

### SECTION III. VEGETATION OF KENTUCKY

At the time of settlement it has been estimated that forests covered about 90–95% of Kentucky, with barrens and other open communities occurring on about 5–10% of the land (Taylor 1958). This vegetation pattern has changed greatly since settlement, primarily from frequent logging, mining, repeated burning, and grazing. Today Kentucky is about 50% forested, and the original barrens have virtually disappeared.

Recent references with information on the vegetation of Kentucky include: for North America—Barbour & Christensen (1993); for southeastern U.S—Martin et al. (1993a,b), Hackney et al. (1993), and Weakley et al. (1998); and for Kentucky—Taylor (1995) and Ulack et al. (1998). Older references providing overviews of Kentucky's vegetation include: Baskin et al. (1987), Braun (1950), Kingsley & Powell (1978), and Küchler (1964). The Kentucky State Nature Preserves Commission (KSNPC) has published numerous volumes on the vegetation and natural communities of various sections of the state (for a listing see Taylor 1995).

Selected references for the vegetation of particular physiographic provinces are as follows: Appalachian Plateaus—Harker et al. (1979), Hinkle et al. (1993), Martin (1987), Smalley (1984, 1986); Interior Low Plateaus—Bryant et al. (1993), Quarterman & Powell (1978); Mississippi Embayment—Bryant & Martin (1988), Heineke (1987), Hendricks et al. (1991), Medley (1987), and Sharitz & Mitsch (1993).

Other references for specific sections of these physiographic provinces include the following: Bluegrass—Bryant (1987), Campbell (1980, 1985, 1987), Martin et al. (1979), Wharton & Barbour (1991); Knobs—Harker et al. (1981), Muller (1987), Muller & McComb (1986), and Wharton (1945); Shawnee Hills—Conrad (1972), Evans (1987), Harker et al. (1980); Highland Rim—Smalley (1980, 1983), and Winstead (1987). For papers on the Highland Rim of Tennessee see Chester (1989). In addition there is a series of reports on the rare species and plant communities of the Daniel Boone National Forest (see Taylor 1995 for a listing). For a series of popular accounts of the natural regions of Kentucky see Campbell (1996a,b, 1997a,b, 1998a,b, 1999, 2000a,b).

#### FOREST REGIONS OF KENTUCKY

Publications by Braun (1950) and Küchler (1964) are generally considered to be the foundation for modern forest region classification in the eastern United States. A recent account of North American vegetation (Barbour & Christensen 1993), based on a more modern synthesis of ideas, still very much follows the general conclusions of Braun and Küchler with reference to Kentucky, recognizing three major forest regions in Kentucky, all associated with physiographic provinces. Küchler (1964) defined these three regions as: the Mixed Mesophytic Forest Region of the Appalachian Plateaus, the Oak-Hickory Forest Region of the Interior Low Plateaus and eastern uplands of the Mississippi Embayment, and the Southern Floodplain Forest Region along the Mississippi Bottoms of the Mississippi Embayment (Figure 4).

Note: only the common names of trees, shrubs, and woody vines are used in the following discussion as well as in the section on Plant Communities—the scientific names

for these woody plants can be found in Tables 5 and 6. Common and scientific names are given for most of the herbaceous species in the discussion.

#### **Figure 4. Forest Regions of Kentucky and the southeastern United States.**

##### **MIXED MESOPHYTIC FOREST REGION**

This forest region, closely associated with the Appalachian Plateaus, extends from southwestern Pennsylvania to north-central Alabama, crossing the eastern third of Kentucky. It is characterized by a rich overstory dominated by a mixture of deciduous tree species including American beech, cucumber magnolia, oaks (white, red), sugar maple, tuliptree, and white ash, as well as eastern hemlock, an evergreen species. Big-leaf and umbrella magnolias are often present in the understory. White basswood and yellow buckeye are nearly always present and serve as indicator species for this forest type. The subcanopy and herbaceous layers are astoundingly rich in species richness, especially in flowering shrubs and spring wildflowers. The central regions of the Appalachians are widely considered to possess the most biologically rich forests of any region in the U.S.; this forest once reached its best development on the rich, mesic slopes and coves of eastern Kentucky.

Braun (1950) recognized a number of forest communities as “association-segregates” of the Mixed Mesophytic Forest Region. These included red maple and black gum forests on flat, poorly drained plateaus; hemlock, oak-beech, oak-hickory on lower slopes; maple-basswood-buckeye on higher, more mesic sites; and various oak and oak-pine communities on drier ridges and slope. One species, the American chestnut, now greatly diminished by the chestnut blight, was common and often dominant throughout many of the upland communities.

##### **OAK-HICKORY FOREST REGION**

This forest region extends over a large portion of the south-central United States and is associated with the Interior Low Plateaus, the Interior Highlands, and portions of the Coastal Plain, including parts of Kentucky, Tennessee, Alabama, Mississippi, and Arkansas. In Kentucky it extends from the western boundary of the Appalachian Plateau, across central Kentucky, to the uplands of the Jackson Purchase. These forests are characterized by mixtures of tree species, especially oaks (black, red, white), and hickories (bitternut, pignut, shagbark), as well as American elm, American basswood, black cherry, black walnut, and white ash. This forest type includes many limestone-associated species (calciphiles) that are absent or uncommon in the eastern regions of the state, such as bur oak, chinkapin oak, Kentucky coffeetree, and rock elm. Lacking are the characteristic Appalachian species such as eastern hemlock, magnolias, sweet birch, white basswood, and yellow buckeye. (These species are present at a few scattered sites across central and western Kentucky). In the uplands of the Mississippi Embayment, woodlands are highly diverse, being mostly oak-hickory, but with some Appalachian-type communities

with American beech, cucumber magnolia, and tuliptree on the slopes of the loess hills. A few remnant barrens sites exist across the province, and barrens species can occasionally be found along roadsides and in old fields.

#### **SOUTHERN FLOODPLAIN FOREST REGION**

This forest region occurs along the major river drainages that eventually empty into the Gulf of Mexico or the Atlantic Ocean. These forests in Kentucky are therefore restricted to the floodplains of the Mississippi River and tributaries. Few extensive forests now exist in this lowland region. There are still occasional stands of bottomland hardwoods, typically dominated by oaks (cherrybark, overcup, swamp chestnut, willow), sugarberry, and sweetgum. Deep water swamps include scattered communities of bald-cypress and tupelo gum.

**Table 5. Scientific names for tree species mentioned in the Introductory sections.**

ash,  
blue (*Fraxinus quadrangulata*)  
green (*F. pennsylvanica*)  
pumpkin (*F. profunda*)  
white (*F. americana*)

basswood,  
American (*Tilia americana*  
*var. americana*)  
white (*Tilia americana var.*  
*heterophylla*)

beech,  
American (*Fagus*  
*grandifolia*)

birch  
river (*Betula nigra*)  
sweet (*B. lenta*)  
yellow (*B. allegheniensis*)

buckeye,  
Ohio (*Aesculus glabra*)  
yellow (*A. flava*)

cherry,  
black (*Prunus serotina*)

coffeetree,  
Kentucky (*Gymnocladus*  
*dioicus*)

cottonwood,  
eastern (*Populus deltoides*)  
swamp (*P. heterophylla*)

cypress,  
bald (*Taxodium distichum*)

elm,  
American (*Ulmus americana*)  
red (*U. rubra*)  
rock (*U. thomasi*)

gum,  
black (*Nyssa sylvatica*)  
tupelo (*N. aquatica*)

hackberry  
(*Celtis occidentalis*)

hemlock  
eastern (*Tsuga canadensis*)

hickory,  
bitternut (*Carya cordiformis*)  
mockernut (*C. tomentosa*)  
pecan (*C. illinoensis*)  
    pignut (*C. glabra*)  
shagbark (*C. ovata*)  
shellbar (*C. laciniata*)  
water (*C. aquatica*)

locust,  
black (*Robinia pseudoacacia*)  
honey (*Gleditsia triacanthos*)  
water (*Gleditsia aquatica*)

magnolia,  
bigleaf (*Magnolia*  
*macrophylla*)  
cucumber (*M. acuminata*)  
Fraser (*M. fraseri*)  
umbrella (*M. tripetala*)

maple,  
boxelder (*Acer negundo*)  
Drummond's red

(*A. drummondii*)  
mountain (*A. spicatum*)  
red (*A. rubrum*)  
silver (*A. saccharinum*)  
striped (*A. pensylvanica*)  
sugar (*A. saccharum*)

oak,  
black (*Quercus velutina*)  
blackjack (*Q. marilandica*)  
bur (*Q. macrocarpa*)  
cherrybark (*Q. pagoda*)  
chestnut (*Q. montana*)  
chinkapin (*Q. muhlenbergii*)  
overcup (*Q. lyrata*)  
pin (*Q. palustri*)  
post (*Q. stellata*)  
red (*Q. rubra*)  
scarlet (*Q. coccinea*)  
swamp white (*Q. bicolor*)  
swamp chestnut  
(*Q. michauxii*)  
white (*Q. alba*)  
willow (*Q. phellos*)

persimmon  
(*Diospyros virginiana*)

pine,  
pitch (*Pinus rigida*)  
shortleaf (*P. echinata*)  
white (*P. strobus*)  
red-cedar, eastern (*Juniperus virginiana*)  
Virginia (*P. virginiana*)

sourwood (*Oxydendrum arboreum*)

sugarberry (*Celtis laevigata*)

sweetgum  
(*Liquidambar styraciflua*)

sycamore  
(*Platanus occidentalis*)

tuliptree, or yellow poplar

(*Liriodendron tulipifera*)

walnut

black (*Juglans nigra*)

water-elm

(*Planera aquatica*)

willow

black (*Salix nigra*)

**TABLE 6. SCIENTIFIC NAMES FOR SMALL TREES, SHRUBS, AND WOODY VINES MENTIONED IN PART 1.**

**Alder, tag**

(*Alnus serrulata*)

**ampelopsis**

(*Ampelopsis arborea*).

**arbutus, trailing**

(*Epigaea repens*).

**arrowwood**

(*Viburnum dentatum*),

**azaleas, wild**

(*Rhododendron spp.*)

**bittersweet**

(*Celastrus scandens*)

**blackhaw**

(*Viburnum prunifolium*)

**bladdernut**

(*Staphylea trifolia*)

**blueberries, lowbush**

(*Vaccinium pallidum*)

highbush

(*Vaccinium corymbosum*)

**buckthorn, Carolina**  
(*Rhamnus caroliniana*).

**buffalo-nut**  
(*Pyrularia pubera*)

**cane, wild**  
(*Arundinaria gigantea*)

**chokeberry**  
black (*Aronia melanocarpa*)  
red (*Aronia arbutifolia*)

**coralberry**  
(*Symphoricarpos orbiculatus*)

**cranberry, mountain**  
(*Vaccinium erythrocarpum*)

**creeper, trumpet**  
(*Campsis radicans*)  
Virginia  
(*Parthenocissus quinquefolia*)

**deerberry**  
(*Vaccinium stamineum*)

**dogwood**  
alternate-leaved (*Cornus alternifolia*)  
Drummond's  
(*Cornus drummondii*),  
flowering (*Cornus florida*),  
red (*Cornus amomum*)

**elderberry**  
(*Sambucus canadensis*)

**farkleberry**  
(*Vaccinium arboreum*)

**fringetree**  
(*Chionanthus virginicus*)

**grapes, wild**  
(*Vitis* spp.)

**greenbriers**  
(*Smilax* spp.)

**hackberry, dwarf**  
(*Celtis tenuifolia*)

**hobblebush**  
(*Viburnum lantanoides*)

**holly**  
swamp (*Ilex decidua*)  
winterberry  
(*Ilex verticillata*)  
mountain (*Ilex ambigua*)

**hop-tree, common**  
(*Ptelea trifoliata*)

**hornbeam, hop**  
(*Ostrya virginiana*)

**huckleberry ,black**  
(*Gaylussacia baccata*)

**hydrangea, wild**  
(*Hydrangea arborescens*)

**Indigo, false**  
(*Amorpha fruticosa*),

**ironwood**  
(*Carpinus caroliniana*),

**ivy, poison**  
(*Toxicodendron radicans*)

**laurel, mountain**  
(*Kalmia latifolia*)

**maleberry**  
(*Lyonia ligustrina*)

**nine-bark**  
(*Physocarpus opulifolius*)

**pawpaw**



(*Asimina triloba*)

**pepperbush, sweet**  
(*Clethra acuminata*)

**pepper-vine**  
(*Ampelopsis arborea*)

**pinkster-flower**  
(*Rhododendron periclymenoides*)

**prickly-ash, common**  
(*Zanthoxylum americanum*)

**privet, swamp**  
(*Forestiera acuminata*)

**redbud**  
(*Cercis canadensis*)

**rose, swamp**  
(*Rosa palustris*)

**sassafras**  
(*Sassafras albidum*)

**serviceberry, smooth**  
(*Amelanchier laevis*)  
downy (*Amelanchier arborea*)

**snowbell, American**  
(*Styrax americana*)

**spicebush** (*Lindera benzoin*)

**stewartia, mountain**  
(*Stewartia ovata*)

**sumac fragrant**  
(*Rhus aromatica*)

**supple-jack**  
(*Berchemia scandens*)

**viburnum maple-leaved**  
(*Viburnum acerifolium*)

**Virginia-willow**  
(*Itea virginica*)

**water-elm**  
(*Planera aquatica*)

**willow**  
Carolina (*Salix caroliniana*)

**wintergreen**  
(*Gaultheria procumbens*)

**witchhazel**  
(*Hamamelis virginiana*)

**withe-rod**  
(*Viburnum cassinoides*)

## **PLANT COMMUNITIES OF KENTUCKY**

The plant communities of Kentucky have been variously described and classified. Most references cited at the beginning of this section provide discussions of community types and species compositions for the various habitats across Kentucky. About 60 ecological communities in Kentucky were listed by KSNPC (Evans 1991a). Campbell (1999) grouped the state's communities into 12 broadly defined categories, and Weakley et al. (1998) listed over 100 community "associations" for Kentucky.

Many rare communities are known to occur in the state. The Nature Conservancy (Grossman et al. 1994) published a survey of rare communities of the United States, and listed seven of these communities as occurring within the borders of Kentucky (Table 7), and four more as potentially occurring in the state. Evans (1991a) listed about 20 community types as among the rarest in the state (Table 8).

Aquatic and wetland communities are particularly difficult to classify. The habitat system described by Cowardin et al. (1979), based on plant life, soils, and frequency of flooding, has been widely used. More recently, systems based on hydrogeomorphology (geomorphic setting, water source, and hydrodynamics), as described by Ainslie et al. (1998), have been increasingly used to classify wetlands in the United States.

The following general discussion provides the reader with an overview of the major plant communities of the state. Changes in soil properties (physical and chemical), soil moisture, and slope characteristics (especially aspect, position, form and steepness) lead to a diversity of intermediate communities. The major community types addressed are, generally from the wettest to the driest: aquatic and open wetland communities, floodplain forests, swamp forests, upland forests, savannas, grass dominated communities, rock-outcrop communities, cliffsides and rockhouses, disturbed places, and surface-mined sites.

**Table 7. Rare plant communities of the United States and known to occur in Kentucky, as recognized by the Nature Conservancy (Grossman et al. 1994).**

- 1) *Alnus serrulata*–*Carex crinita*/*Osmunda* spp./*Sphagnum* spp. [common alder–sedge/royal-fern/sphagnum] Sparse Shrubland—shrub wetland/acid seep of central and eastern Kentucky.
- 2) *Quercus stellata*–(*Q. palustris*)–*Cinna arundinacea* [post oak–(pin oak)–woodreed grass] Flatwoods Forest—swamp forest of central and western Kentucky)
- 3) Forested canebrakes of bottomland terraces in western Kentucky—swamp forest with swamp chestnut oak (*Quercus michauxii*), cherrybark oak (*Q. pagoda*), and sweetgum (*Liquidambar styraciflua*) in the overstory and wild cane (*Arundinaria gigantea*) in the understory.
- 4) *Andropogon gerardii*–*Panicum virgatum* [big bluestem-switchgrass] Wet-Mesic Herbaceous Vegetation—grass-dominated community (wet barrens) of chiefly of central and western Kentucky.
- 5) *Quercus stellata*–*Q. marilandica*/*Vaccinium arboreum*/*Danthonia spicata* [post oak-blackjack oak/farkleberry/poverty grass] Sparse Woodland—oak barrens of western Kentucky)
- 6) *Quercus stellata*–*Q. velutina*–*Q. alba*–(*Q. falcata*)/*Schizachyrium scoparium* [post oak-black oak-white oak–(southern red oak)/little bluestem] Sparse Woodland —oak barrens of central and western Kentucky.
- 7) *Schizachyrium scoparium*–*Aristida* spp.–*Danthonia spicata* [little bluestem/three awn grass/poverty grass] Shale Glade Herbaceous Vegetation—rock out-crop glades of the Knobs.

**Table 8. Rare plant communities of the United States and known to occur in Kentucky, State Nature Preserves Commission (Evans 1991a).**

### **Upland/Xerophytic Communities**

#### **Forests**

Appalachian pin-oak forest

Bluegrass mesophytic cane forest of the Inner Bluegrass

Coastal plain mesophytic cane forest of the loess bluffs along the Mississippi River

Cumberland highlands forest of Black Mountain

Xerohydric flatwoods

#### **Savanna-woodlands**

Bluegrass savanna-woodland of the Bluegrass Region

Pine savanna/woodland of the Appalachian Plateaus

#### **Grass-dominated communities**

Barrens (sandstone barrens of the Shawnee Hills; limestone barrens of the Mississippian Plateau and in the Outer Bluegrass; shale barrens of the Knobs)

Prairies (tallgrass prairie and limestone prairie of the Highland Rim and Mississippi Embayment; sandstone prairies of the Shawnee Hills)

#### **Glades Communities**

Dolomite, Limestone slope, Limestone flat rock, chiefly of the Interior Low Plateaus

Sandstone glades of Cumberland Plateau and Shawnee Hills

Siltstone/Shale glades of the Knobs

### **Lowland/Wetland Communities**

Gravel/cobble bar of Cumberland Plateau streams

Bald-cypress swamp of the Mississippi Embayment and western Interior Low Plateaus

Sinkhole/depression swamps and marshes of Interior Low Plateaus and Appalachian Plateaus

Wet prairies of the Interior Low Plateaus and Mississippi Embayment

Bottomland hardwood swamps of the Mississippi Embayment

Seeps (acid, calcareous, Cretaceous Hills)

Floodplain forests, marshes, sloughs and lakes, especially of the Mississippi Embayment

### **AQUATIC AND OPEN (NON-FORESTED) WETLAND COMMUNITIES**

Aquatic and open wetland communities occur across Kentucky but are the most abundant in the lowlands of the Mississippi Embayment and western Interior Low Plateaus, and the least common in the Appalachian highlands. These non-forested communities, characterized by permanent water, occasional flooding, or a high water table, are dominated by herbaceous or shrubby vegetation. Four general community types can be described—standing water, running water, emergent wetland (transitional to terrestrial habitats), and shrub wetland (transitional to forested wetland).

### **STANDING WATER COMMUNITIES**

Examples of these communities include ditches, farm ponds, natural ponds and lakes, and artificial impoundments. Many kinds of “true” aquatic plants (those modified for life on or below the water surface) occur in these habitats. These plants can be divided into three major categories, as listed below, with examples from the Kentucky flora:

- 1) **Plants free-floating on water surface**—frog’s-bit (*Limnobium spongia*), mosquito fern (*Azolla caroliniana*), and all species in Lemnaceae (some free-floating just below surface).
- 2) **Plants with stems chiefly submersed, the leaves cauline and typically narrow or divided/dissected** (sediment-rooted except in *Ceratophyllum* and *Utricularia*)—bladderworts (*Utricularia* spp.), fanwort (*Cabomba caroliniana*), featherfoil (*Hottonia inflata*), horned pondweed (*Zannichellia palustris*), hornworts (*Ceratophyllum* spp.), pondweeds (*Potamogeton* spp.), water-celery (*Vallisneria americana*), water-milfoils (*Myriophyllum* spp.), water-nymphs (*Najas* spp.), water-purslane (*Didiplis diandra*), water star-grass (*Heteranthera dubia*), water starwort (*Callitriche heterophylla*), water-weeds (*Elodea* spp.), and white and yellow crowfoot (*Ranunculus aquatilis* and *R. flabellaris*).
- 3) **Plants rooted with stems and/or leaves chiefly floating and often cordate or orbicular, sometimes narrower**—alligator-weed (*Alternanthera philoxeroides*), American lotus (*Nelumbo lutea*), arrow-heads (*Sagittaria* spp.) buttercup pennywort (*Hydrocotyle ranunculoides*), creeping and showy water-primrose (*Ludwigia peploides* and *L. uruguayensis*), floating heart (*Nymphoides peltata*), fragrant water-lily (*Nymphaea odorata*), goldenclub (*Orontium aquaticum*), mud-plantains (*Heteranthera* spp.), pondweeds (*Potamogeton* spp.), water-clover (*Marsilea quadrifolia*), water-hyssop

(*Bacopa rotundifolia*), water-shield (*Brasenia schreberi*), and yellow pond-lily (*Nuphar advena*).

Most aquatic and wetland species of standing water communities are widespread in the state, but some are known to have a very limited distribution. For example, *Azolla caroliniana*, *Cabomba caroliniana*, *Heteranthera dubia*, *Hottonia inflata*, and *Limnobium spongium* are known to occur only in far western portions of Kentucky. Haynes (2000) reviewed the status of aquatic plants in the southeastern U.S., including a discussion of endemic species, exotic aquatics, areas of origin, and an overall listing for the region.

Emergent perennials (those rooted in sediments but with stems and leaves held above the water surface) occurring in shallow water or along shorelines of both standing and running water communities are discussed below under Emergent Wetlands.

## **RUNNING WATER COMMUNITIES**

Examples of these communities include canals, streams, and rivers. The larger river systems often have extensive areas of sandy/muddy shorelines or bars, these typically occupied by rushes (*Juncus* spp.), sedges (especially *Fimbristylis* spp.), and spike-rushes (*Eleocharis* spp.), as well as hedge-hyssop (*Gratiola viscidula*), mermaidweed (*Proserpinaca palustris*), small-flowered St. John's wort (*Hypericum mutilum*), and tooth-cup (*Rotala ramosior*). Gravel bars in smaller streams are often dominated by smartweeds (*Polygonum* spp.) and water-willow (*Justicia americana*). A few submersed or floating-leaved pondweeds (*Potamogeton* spp.) may occur in bends and pools of slow-moving streams. Rapid water streams with gravelly or rocky bottoms generally have few vascular plants, and most of these are the widespread emergent species along the margins. The only submersed vascular plant adapted for life in rapid streams in Kentucky is riverweed (*Podostemum ceratophyllum*), which occurs in a few Appalachian streams and has special disk-like structures for attaching to rocks or wood.

Unusual plant communities occur along some high gradient Appalachian streams. They are best exemplified by sites along the Cumberland River, Rockcastle River, and Big South Fork. Shrubby zones along the bouldery banks are usually inhabited by a variety of small individuals of black locust, river birch, sweetgum, and winged elm, as well as shrubby species such as Carolina willow, nine-bark, red dogwood, tag alder, wild azaleas, and wild hydrangea. The grassy banks are often barrens-like (see description below), with grasses such as big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), and little bluestem (*Schizachyrium scoparium*), and numerous rare species are associated with this streambank habitat (Table 9).

Forested communities associated with stream-side and adjacent habitats are discussed below under Floodplain Communities.

## **EMERGENT WETLANDS**

Examples of these communities, dominated by emergent herbaceous perennials, include wet barrens, wet meadows, marshes, fens, and seeps. Wet meadows and wet barrens (the latter with more prairie species) are primarily grass-dominated, whereas marshes are usually wetter and with more ferns and flowering herbs. Fens are bog-like seepage areas of flatlands, often with a thick ground cover of sphagnum moss and graminoids. Spring seeps occur on slopes, and usually lack the sphagnum cover. True sphagnum bogs do not occur in Kentucky (L. McKinney, pers. comm.)

There are numerous examples of emergent perennial species, with members of the *Cyperaceae* (sedges), *Juncaceae* (rushes), and *Poaceae* (grasses) being especially abundant, as well as cattails (*Typha* spp.), bur-reeds (*Sparganium* spp.), smartweeds (*Polygonum* spp.); other important families in these habitats include the *Alismataceae*,

*Asteraceae*, *Lamiaceae*, *Onagraceae*, and *Scrophulariaceae*. Examples of characteristic species are given below (these species may also form herb layers in partly wooded wetlands):

1) *Graminoid species common in open wetlands across the state*—beak-rushes such as *Rhynchospora capitellata*, *R. corniculata*, and *R. glomerata*; bulrushes such as *Scirpus atrovirens*, *S. cyperinus*, *S. pendulus*, *Schoenoplectus pungens*, and *S. tabernaemontanii*; caric sedges such as *Carex crinita*, *C. frankii*, *C. lupulina*, *C. lurida*, *C. tribuloides*, *C. typhina*, and *C. vulpinoidea*; flat sedges such as *Cyperus esculentus*, *C. flavescentis*, *C. pseudovegetus*, and *C. strigosus*; grasses such as *Agrostis gigantea*, *Chasmanthium laxum*, *Calamagrostis cinnoides*, *Glyceria striata*, *Leersia oryzoides*, *L. virginica*, and several species of *Panicum* and *Paspalum*; rushes such as *Juncus acuminatus*, *J. diffusissimus*, *J. effusus*, *J. marginatus*, *J. tenuis*, and *J. torreyi*; and spike-rushes such as *Eleocharis erythropoda*, *E. ovata*, and *E. tenuis*.

2) *Non-graminoid emergent herbs typical of open wetlands across the state (including the Bluegrass area)*—cardinal-flower (*Lobelia cardinalis*), cattails (*Typha* spp.), common marsh-pink (*Sabatia angularis*), ditch stonecrop (*Penthorum sedoides*), false nettle (*Boehmeria cylindrica*), field horsetail (*Equisetum arvense*), joe-pye weeds (*Eupatorium* spp.), lizard's-tail (*Saururus cernuus*), lobelias (*Lobelia puberula* and *L. siphilitica*), rose-mallow (*Hibiscus moscheutos*), square-pod water-primrose (*Ludwigia alternifolia*), swamp milkweed (*Asclepias incarnata*), tickseeds (*Bidens* spp.), touch-me-nots (*Impatiens* spp.), and water hemlock (*Cicuta maculata*).

3) *Emergent wetland species (some of these quite rare) chiefly associated with the Mississippi Embayment and western Interior Low Plateaus*—graminoid species such as *Calamagrostis canadensis*, *Cyperus albomarginatus*, *C. polystachyos*, *Echinodorus berteroi*, *Fimbristylis vahlii*, *Glyceria arkansana*, *G. pallida*, *Lipocarpa micrantha*, *Leersia lenticularis*, and *Zizaniopsis miliacea*; non-graminoid species such as Coastal Plain hydroleas (*Hydrolea ovata*, *H. uniflora*), irises (*Iris fulva*, *I. brevicaulis*), small-flowered water-primrose (*Ludwigia glandulosa*), water-parsnip (*Sium suave*), and water-willow (*Justicia ovata*).

4) *Emergent wetland species chiefly associated with the Appalachian Plateau*—many rare plant species occur in these habitats, including grass-pink (*Calopogon tuberosus*), a hedge-hyssop (*Gratiola pilosa*), Nuttall's lobelia (*Lobelia nuttallii*), purple and white fringed orchid (*Platanthera psycodes* and *P. integrilabia*), rose-pogonia (*Pogonia ophioglossoides*), spreading pogonia (*Cleistes bifaria*), and yellow-eyed grasses (*Xyris* spp.); many other rare species, these often associated with the Coastal Plain, can occasionally be found in the marshes, fens, and wet meadows of the Appalachians and are most common on the tablelands of the Cumberland Plateau; these habitats are among the rarest and most endangered communities in Kentucky.

## SHRUB WETLANDS

These habitats have a woody cover of shrubs and small trees, with an herb layer similar to those of emergent wetlands described above. They can occur at a variety of open wetland sites, including depressions with a fragipan or in seepage areas. Shrub wetlands can be viewed as

transitional to forested wetlands, discussed in the next two sections. Shrubby species common in wetlands across the state include buttonbush, pawpaw, tag alder, and willows. In southern and western parts of the Interior Low Plateaus shrubby species such as false indigo, red and black chokeberries, Virginia-willow, and swamp rose occur. Nearly all of the above mentioned species can also be found in the Mississippi Embayment and the Appalachian wetlands. Shrubby species of western Kentucky are the same as those listed below for swamp forests of the region. Shrubs and small trees chiefly found in Appalachian wetlands include pinkster-flower, maleberry, highbush blueberry, and withe-rod.

For more information on aquatic and wetland communities in Kentucky and nearby regions see Campbell (2000b), Guthrie (1989), Hackney et al. (1993), Henson (1990), Jones (1989), Mitsch & Gosselink (1993), Webb et al. (1988), and Webb & Bates (1989).

### SWAMP FORESTS

In this category is a heterogenous group of forested wetlands that occur in areas of permanent or semi-permanent standing water or in areas with high water tables or saturated soil through much of the growing season. They may occur in lowlands associated with stream corridors or in uplands associated with seeps, streamheads, or poorly drained depressions. Swamp forests are found across Kentucky but are most extensive and complex in the Mississippi Embayment and western Interior Low Plateaus. Deep-water swamps occur in various bottomland settings, primarily in association with the major drainage systems of the Mississippi, Ohio, and Green rivers and their tributaries. The sites with deepest water are occupied by bald-cypress, buttonbush, and water tupelo. Other associates include Drummond's red maple, oaks (overcup, swamp chestnut), pumpkin ash, swamp cottonwood, water hickory, and water-locust. Subcanopy species include American snowbell, swamp privet, Virginia-willow, and water-elm. Herbaceous species are similar to those listed above for open-water wetlands of the region. These communities are essentially restricted to the far-western portions of the state although some of the characteristic species occur sporadically eastward to the Cumberland Plateau.

Table 9. Rare vascular plant species primarily associated with rocky/grassy stream banks of the Appalachian Plateaus. All are state listed and two---*Conradina verticillata* and *Spiraea virginiana*, are federally listed.

*Baptisia australis* var. *minor*  
*Ceanothus herbaceus*  
*Conradina verticillata*  
*Comptonia peregrina*  
*Eupatorium semiserratum*  
*Eurybia saxicastellii*  
*Lathyrus palustris*  
*Leucothoe racemosa*  
*Marshallia grandiflora*  
*Solidago gracillima*  
*Solidago randii*  
*Spiraea virginiana*  
*Spiranthes lucida*  
*Tephrosia spicata*

## *Vitis rupestris*

Across central and eastern Kentucky swamp forests also develop in upland depressions (swales) and sinkholes, flat headwater areas, and abandoned river channels. The soils in the upland depressions typically have a hard clay fragipan that retains water at or near the surface for much of the growing season (although they may dry out for parts of the year). These forests often exhibit combinations of floodplain and upland species typical of the region. For example, on the Highland Rim, oak species (overcup, pin, swamp white, and willow) are often dominant, as well as blackgum, green ash, red maple, silver maple, sweetgum, and sycamore. Small trees and shrubs include buttonbush, highbush blueberry, ironwood, pawpaw, red dogwood, spicebush, and Virginia-willow. For additional information of swamp forests of the Highland Rim see Baskin et al. (1997) and Ellis & Chester (1989).

The typical swamp community (now very rare) of the Knobs and Bluegrass is the swamp white oak/pin oak community, often with blackgum, green ash, red maple, and sweetgum as associate species, and an understory of pawpaw, redbud, and spicebush (see Bryant 1978a, Meijer et. al. 1981).

In the Appalachians these swampland communities occur mostly in flatland depressions and in streamheads. The typical dominants are red maple and blackgum, with associates that include sourwood, sweetgum, tuliptree, and white oak, with swamp whiteoak and pin oak in some communities. Understory species include arrowwood, highbush blueberry, umbrella magnolia, wild azaleas, and winterberry holly. For an account of similar habitats in Tennessee see Jones (1989).

Acid seep communities may develop at the base of sandstone or gravelly hills. Woody species at these sites often include ironwood, red maple, river birch, and sweetgum, and the herb layer is usually rich with ferns, rushes, sedges, and rare flowering plants (see Funk & Fuller 1978, 1980). Calcareous seeps occur in limestone woods, with such canopy species as green ash, shellbark hickory, and swamp white oak, and are usually accompanied by a distinctive ground cover of sedges and grasses.

Swamp forests have been severely impacted by human activities. Old-growth stands of bald-cypress in western Kentucky have virtually disappeared. Swamp forests across central and eastern Kentucky have also nearly vanished, with only a few stands at scattered localities. Many rare species are associated with these habitats, including one federal candidate, the white fringed orchid (*Platanthera integrilabia*), associated with thinly wooded wetlands of the Cumberland Plateau.

## **FLOODPLAIN FORESTS**

Floodplain forests are found throughout Kentucky and are most extensive along the major river and stream systems of western and central Kentucky. Floodplain forests also occur on the tablelands of the Cumberland Plateau and along the corridors of the lower reaches of the major streams emerging from the Appalachians. These forests occur on the elevated banks (built up by



heavy siltation) along streams, and in the adjacent bottomlands in areas of temporary or seasonal flooding. The dominant trees shift according to flooding regime and slight differences in soil and elevation.

The vegetation of streambanks, which must endure frequent and heavy disturbance, is of a pioneer and weedy type, and usually includes such “soft-hardwood” species as black willow, box elder, eastern cottonwood, green ash, river birch, silver maple, and sycamore. There are few shrubs, but woody vines such as trumpet creeper and poison ivy are often present. The herb layer may be dense with stands of Canada nettle (*Laportea canadensis*) and touch-me-nots (*Impatiens capensis* and *I. biflora*). All of these species occur across Kentucky except river birch, which typically occurs only in acid soil regions. In some areas that have been heavily deforested, these narrow strips of trees are the only woody vegetation in the region.

Bottomland hardwood communities occur beyond the streambanks, in backwaters and flats, and on first terraces and low ridges. These areas may be inundated for short periods in the spring and early summer, and have a richer mixture of species than the streambanks. Included are plant species with almost state-wide ranges, as well as species characteristic of the particular region. Wide-ranging bottomland trees include American elm, blackgum, green ash, pin oak, red maple, shellbark hickory, and sweetgum. Other widespread woody plants of these habitats include ironwood, pawpaw, spicebush, and wild cane.

Canopy species chiefly restricted to the bottoms of Mississippi River and Ohio River lowlands include several oaks (cherrybark, overcup, swamp chestnut, and willow), as well as pecan hickory and sugarberry, although some of these species do range eastward as far as the Cumberland Plateau. Associated shrubs and woody vines include American snowbell, pepper vine, supple-jack, swamp holly, swamp privet, and Virginia-willow (see Bryant 1990).

Bottomland forests of the Highland Rim usually include the wide-ranging species mentioned above, a mingling of oaks from central and western Kentucky (swamp chestnut, swamp white, and willow), as well as American beech, honey locust, and tuliptree. Typical associated shrubs and small trees include tag alder, bladdernut, red dogwood, common elderberry, and winterberry holly.

Central Kentucky floodplains display some differences from those previously described. The Knobs floodplain forests are similar those of the Highland Rim, but often with more upland species such as bitternut hickory, black walnut, Ohio buckeye, and sugar maple. River and stream terraces in the Bluegrass are typically composed of American elm, black walnut, boxelder maple, hackberry, red elm, sycamore, and white ash, with an understory of Drummond’s dogwood, Carolina buckthorn, and redbud.

In the Appalachians the floodplain flats and lower terraces along streams are often characterized by various combinations of American beech, black gum, red maple, sweetgum, sycamore, and tuliptree. In their canopy as well as their understory they are very similar to the Appalachian swamp forests described above. Species more typical of mesic lower slopes, such as eastern hemlock, sugar maple, and yellow buckeye, can often be found on the narrower floodplains in the upper reaches of these streams.

Floodplain forests are among the most endangered communities in Kentucky. Most stands have been heavily timbered, drained, and ditched so that only remnants remain. In many cases these generally flat, fertile lands have been converted for agricultural purposes or for home sites.

## UPLAND FORESTS

Transition forests between floodplain and upland habitats occur on upper terraces above stream corridors. They are generally similar across the state, and include such widespread species as basswood (American and white), black walnut, northern red oak, red elm, sugar maple, tuliptree, white ash, and white oak. In south-central and eastern portions of the state American beech is a common component, and in north-central Kentucky, various species associated with limestone habitats, such as Kentucky coffeetree and Ohio buckeye, may also be present.

Upland forests occur in areas removed from the threat of flooding, on rolling uplands, slopes, ridges, and summits. They occur in all regions of Kentucky, sharing many of the same species, but varying by type of terrain, soil depth and structure, moisture regime, and aspect. It should be noted that most upland forests have been disturbed repeatedly and that the current community structure is likely very different from that of the original forests. From most mesic to most xeric, Kentucky upland forests can be generally grouped into 1) mixed deciduous (with eastern hemlock in some communities), 2) mixed oak and associates (often oak/hickory or oak/ash), 3) xeric oaks and associates (often oak/eastern red-cedar, or oak/pine, depending on substrate), and 4) pine forests.

### **MIXED DECIDUOUS FORESTS**

Mixed deciduous forests occur in deep, rich, mesic (moist but well-drained soils), especially on lower and north-facing slopes, and in ravines. Frequently encountered species of mesic uplands across Kentucky include American beech (except in the Inner Bluegrass), bitternut hickory, black cherry, black walnut, red oak, shagbark hickory, sugar maple, tuliptree, white ash, and white oak. Common understory species are bladdernut, wild hydrangea, redbud, flowering dogwood, spicebush, and pawpaw.

In the rich Appalachian forests, these canopy species mingle with cucumber magnolia, eastern hemlock, sweet birch, white basswood, white pine, and yellow buckeye, and, at higher elevations, with Fraser magnolia and yellow birch, to form the classic “mixed mesophytic forest” of Braun (1950), from which the forest region takes its name. Depending on changes in elevation, dissection, and moisture, different combinations of these species may assume dominance. The many small trees and shrubs that associate in these rich communities include buffalo-nut, magnolias, maple-leaved viburnum, mountainstewartia, sweet pepperpush, and wild azaleas. Similar Appalachian-type communities (including such species as American beech, cucumber magnolia, eastern hemlock, sugar maple, yellow birch, yellow buckeye, and white basswood) also occur in scattered locations in the Knobs, Highland Rim, Mississippi River bluffs, and in the Dripping Springs Escarpment of the Shawnee Hills. (See Bryant 1993: McKinney et al. 1991; Thompson & Jones 1986). These communities with disjunct Appalachian species have often been interpreted as relic or refugial in nature, being sites where mixed mesophytic forests retreated or persisted during glacial advances (Bryant 1993).

Mesic upland forests of central and western Kentucky generally lack the typical Appalachian species and are characterized by the presence of the widespread canopy and understory species listed above, as well as American basswood, American elm, black maple, hackberry, Kentucky coffeetree, Ohio buckeye, red maple, red oak, shellbark hickory, and Shumard oak. The spring flora is rich with a variety of wildflowers, including two federally listed species in central Kentucky—bladder-pod (*Lesquerella globosa*) and Braun’s rock cress (*Arabis perstellata*). Other variants of the mixed hardwoods community occur in the limited areas of glaciated northern Kentucky (see Bryant 1978b).

The most endangered mesic upland forest in Kentucky is the Cumberland Highlands Forest which occurs above 1100 m (3700 ft) on Black Mountain. This all-deciduous forest contains species that are frequently found in the Northern Hardwoods community of New England and others more allied with forests of the Smoky Mountains. Weakley et al. (1998) described this forest of Fraser magnolia, striped maple, sugar maple, yellow birch, and yellow buckeye as a completely unique community of eastern United States. Other common woody plants include black cherry, black locust, cucumber magnolia, red maple, red oak, and tuliptree. Less frequent associates include American beech, bitternut hickory, blackgum, sweet birch, white basswood, and white oak. Small trees and shrubs include alternate-leaved dogwood, buffalo-nut, highbush blueberry, mountain holly, smooth serviceberry, wild hydrangea, and sprouts of American chestnut. The only known Kentucky populations of hobblebush and mountain cranberry occur in this community. Woodland herbs include Appalachian bellflower (*Campanula divaricata*), basil bee-balm (*Monarda clinopodia*), northern horse-balm (*Collinsonia canadensis*), silver-rod (*Solidago bicolor*), and starry campion (*Silene stellata*). Many state-listed species occur in these high elevation habitats, and a number of these species are found nowhere else in the state (Table 10). For more information on Black Mountain and associated areas see Braun (1940), Campbell (1997b), Davis and Barbour (1978), and KSNPC (1998).

**Table 10. Kentucky Endangered and Threatened Species with current populations known chiefly from the Cumberland Mountains (those species known only from Black Mountain are indicated by “BM”. Geographic affinities are indicated by A, for southern Appalachian distribution, E, for general distribution in e. U.S., and N for a northern U.S. distribution (See “Floristic Affinities”).**

N–*Adlumia fungosa*  
A–*Angelica triquinata* BM  
N–*Botrychium oneidense* BM  
N–*Botrychium matricariifolium*  
N–*Carex leptoneuria*  
A–*Carex roanensis*  
E–*Chelone obliqua* var. *obliqua*  
A–*Convallaria montana*  
A–*Cymophyllus fraserianus*  
E–*Eupatorium maculatum* BM  
E–*Eupatorium steelii*  
A–*Gentiana decora*  
N–*Helianthemum canadense*  
E–*Heracleum maximum* BM  
A–*Listera smallii*  
E–*Lycopodium inundatum*  
N–*Oclemena acuminatus*  
N–*Paronychia argyrocoma*  
N–*Rubus canadensis*  
A–*Solidago roanensis*

E–*Stachys eplingii*  
N–*Streptopus lanceolatus* BM  
N–*Trillium undulatum*  
A–*Vaccinium*  
    *erthyocarpum* BM  
N–*Viburnum lantanoides* BM

### **MIXED OAK FORESTS (OFTEN OAK-HICKORY OR OAK-ASH)**

Mixed oak forests typically occur on rolling uplands and on mid to upper slopes across the state. These sites tend to be occupied by more upland oak and hickory species, with fewer mesic species of the mixed hardwoods communities. The forests vary greatly across the state but the major community types can generally be grouped into mixed oaks or oak-hickory or oak-ash. The mixed oak and oak-hickory forests predominate in acid to neutral soils that occur in the uplands of the Appalachians, the Knobs, the Shawnee Hills, and the Mississippi Embayment. White oak is often a dominant, associating with American elm, bitternut hickory, blackgum, black oak, chestnut oak, red maple, red oak, shagbark hickory, sugar maple, tuliptree, and white ash. Formerly American chestnut was a significant component. White pine and American beech are present in some Appalachian communities, as well as other upland oaks and hickories. Many species in the Ericaceae, as well as flowering dogwood, greenbriers, redbud, and wild grapes are common in the understory.

Oak-ash communities are associated primarily with limestone regions typical of the Bluegrass and Highland Rim, and also occur on other limestone sites scattered across the state. These forests are often composed of blue ash, chinkapin oak, hop hornbeam, plumleaf viburnum, Shumard oak, sugar maple, and white ash.

Two alarming trends are now evident in these mixed oak forests: 1) the decline of oaks and hickories, as evidenced by slowed growth rates and higher mortality (see “Effects of Acid Precipitation and Ozone”); and 2) the invasion of red maple into these upland forests, often to the exclusion of oak and hickory seedlings.

### **XERIC OAK FORESTS (OFTEN OAK-PINE OR OAK-CEDAR)**

These communities occur in habitats characterized by dry, thin and rocky soils of peaks, ridges, and south-facing upper slopes. Compared to typical mixed oak habitats, these sites are more severe in exposure and with poorer soil development and less moisture. A typical dry upland community of acid soils in the Appalachians, Knobs, and Shawnee Hills, is often dominated by chestnut oak, in association with various combinations of other upland oaks (black, blackjack, post, red, scarlet, southern red, white), and pines (pitch, shortleaf, Virginia). Other associates include blackgum, hickories (mockernut, pignut, sand, shagbark), persimmon, red maple, sourwood, and, formerly, American chestnut. The shrub layer is often dominated by members of the Ericaceae, including black huckleberry, deerberry, farkleberry, lowbush blueberry, mountain laurel, trailing arbutus, and wintergreen. Many other small trees, shrubs, and woody vines are present, including downy serviceberry, greenbriers, sassafras, and witchhazel.

In the dry uplands of the calcareous Bluegrass, the typical community is often Table 10. Kentucky Endangered and Threatened Species with current populations the dominated by chinkapin oak, with major associates including blue ash, eastern red-cedar, rock elm, and white ash. Some of the widespread oaks (red and white) and hickories (pignut and shagbark) may also

be present. The understory in these limestone uplands lack the characteristic members of the Ericaceae typical of acid woodlands, and instead is composed of such species as redbud, Carolina buckthorn, common hop tree, coralberry, dwarf hackberry, fragrant sumac, hop-hornbeam, prickly-ash, and redbud. Similar communities occur at scattered limestone sites in the Appalachians, the Knobs, and the Shawnee Hills.

Throughout the dry upland forests of the Highland Rim upland oaks (black, blackjack, chinkapin, post, southern red, white), and upland hickories (mockernut, pignut, shagbark) predominate, usually with white oak as the most conspicuous species. Other associates include downy serviceberry, eastern red-cedar, and sassafras. In the western-most sections, including the Land Between the Lakes region, chestnut oak and post oak often become more predominant in the uplands.

The driest woodlands of the Mississippi Embayment are the gravelly uplands dominated by blackjack oak. Upland hickories and oaks (especially black, post, and southern red) often occur as associates.

### **PINE FORESTS**

On some dry ridges and summits of the Appalachians the typical canopy species are the hard pines (pitch, Virginia, and sometimes shortleaf), with occasional chestnut oak, pignut hickory, scarlet oak, and other xeric species. The trees are often stunted and scrubby on the driest sites. Pine Mountain was so named because of the prevalence of pines on dip slopes and crests. The pines become less important westward, with pitch ranging into the eastern Knobs, shortleaf to the Land Between The Lakes, and Virginia pine into the Shawnee Hills. Extensive pine communities of southeastern Kentucky were decimated by the Southern pine beetle from 1999--2001. Stable pitch pine communities in the Appalachians are now among the rarest upland communities in the state.

Other pine communities also occur in Kentucky, including scattered natural stands and plantations of white pine in the Appalachians. Plantations of loblolly pine (*Pinus taeda*), which is not native to Kentucky, have been planted in south-central and western Kentucky.

Xeric oak forests and pine forests, occurring on the highest, driest sites across the state, are relatively low in species numbers. These communities in the more extreme and less disturbed settings are almost exclusively of native species, for few non-native species are able to invade these habitats. Several rare plant species are known from these habitats, including some species associated with the barrens or glade-like areas that occur at the more open sites in these communities (see "Grass-dominated Communities," below).

### **BLUEGRASS ASH-OAK SAVANNA**

The open ash-oak community reported by early settlers and travelers in central Kentucky is considered here as a unique community in the state. This concept follows that of Braun (1950), who described the vegetation of the Bluegrass as an anomaly in the eastern deciduous forest. Today only scattered remnants remain, a few as relict old-growth stands; the dominant trees are mostly blue ash, bur oak, chinkapin oak, Shumard oak, white ash, and shellbark hickory. Understory is typically lacking in modern stands, having been mostly replaced by fields of non-native grasses. The wild cane and numerous native wildflowers described by early travelers have all but disappeared. Running buffalo clover (*Trifolium stoloniferum*), considered to be a original component of this community, is now listed as Threatened at the state level and Endangered at the federal level.

Many of the first accounts of 18<sup>th</sup> century travelers to the Bluegrass region referred to the beautiful landscape with its rolling hills, its park-like appearance of scattered large trees, the dense stands of wild cane, and numerous wildflowers (see Bryant et al. 1993; Campbell 1980, 1985, 1987, 1996b; Davidson 1950; McInteer 1952; Wharton & Barbour 1991). Several kinds of trees were frequently mentioned: ashes, buckeye, cherry, coffeetrees, elms, locusts, oaks, sugar maple, and walnut. The reasons for the openness of the woodlands have been the subject of much debate, with most authors focusing on the effects of periodic fires set by native Americans, combined with the effects of grazing animals. Platt & Brantley (1997) provided a historical and ecological account of canebrakes in the southeastern United States

The term “savanna” has been used historically to refer to both open grassland and open woodland communities. It is here used in the sense of Anderson and Bowles (1999) and Fralish et al. (1999) as an open ash-oak woodland with less than 50% canopy cover, a transition between the forests and the barrens/prairies of the region.

Other types of open woodlands with savanna-like features occur in the state. They differ in both floristics and vegetation from the Bluegrass ash-oak savanna, and are discussed in the following section.

#### **GRASS-DOMINATED COMMUNITIES (BARRENS/PRAIRIES)**

At the time of settlement grass-dominated communities probably occupied about 6–10% (6000–10000sq km) of Kentucky. Imlay (1797) described “extensive plains” in south-central Kentucky, about 150 miles long and 50 miles wide in a south-west direction (also see quote by F.A. Michaux in “History of Floristic Botany”). Imlay noted that occasional groves of trees were the only obstruction to a “boundless horizon.” Other early observers described these “immense meadows” as occurring in an arc around the Shawnee Hills, from near the Ohio River in Meade County to Montgomery, Robertson, and Stewart counties in Tennessee, and west to Trigg and Caldwell counties in Kentucky. These were the so-called “Big Barrens.” West of the Tennessee and Cumberland Rivers in Kentucky other extensive areas of barrens vegetation occurred in Ballard, Graves, Calloway, and McCracken counties. Grass-dominated communities have also been documented at various other sites across Kentucky (see below). Many of these are dry upland sites, but barrens-type vegetation can also occur along rocky river banks in the Appalachians, and in low, poorly drained areas (wet barrens).

The larger barrens communities are associated with level to steeply rolling plains, and are characterized by a cover of perennial grasses and herbs, along with scattered shrubs and scrubby trees. Most grass-dominated communities in Kentucky occur over limestone, but similar communities may also occur on sandstone, shale, or siltstone. Those occurring on flat to rolling terrain have almost been totally eliminated as these lands were converted for use as pasture or row crops, or, with fire suppression, have undergone succession to woodland. This once extensive community type has now been reduced to scattered sites mostly in central and western Kentucky, with all of the quality sites probably totaling less than 1 sq km.

The Big Barrens and similar communities in Kentucky and Tennessee have been the subject of many reviews and studies (see Baskin & Baskin 1978, 1981, Baskin et al. 1994, Baskin et al. 1999, Chester 1988, Chester et al. 1997b, DeSelm 1989, 1994, DeSelm & Murdock 1993, Dicken 1935, Garman 1925, McInteer 1942, and Ray 1997). The question of how the Big Barrens originated has continued to fascinate investigators. Are they remnants of warmer climates after the last glacial advance when tall grass prairie extending into eastern United States (see Transeau 1935), or are they former forests that were subjected to periodic burning by native

Americans, as argued by Baskin et al. (1994, 1999)? Paleoecological studies by Wilkens et al. (1991) supported this latter idea, but Ray (1997) contended that tall grass prairie could have already been in the Big Barrens region prior to the arrival of native Americans, having been maintained for thousands of years by lightning-caused fires. Anderson & Bowles (1999) considered the barrens regions of central and western Kentucky as part of the eastern prairie-forest transition and referred to the grassy-scrubby areas as fire-maintained barrens/brush prairies.

The “hill prairies” that occur in the Knobs and northern Bluegrass have also been interpreted as relicts of former prairie-type vegetation occurring in the region about 10,000 years ago (see Braun 1950, Bryant 1981, Campbell et al. 1989, and Harker et al. 1981). The natural persistence of hill prairies was attributed by Evers (1955) to a combination of several factors, including priority of occupation by prairie species, dry and exposed habitats, height and orientation of the bluffs, and permeability of the substratum. Other similar communities interpreted as remnants of tall grass prairie, including sites over limestone and sandstone, have been described in the Knobs and Shawnee Hills by Bryant (1977), Evans (1987), and Harker et al. (1980, 1981).

Various other kinds of barrens/prairies and their gradations with savanna have been described in Kentucky, including cedar barrens and sandy barrens of the northern Highland Rim (Braun 1950, Cranfill 1991); post oak woodlands of the western Highland Rim (Fralisch et al. 1999); limestone barrens of the northern Cumberland Plateau (Campbell et al. 1992); and sandstone barrens of the southern Appalachian Plateau (Campbell et al. 1991, Martin 1989). The latter two publications noted the many historical references to the park-like forests encountered by the early settlers in the southern Cumberland Plateau, often described as savanna-like woodlands of pines and oak, with areas of cane and clover and tall grass.

From the above discussion, it is apparent that there is no unanimity of opinion on either the origins or nomenclature of grass-dominated communities in Kentucky and Tennessee. Whether interpreted as recent, fire-maintained “barrens” or ancient, relict “prairies,” these communities, regardless of substrate, share many of the same dominant species. Little bluestem (*Schizachyrium scoparium*) is typically the dominant grass, along with tall grasses such as big bluestem (*Andropogon gerardii*), Elliott’s broom-sedge (*A. gyrans*), Indian grass (*Sorghastrum nutans*), and silver plume grass (*Saccharum alopecuroides*); in wetter prairies, gama grass (*Tripsacum dactyloides*), prairie cord grass (*Spartina pectinata*) and switch grass (*Panicum virgatum*) occur. Tall yellow-flowered composites include hairy sunflower (*Helianthus hirsutus*), prairie-dock (*Silphium terebinthinaceum*), sunflower-everlasting (*Heliopsis helianthoides*), tall tickseed (*Coreopsis tripteris*), and whorled rosinweed (*Silphium trifoliatum*). The combination of tall grasses and tall yellow composites serves to make these communities, even in small patches, readily identifiable, even from moving vehicles during roadside searches. The attractiveness of this community is enhanced by the presence of many colorful flowering plants, including species of blazing stars (*Liatris* spp.), coneflowers (*Echinacea* spp.), eupatoriums and joe-pye weeds (*Eupatorium* spp.), goldenrods (*Solidago* spp.), ironweeds (*Vernonia* spp.), lobelias (*Lobelia* spp.), milkweeds (*Asclepias* spp.), and wild asters (*Symphyotrichum* spp.). Shrubs and scrubby trees are sometimes present, including winged sumac, persimmon, red maple, blackgum, blackjack oak, hickories, post oak, mockernut hickory, eastern red-cedar, and sassafras. Diagnostic species on calcareous sites include aromatic aster (*Symphyotrichum oblongifolium*), hoary puccoon (*Lithospermum canescens*), stiff goldenrod (*Oligoneuron rigidum*), and white prairie-clover (*Dalea candida*). See Chester et al. (1997b) for a flora of the Kentucky-Tennessee barrens.

Barrens on the Appalachian plateaus have more tree cover and are referred to as “oak” or “pine” barrens. The common woody species include upland oaks (chestnut, blackjack, and post), pines (Virginia, pitch, and shortleaf), farkleberry, and other *Vaccinium* species. Herbaceous species include blackseed needle grass (*Piptochaetium avenaceum*), shaggy golden-aster (*Chrysopsis mariana*), upland asters (especially *Symphyotrichum patens*, *S. pilosus*, and *Eurybia surculosa*), upland goldenrods (*Solidago spp.*), Virginia goat’s-rue (*Tephrosia virginiana*), and many other legumes. Several state-listed species occur in this habitat, including American cow-wheat (*Melampyrum lineare*), bitter-milkwort (*Polygala polygama*), eastern silvery aster (*Symphyotrichum concolor*), yellow wild indigo (*Baptisia tinctoria*), and one federally listed species, chaffweed (*Schwalbea americana*), now considered Historical in Kentucky.

Only scattered remnants of the presettlement grassland-dominated communities remain today, and a few sites, especially the larger and more significant ones, are now under state or federal protection. Species typical of these communities now occur mostly in roadside or old-field habitats in Kentucky. Some of the more remote sites on upper hillsides and along rivers in various parts of the state are little disturbed and retain many of their unique species. Although much reduced in size, the remaining communities contain some of Kentucky’s rarest plants (Table 11).

Table 11. Some rare plant species associated with calcareous barrens and similar communities of Kentucky. All are state listed, and two— *Helianthus eggertii* and *Solidago shortii*, are also federally listed.

*Agalinis skinneriana*  
*Aristida ramosissima*  
*Baptisia australis*  
*Baptisia bracteata*  
*Baptisia tinctoria*  
*Bouteloua curtipendula*  
*Cypripedium candidum*  
*Dalea purpurea*  
*Delphinium carolinianum*  
*Gentiana flavida*  
*G. puberulenta*  
*Helianthus eggertii*  
*Muhlenbergia cuspidata*  
*Onosmodium hispidissimum*  
*Onosmodium molle*  
*Onosmodium occidentale*  
*Silene regia*  
*Silphium laciniatum*  
*Solidago shortii*  
*Spiranthes magnicamporum*  
*Symphyotrichum pratense*  
*Trifolium reflexum*

## ROCK OUTCROP COMMUNITIES (GLADES, LEDGES, CLIFFTOPS)



Rock outcrop communities can be defined as naturally treeless habitats with thin soils and bedrock at or near the surface (see Somers 1986 for papers on the biota, ecology, and history of cedar glades). They can also be considered as primary communities, with exposed substrates and vegetation maintained in early stages of succession. These habitats present severe challenges for plant growth, including extreme exposure to sun and great variation in seasonal temperature and moisture, with summer and fall months very hot and dry, and spring months cool with periods of immersion during rainy periods. Mosses, lichens, and cyanobacteria often form a significant portion of the ground cover. The term “glade” has traditionally been used to describe rocky openings on flat to moderately sloping terrain, often occurring as “islands” within woodlands. The predominant vegetation is annual grasses and herbs, with the dominant families being Asteraceae, Cyperaceae, Fabaceae, and Poaceae. Baskin et al. (1994) emphasize that these herbaceous communities are climax communities and not early successional stages in the development of a woodland (in contrast to their definition of barrens). In Kentucky these glades occur most frequently over calcareous substrates, either limestone or dolomite, but can also occur on sandstone, shale, or siltstone. The calcareous communities in particular, frequently associated with adjoining eastern red-cedar thickets, are often called cedar glades. Those communities on more acid substrates typically are surrounded by pines and scrubby upland oaks. Glade-like communities can also occur on the rocky surfaces of ledges and clifftops. In Kentucky, cedar glades are chiefly found in the Interior Low Plateaus, especially the Highland Rim. Sandstone and shale glades are less common, but do occur at various sites, especially in the Shawnee Hills and in the Appalachians. Quarterman et al. (1993) provided an overall consideration of rock outcrop communities in the southeastern U.S., and Baskin & Baskin (1999, 2003) have published more recent reviews of the limestone/dolomite glades and their characteristic flora in the southeastern United States.

Cedar glades have a characteristic flora. Succulents such as false aloe (*Manfreda virginica*), prickly-pear (*Opuntia humifusa*), and widow’s-cross stonecrop (*Sedum pulchellum*) are often present (Johnson 1981). According to Baskin & Baskin (1975, 1978), species commonly occurring in Kentucky cedar glades include blue-eyed-grass (*Sisyrinchium albidum*), false pennyroyal (*Isanthus brachiatus*), limestone adder’s-tongue (*Ophioglossum engelmannii*), little skullcap (*Scutellaria parvula*), pasture-heliotrope (*Heliotropium tenellum*), poverty dropseed (*Sporobolus vaginiflorus*), whorled milkweed (*Asclepias verticillata*), and wild petunia (*Ruellia humilis*). Baskin & Baskin (1986, 1999, 2003) list a number of Kentucky species that are considered to be endemic to cedar glades, including the false gromwells (*Onosmodium* spp.), the glade cresses (*Leavenworthia* spp.), the glade fameflower (*Talinum calcaricum*), a lobelia (*Lobelia gattereri*), and a violet (*Viola septemloba* subsp. *egglestonii*).

Limestone outcrops supporting a glades-type flora also occur in the Appalachians and in other regions of the state, often in narrow strips along clifftops and on ledges. The flora of these communities is less rich than the larger sites on the Highland Rim but does include some rare species, as detailed by Palmer-Ball et al. (1988), including mountain-lover (*Paxistima canbyi*), plains muhly (*Muhlenbergia cuspidata*), and rough dropseed (*Sporobolus clandestinus*).

Sandstone glades and outcrops occur in the Shawnee Hills and at scattered sites in the Appalachian Plateaus. Fralish et al. (1999) described a red-cedar sandstone glade in the Shawnee Hills as extremely xeric, with few grasses, a number of succulents, and a ground cover of mosses and lichens. Palmer-Ball et al. (1988) and Campbell et al. (1989, 1990, 1993) described several different examples of open sandstone outcrop and glade communities in the Daniel Boone National Forest. Species common to these studies were creeping aster (*Eurybia*

*surculosa*), forest tickseed (*Coreopsis major*), little bluestem (*Schizachyrium scoparium*), oat grasses (*Danthonia sericea* and *D. spicata*), orange-grass (*Hypericum gentianoides*), rushfoil (*Crotonopsis elliptica*), and small-headed blazing-star (*Liatris microcephala*). Rare species included Appalachian fame-flower (*Talinum teretifolium*), Appalachian stitchwort (*Minuartia glabra*), and silver whitlow-wort (*Paronychia argyrocoma*). These sandstone openings are typically bordered by scrubby pines, oaks, and ericaceous species.

Shale and siltstone glades are less frequent in the state, occurring occasionally in the Appalachians, Knobs, and Shawnee Hills. The loose layers of rocks are unstable and these communities are easily disturbed. Scrubby pines and oaks are usually present, and the herb layer is sparse, with a few grasses (*Danthonia*, *Dichanthelium*, and *Panicum* spp.), as well as a few flowering herbs such as clasping aster (*Symphotrichum patens*), forked-chickweed (*Paronychia canadensis*), and pink catchfly (*Silene caroliniana* var. *wherryi*). Campbell et al. (1992) described siltstone glades in the Morehead Ranger District as an unusual community for the region, with both eastern red-cedar and Virginia pine, infrequent species such as fringe-tree, typical glade grasses, and flowering herbs such as divaricate sunflower (*Helianthus divaricatus*), lacerate blazing-star (*Liatris aspera*), and whorled milkweed (*Asclepias verticillata*).

## CLIFFSIDES AND ROCKHOUSES

Cliffs in Kentucky have been formed by the cutting of streams and rivers through the rock strata, by former geological upheavals, and by the collapse of cave systems in limestone areas. These habitats present severe challenges to plants because of the open exposure. Soil is usually restricted to crevices, there is high erosion, water is often lacking, and growing space is limited. Cliffside communities are characterized by lichens, mosses, gnarled woody plants, woody vines, and ferns (in seepage areas). These communities differ largely according to their substrate and may also include a few grasses and herbaceous species more typical of the particular types of glades and cliff tops associated with these substrates.

Calcareous cliffs typically support the growth of woody plants such as eastern red-cedar, upland oaks, white ash, dwarf hackberry, trumpet-creeper, bittersweet, poison ivy, and Virginia creeper. Grasses include dropseeds (*Sporobolus* spp.) and muhly grasses (*Muhlenbergia* spp.). Characteristic ferns include *Asplenium resiliens*, *A. rhizophyllum*, *A. C. feei*, *C. lanosa*, *Cystopteris tennesseensis*, *Pellaea atropurpurea*, *P. glabella*, and *Woodsia obtusa*. *ruta-muraria*, *Cheilanthes alabamensis* (state Endangered),

Sandstone cliffs may have a scrubby growth of pines, oaks, elms, and ferns such as *Asplenium bradleyi*, *A. montanum*, *A. pinnatifidum*, *A. trichomanes*, *Dennstaedtia punctilobula*, and *Polypodium virginianum*. Several very rare ferns may also occur in these habitats, including *Cystopteris tenuis* and *Woodsia scopulina*.

These cliffline communities have received little attention from researchers, and future surveys are likely to reveal assemblages of rare species in these unusual and difficult-to-reach habitats. Until recently these communities have been little disturbed, but there is a potential new threat from rock-climbers. With the increase in popularity of this sport in recent years, especially in the Red River Gorge area, these cliffline communities, often including several rare species, are being impacted in a variety of ways. The degree of damage has yet to be determined, but there seems little doubt that fragile plant and animal communities along the popular climbing routes could easily be damaged, as has been reported in recent articles (Francis 2001; Kelly & Larson 1997; McMillan & Larson 2002, McMillan et al. 2003).

Another type of cliff community occurs in seepage areas and at the cliff base under overhanging ledges termed rock shelters or rockhouses. These are more protected sites, often with dripping water. Some species occur under or near both calcareous and sandstone rockhouses, including clearweed (*Pilea pumila*), columbine (*Aquilegia canadensis*), pellitory (*Parietaria pennsylvanica*), round-leaved catchfly (*Silene rotundifolia*), and walking fern (*Asplenium rhizophyllum*).

Characteristic species of calcareous shelters and seepage areas include bulblet bladderfern (*Cystopteris bulbifera*), eastern shooting-star (*Dodecatheon meadia*), Kentucky pearlwort (*Sagina fontinalis*, state listed), maple-leaved alum-root (*Heuchera villosa*), pink catchfly (*Silene caroliniana* var. *wherryi*), Virginia bluebells (*Mertensia virginica*), and widow's cross (*Sedum pulchellum*).

Species often found in sandstone rock shelters and seepages include ferns such as *Asplenium trichomanes*, *Dryopteris marginalis*, *Huperzia porophylla*, and *Selaginella apoda*, as well as the mountain meadow-rue (*Thalictrum clavatum*). Walck et al. (1996) provided an extensive discussion of sandstone rockhouses, including information on physical characteristics of the habitat, plant life (nonvascular and vascular), animal life, and human use. They included a detailed account of endemism in these habitats, and listed the following Kentucky taxa as endemic to sandstone rockhouses: Appalachian bristle fern (*Trichomanes boschianum*), Appalachian trichomanes (*Trichomanes intricatum*), Cumberland stitchwort (*Minuartia cumberlandensis*), French's shooting-star (*Dodecatheon frenchii*), meadow-rue (*Thalictrum mirabile*), rockhouse white snakeroot (*Ageratina luciae-brauniae*), round-leaved catchfly (*Silene rotundifolia*), shoestring fern (*Vittaria appalachiana*), small-flowered alum-root (*Heuchera parviflora*), and white-haired goldenrod (*Solidago albopilosa*). All of these taxa except *Heuchera parviflora* are state-listed, and two---*Minuartia cumberlandensis* and *Solidago albopilosa*, are federally listed. Another state-listed species occasionally found in sandstone rockhouses is claw saxifrage (*Saxifraga michauxii*).

Farrar (1998) noted that the endemic rockhouse ferns (*Trichomanes* and spp.), as well as a number of bryophyte taxa, have their closest relatives in tropical regions. These plants have evidently been able to persist in the special conditions of the rockhouse since tropical floras occurred in the region, perhaps for as long as 15 million years.

Sandstone rockhouses and cliff habitats also have archeological significance because of the presence of many artifacts from Native Americans. In the past they have often been targeted by artifact-hunters and often suffered severe damage from digging and other disturbance. In addition, many of these sites have been popular hiking and camping destinations, and the trampling has so damaged the plant populations that many sites are now almost devoid of vegetation.

## **DISTURBED COMMUNITIES**

Nearly all plant communities in Kentucky have been impacted to some degree by human activities. In addition many natural disturbances occur, as in the case of wind, floods, or lightning fires. Disturbed (or cultural) communities are here defined as those communities so heavily impacted by humans that the natural community has been removed and replaced by a one with a high percentage of weedy, non-native species. In some regions of Kentucky, especially urban areas, the disturbed community is the predominant type of vegetation. Examples of disturbed communities include fields, thickets, yards, railroads, vacant lots, sidewalks, parking lots, landfills, mine spoils, revegetated strip mines, waste places, cultivated fields, gardens, farm

ponds, roadsides, and rubbish heaps, i.e., ruderal habitats. These habitats are often occupied by weedy annual herbs but may also include long-lived perennial herbs as well as woody vines, shrubs, and trees. The non-native species come from all over the world, with the greatest numbers native to Europe and Asia. Many have been introduced accidentally, but many others were brought to the United States deliberately for specific purposes, including erosion control, ornamental use, and wildlife foods. Some species have become exceedingly troublesome, for various reasons, including toxic threats (poison-hemlock, *Conium maculatum*), pasture degradation (thistles, *Carduus* and *Cirsium* spp.), and the invasion of natural communities (garlic-mustard, *Alliaria petiolata*; purple loosestrife, *Lythrum salicaria*; privets, *Ligustrum* spp.; and bush honeysuckles, *Lonicera* spp.), often to the exclusion of the native flora. Many of the common weeds of Kentucky are described and illustrated in Haragan (1991).

### **SURFACE-MINE PLANT COMMUNITIES**

Several hundred thousand acres of surface-mined lands now exist in Kentucky (Ulack et al. 1998). Some of these lands were completely abandoned and allowed to undergo succession, and others were subjected to various reclamation techniques, often involving regrading, the construction of sediment ponds, burying of acidic wastes, addition of lime or fertilizer, and planting of various woody plants and herbs. Stricter reclamation requirements were established in 1977 with the passage of the Surface Mine Control and Reclamation Act. A significant series of studies on the success of various reclamation techniques has been conducted by researchers at Berea College, Georgetown College, the Northeast Forest Experiment Station in Berea, Kentucky, and later, in Burlington, Vermont (see Rafaill & Thompson 2002; Thompson & Wade 1991; Thompson et al. 1984, 1986, 1996; Vogel & Thompson 1987; and Wade & Thompson 1993, 1999, 2002). The general conclusion from these studies is that floras resembling those of the surrounding area will eventually develop at these sites, and that these floras are sometimes relatively rich with orchids and other rare or state-listed species.

The results are often dependent on the post-mining soil conditions, grading techniques, selection of species to be planted, and types of plant communities in adjoining areas. In most reclamation efforts non-native species were used, including autumn olives (*Elaeagnus* spp.), bird's-foot trefoil (*Lotus corniculatus*), black alder (*Alnus glutinosa*), clovers (*Trifolium* spp.), fescue (*Festuca* spp.), lespedezas (*Lespedeza* spp.), loblolly pine (*Pinus taeda*), and privets (*Ligustrum* spp.), as well as native species such as black locust, Indian grass (*Sorghastrum nutans*), and switch grass (*Panicum virgatum*). Black locust and black alder, both nitrogen fixers, were two of the most widely used trees. At some sites experimental stands of mixed native hardwoods and mixed pines were established for later monitoring studies. Natural succession by propagules from species in adjoining woodlands was relatively quick, especially by small-fruited trees such as black gum, flowering dogwood, red maple, sourwood, tuliptree, and white ash. The development of a dense tangle of prickly vines and shrubs, especially blackberries (*Rubus* spp.) and greenbriers (*Smilax* spp.), is characteristic of these sites. Many herbaceous invaders also became quickly established, with members of the Asteraceae and Poaceae often predominating.

In general, with natural succession, the post-mining plant community becomes more and more similar to the communities typical of the region. Differences do persist, especially in the composition of the herbaceous flora and in the presence of more wetland species in ponds and other wet areas. Current communities on these surface-mined sites are thus a combination of survivors from plantings and species that have become established naturally. Because of

variations in site locality and condition, and in the variation in reclamation methodology, there is no single community type typical of all surface-mined lands. There is evidence to suggest that the post-1977 reclamation requirements have not been an improvement on earlier techniques. In fact, the current regulations requiring more grading (and soil compaction) and the establishment of an initial cover of grasses and legumes, may retard the natural invasion from surrounding woodlands and may actually lead to lower species richness (Wade & Thompson 1999).