades with particularly high cliffs of the High Bridge Group.

Of the 541 vascular plant species found at Raven Run (including adjacent ravine slopes), over 90% were also found at Jessamine Gorge (Campbell and Meijer, 1989). Despite the similarity in the flora of the central and eastern Palisades, many of the rarer species reported from the central Palisades, especially those of extreme or unusual habitats, are unknown at Raven Run, including *Cerastium arvense* L., *Cladrastis lutea* (Michx. f.) Koch, *Hypericum sphaerocarpum* Michx., *Melica nitens* Nutt., *Oryzopsis racemosa* (Smith) Ricker, *Paxistima canbyi* Gray, *Phlox bifida* Beck, *Schizachne purpurascens* (Torr.) Swallen, *Trillium nivale* Riddell, *Waldsteinia fragarioides* (Michx.) Tratt., and *Viola walteri* House. Of these, only *O. racemosa, S. purpurascens,* and *V. walteri* have been reported in the eastern Palisades at Boone Creek. Also virtually unknown in the eastern Palisades are some species of the central Palisades which occur on low terraces (e.g., *Iris cristata* Ait., *Meehania cordata* (Nutt.) Britton, and *Monarda clinopodia* L.) and on high terraces, ridges, and blufftops (e.g., *Aster macrophyllus* L., *Hydrastis canadensis* L., *Pedicularis canadensis* L., *Perideridia americana* (Nutt.) Reichb., *Quercus falcata* Michx., and *Veronicastrum virginicum* (L.) Farw.). Among rare species more widely scattered in the Palisades, *Sagina fontinalis* Short & Peter is notably absent at Raven Run, though suitable habitat exists on some mossy seeps.

In contrast, several species from the Raven Run area are essentially unknown in the central Palisades. Some are rare in the Bluegrass but frequent in Appalachian Kentucky or other regions with more acid soils (e.g., *Aplectrum hyemale, Carex laxiculmis, C. plantaginea, Chimaphila maculata,* and *Panicum anceps).* In addition, two species at Raven Run, *Aureolaria flava* and *Solidago harrisii,* are typical of dry calcareous woods in the Eastern Knobs. The presence of these species in the more eastern Palisades area might reflect shorter dispersal distances from Appalachian regions. *Malvastrum hispidum, Onosmodium hispidissimum,* and *Prenanthes crepidinea,* which occur on upper slopes and ridges at Raven Run but are unknown in the central Palisades, may be relics of open woods, grasslands, or glades on uplands' Lexington Limestone.

Comparison of Forest Vegetation. Shifts in dominant species and average forest composition along the Palisades are probably minor (Martin, *et al.,* 1979; Campbell and Meijer, 1989). However, because of its more rugged and varied topography, Jessamine Gorge has more unusual or extreme soils. Forest types that are better developed there include: *Fagus-Liriodendron* on acid terraces and benches; *Quercus alba-Carya ovata* on infertile ridges and blufftops; and brushy

open *Quercus muehlenbergii-Fraxinus quadrangulata-Juniperus* on xeric, narrow, dolomitic points. Compared to Jessamine Gorge, Raven Run has a larger proportion of forest on deeper soils, because the Sanctuary extends further up onto broader ridges. Although generally no more than 50 years old, the ridge forest at Raven Run will ultimately provide an opportunity to compare the undisturbed vegetation on deep soils of the Inner Bluegrass plains (Maury and McAfee series) with that on shallow soils of the Palisades (Fairmount and shallower McAfee). This edaphic gradient had no clear shift in mesic versus subxeric vegetation before settlement (Campbell, 1980, 1987). On the plains prior to settlement, subxeric forest, dominated by *Quercus, Fraxinus,* and *Carya,* occurred only in the putative fire-maintained, savanna-like woodlands (Bryant, *et al.,* 1980), while in the Palisades, these genera tend to dominate only on south- to west-facing slopes and ridgetops (Martin, *et al.,* 1979).

Of particular interest are the changes that occur among species of mature mesophytic forest from deep residual soils typical of the plains to shallow colluvial soils typical of the ravines. In addition to the current survey, the following comparisons include observations from previous studies (Campbell, 1980, 1989; Campbell and Meijer, 1989). On deeper soils, abundant trees include *Acer nigrum* (locally dominant), *Carya cordiformis* (often codominant), *Celtis occidentalis, Ulmus americana, Juglans nigra, Aesculus glabra, Gymnocladus dioica,* and *Quercus macrocarpa* (rare at Raven Run). Abundant trees on shallower soils include *Acer saccharum* (dominant), *Quercus rubra* (often codominant), *Q. muehlenbergii, Aesculus flava, Tilia* spp., and *Ulmus rubra.* More widely distributed trees include *Q. shumardii* and *Fraxinus americana.* Abundant forest herbs with peak abundance on deeper soils include *Cystopteris protrusa, Viola papilionacea, V. striata, Osmorhiza longistylis, Chaerophyllum procumbens, Phacelia purshii, Hydrophyllum macrophyllum, Polymnia uvedalia, Eupatorium rugosum, Polygonatum canaliculatum, Camassia scilloides, Festuca subverticillata, Poa sylvestris, Elymus* sp. nov. (Brooks), *Carex blanda, C. jamesii,* and *C. oligocarpa.* Those abundant on shallower soils include *Dryopteris marginalis, Cystopteris bulbifera, Asarum canadense, Hepatica acutiloba, Viola sororia, V. pubescens, Osmorhiza claytonii, Phacelia bipinnatifida, Hydrophyllum canadense, Polymnia canadensis, Solidago flexicaulis, Polygonatum pubescens, Allium tricoccum, Elymus villosus, Carex careyana, C. albursina, C. laxiflora,* and *C. communis.* Widespread species in both forest types include *Stellaria corei, Erythronium americanum,* and *Polygonatum biflorum.* A similar edaphic gradient may be evident in early forest succession. Whether this vegetational gradient from steep to gentle slopes is due to direct edaphic factors, or whether there are complicating indirect relationships with microclimate (e.g., more humidity in the ravines), hydrology (e.g., more seeps in the ravines), herbivores (e.g., more grazing, trails, and burrows on deeper soils), or other disturbances (e.g., more tree falls in the ravines) needs further research.

While this gradient includes several intrageneric species shifts, few clear shifts occur among higher taxa or life-forms. However, most spring-flowering winter annuals in Bluegrass woodlands are typical of deeper mesic soils (i.e., *Stellaria media, Lamium purpureum, Galium aparine, Urtica chamaedryoides, Corydalis flavula, Phacelia purshii, Chaerophyllum* spp., *Collinsia verna,* and *Valerianella* spp.). Only a few of these species extend to shallower soils,

sometimes mixing with the few winter annuals of rocky openings (e.g., *Sedum pulchellum* and *Arenaria patula*) and summer annuals of disturbed areas (e.g., *Parietaria pensylvanica, Cuphea viscosissima,* and *Torilis arvensis*). In contrast, most biennials (e.g., *Phacelia bipinnatifida, Hydrophyllum appendiculatum,* and *Synandra hispidula*) and monocarpic species of more variable age (e.g., *Campanula americana, Polymnia canadensis, Arabis laevigata,* and *Frasera caroliniensis*) are most frequent on shallower mesic to subxeric soils, and some mix with the summer/fall annuals of seeps and floodplains (e.g., *Pilea pumila, Impatiens* spp., *Polygonum* spp., and *Microstegium vimineum*). The exotic biennial, *Alliaria petiolata,* is exceptional, occurring widely on deeper upland soils. Although several monocarpic woodland species have been studied (Baskin and Baskin, 1975, 1979a, 1984; Bender, 1991; Bloom, 1988), why most of them are more frequent on the calcareous soils of central Kentucky, rather then on acid Appalachian soils, is not known. Favorable factors for success in deciduous forests on fertile calcareous soils might be greater light and/or nutrient levels during the winter as well as the fluctuating impacts of herbivores. Longer-lived monocarpic species may respond greatly to variation in water supply from year to year (Bender, 1991; Bloom, 1988).

Old-Field Succession. Old-field succession in east-central States includes the following general features (Bard, 1952; Bazzaz, 1968, 1975; Drew, 1942; Inouye, *et al.,* 1987; Keever, 1950, 1979, 1983; Odum, 1960; Oosting, 1942; Pickett, 1982; Quarterman, 1957; Thomson, 1943; Tilman, 1987).

1. During the first 1-5 years, annuals are frequent. These annuals include a few native Asteraceae (i.e., *Ambrosia* spp., *Bidens* spp., and *Erigeron* spp.); several Poaceae, mostly warm-season and exotic (i.e., *Panicum* spp., *Aristida* spp., *Setaria* spp., *Digitaria* spp., *Cynodon dactylon* (L.) Pers., and *Bromus* spp.); Brassicaceae, mostly exotic (i.e., *Barbarea* spp., *Brassica* spp., *Cardamine* spp., *Draba* spp., and *Lepidium* spp.); Caryophyllaceae, mostly exotic (i.e., *Stellaria* spp., *Cerastium* spp., and *Holosteum umbellatum*); a few exotic Fabaceae (i.e., *Melilotus* spp. and *Lespedeza* spp.); and others (i.e., *Oxalis* spp., *Ipomoea* spp., *Lamium* spp., *Plantago* spp., *Diodia* spp., *Mollugo verticillata, Amaranthus* spp., and *Chenopodium* spp.).
2. During the years 2-10, monocarpic species and competitively inferior biennials and perennials reach their greatest abundance. Included in this group are several Asteraceae (i.e., *Cirsium* spp., *Carduus* spp., *Chrysanthemum* spp., *Gnaphalium* spp., *Hieracium* spp., *Aster pilosus,* and *Solidago nemoralis*) and others (i.e., *Trifolium* spp., *Fragaria* spp., *Potentilla* spp., *Rumex* spp., *Oenothera* spp., and *Daucus carota*).
3. During years 5-20, tall perennials are dominant along with a few exotics. Common species include several Asteraceae (i.e., *Solidago* spp., *Aster* spp., *Vernonia* spp., *Verbesina* spp., *Eupatorium* spp., and *Helianthus* spp.), Poaceae (i.e., *Andropogon* spp., *Sorghastrum* spp., *Sorghum* spp., *Panicum* spp., *Tridens flavus, Agrostis* spp., and *Poa* spp.), and Fabaceae (*Desmodium* spp. and *Lespedeza* spp.). Most woody pioneers have fleshy fruit or small wind-dispersed seeds, and many spread clonally.

The old fields at Raven Run generally conform to this pattern with *Solidago altissima* and other tall Asteraceae dominant in later stages. However, several species typical of old fields on poorer soils are uncommon or absent at Raven Run. These include *Diodia virginiana* L., *Aristida* spp., *Lespedeza* spp., *Sorghastrum nutans, Andropogon* spp. (except *A. virginicus,* which does occur on poor soil at Raven Run), *Sassafras albidum, Diospyros virginiana* L., and *Pinus* spp. Some of these species might be more common at Raven Run if dry, infertile, and eroded fields had not been so extensively reclaimed by young forest of *Juniperus.* These suggested relationships between old-field composition and soil fertility deserve more study on a regional scale. For example, there is much similarity (e.g., in abundance of Ulmaceae) between the Bluegrass Region of Kentucky and the Central Basin of Tennessee, which has similar phosphatic limestone and high soil fertility (Quarterman, 1957).

Some common exotic weeds of the Bluegrass Region are notably absent or infrequent in the Raven Run fields, including some tap-rooted, short-lived, monocarpic perennials (i.e., *Conium maculatum, Pastinaca sativa, Dipsacus fullonum,* and *Carduus nutans*). In contrast, these perennials are locally abundant on nearby roadsides, where they may be favored by more frequent disturbance (McCarty and Scifres, 1969; Baskin and Baskin, 1979b, 1990). The only frequent monocarpic perennials in the fields of Raven Run are *Daucus carota* and *Cirsium discolor.*

Invasive Exotic Species. About 112 of the 541 vascular species at Raven Run are exotic to North America. Most are restricted to fields, where several are abundant (e.g., *Festuca elatior, Poa pratensis, Dactylis glomerata, Phleum pratense, Bromus japonicus,* and *Trifolium campestre*) or frequent (e.g., *Melilotus officinalis, Potentilla recta, Daucus carota, Dianthus armeria, Chrysanthemum leucanthemum,* and *Achillea millefolium*). Much *Poa pratensis* in this region has Old World origins, but the abundant form with narrower leaves found at Raven Run may be the native taxon called *Poa angustifolia* by Fernald (1950).

A few herbaceous exotics occur more frequently in woody communities than in the open fields. These include *Microstegium vimineum, Ornithogalum umbellatum, Lamium purpureum, Glechoma hederacea, Duchesnea indica, Alliaria petiolata,* and *Stellaria media.* These herbaceous exotics are generally restricted to young or disturbed forests, thickets, and trailsides. However, the annual *Microstegium* and biennial *Alliaria* have invaded mature forests in several regions of Kentucky during recent decades, and these species will probably continue to increase in the Inner Bluegrass. *Microstegium* is widely scattered at Raven Run on moist trails and streambanks, especially the South Fork. *Alliaria* is abundant along the Kentucky River downstream from the central Palisades section and in northern Kentucky. Though uncommon at Raven Run, several plants have been seen along stream banks and the new paved trail.

The most abundant exotics in the woods at Raven Run are the following shrubs and vines.

Lonicera maackii. This northeast Asian species has become the major exotic shrub of the Bluegrass Region since 1950 (Luken, 1988). *Lonicera maackii* is widespread at Raven Run in successional forests but much less frequent in older forest, where dense shade is provided by *Acer saccharum, Fraxinus* spp., and other trees.

Lonicera japonica. This Asian vine is abundant in Kentucky. At Raven Run, *L. japonica* is locally dominant in older fields and in the open parts of younger woods. The species is less frequent in forest with a continuous tree canopy.

Euonymus fortunei. This Japanese vine has spread into parts of the Bluegrass since 1950. At least five patches, 5-25 m^2, occur at Raven Run. Although not yet as widespread in this region as *Lonicera* spp., *E. fortunei* appears more shade-tolerant and persistent in older forest.

Hedera helix. This vine from western Europe is not widespread in Kentucky, but it has formed large patches on some rocky slopes, especially with limestone cliffs. At Raven Run, three dense, spreading patches totaling at least 1000 m^2 occur on moist, shady cliffs and lower slopes near the river. Almost all native ground vegetation has been excluded from these patches.

Less frequent woody exotics include the shrubs, *Rosa multiflora, Euonymus alatus,* and *Rhamnus citrifolia* as well as a tree, *Populus alba.* These exotics are mostly restricted to thickets and forest edges. *Populus alba* has formed a sprouting clone at the edge of the northern field, but most of another clone in young forest (northwest of the barn) has died.

The woody exotics at Raven Run are evergreen, except for *Lonicera maackii,* which is leafless for only 4-5 months. In contrast, the calcareous regions of Kentucky have virtually no native evergreen woody plants except for *Juniperus virginiana* and the facultative evergreen, *Bignonia capreolata* (Campbell, 1980, 1987). This poses an interesting biogeographic question: "Is the paucity of native evergreens a historical accident with Old World species filling previously empty ecological niches, or were ecological factors (possibly eutrophic soils, winter browsing, or fire) inimicable to evergreen species before settlement?" Under current conditions, whether these exotics will persist or perhaps increase in number as the forest ages is unknown, but some appear to pose serious, long-term, competitive threats to the native vegetation. To restore stands of native vegetation may require continual eradication of such exotics.

SUMMARY OF THE OVERALL SIGNIFICANCE OF RAVEN RUN AS A NATURAL AREA

The Raven Run Nature Sanctuary is an excellent area for the preservation and restoration of the native vegetation of the Inner Bluegrass and for related educational and research activities for the following reasons:

1. The 375 acre area is owned by the Lexington-Fayette Urban-County Government and managed primarily for natural qualities. Raven Run is the only permanently protected natural area in Fayette County, other than the nearby Elk Lick Falls area.
2. Twenty-three species found at Raven Run are rare in the Bluegrass Region or, in some cases, throughout Kentucky. These species provide subjects for research on habitat specializations and population dynamics.
3. A diversity of forest types is represented from floodplains, to moist and dry slopes, to broad ridges. Much of the area has been logged, grazed, or farmed in the past, but some of the steeper slopes are dominated by species typical of the inferred climax condition.

4. The ridges have some unusually mature old fields dominated by native herbs, though pasture grasses and exotics are frequent. Two important ecological questions concerning these old fields are (1) whether they are similar to areas disturbed by ungulates and humans before settlement and (2) whether management tools, such as fire, can reduce the proportion of exotic to native species.

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