

## Appendix 1: Functional Groups

### Large Trees

These can be defined as woody plants with potential for dominant tall stems, usually exceeding 8 m in height, and often reaching into the canopy of closed forests. Species can be divided into two main subgroups, which are generally distinct with few intermediates. On relatively mesic sites, further divisions can be based on various independent patterns in regeneration, especially species associated with closed forest versus open woodland. Open woodland species tend to be shorter, more often scrubby (with persistent lower branches), thorny, root-suckering, fleshy-fruited, insect-pollinated, and dioecious.

**A. Canopy-concentrated Trees (“intolerants”):** these tend to have relatively rapid extension growth (compared to tolerants in the same habitat), potential to compete and dominate in young canopies, relatively little persistence in understories, and low tolerance of competition: red cedar, tulip tree, sycamore, cottonwoods(\*), black willow(\*), oaks, walnuts, bitternut, osage-orange, coffee tree\*, honey locust(\*), black locust\*, tree-of-heaven\*. Some of these (\*) can spread from vigorous lateral suckers on the roots (or perhaps stems), especially at woodland edges, but these suckers do not persist in deeper shade. Most species are relatively unpalatable, and several have thorns (or prickly leaves in red cedar).

**B. Understory-concentrated Trees (“tolerants”):** these tend to have relatively slow growth (compared to intolerants in the same habitat), concentration in subcanopies, relatively frequent seedlings and saplings in the understories, and moderate to high tolerance of competition: basswoods, maples, buckeyes, elms, hackberry, mulberries, black cherry (?), beech, hickories (most species), ashes. Few of these produce root-suckers (perhaps only red elm in some low understories). Some produce widespread seedlings in the forest but tend to remain highly suppressed in understories unless there are canopy gaps (e.g. black cherry). Some species are relatively palatable, and none have spines or thorns.

**Typical Habitats.** Trees can potentially cover almost the full range of natural habitats in the central Bluegrass, except for rivers and streams, plus scattered small ponds and rock outcrops. At least 90% of the region was “well-wooded” before settlement, without significant gaps between trees, and probably at least 99% had at least scattered trees within the vegetation.

**Local Occurrence.** Most of the originally widespread tree species are still widely scattered or locally abundant in the region (see ecological notes in previous section). Only a few species were probably widespread but now largely disappeared from more settled and farmed sections: slippery elm and perhaps, more locally, tulip poplar, basswoods, beech and northern red oak.

**Problematic Aliens.** The most seriously invasive species are tree-of-heaven, which spreads by wind and root-suckers vigorously, and white mulberry, which spreads by birds and stump suckers vigorously. Other locally problematic species include white poplar (*Populus alba*) and bird cherry (*Prunus avium*), which both spread by root-suckers. Osage-orange is not known to have occurred in Kentucky at the time of settlement, but it has been introduced from its glacial refuge in Arkansas, Oklahoma and Texas; it prospers in rough cattle pastures and associated old fields, and could be considered part of the broader eutrophic woodland community in eastern North America.

**Restoration Notes.** Although most native species are widespread, most are not propagated yet in large numbers from local sources. Some are virtually unavailable from nurseries anywhere in the Ohio Valley. For widespread restoration in the region, it is critical that nurseries develop more potential for propagation of native species.

**Conservation Targets:** focus on propagation and planting of selected intolerants (oaks, bitternut, coffee) and selected tolerants (sugar/black maple, stinking buckeye, slippery elm, shellbark, blue ash). Note also that exotic pests and diseases have greatly affected some species already (especially white walnut, but also white elm, red mulberry). The ashes are now severely threatened by the emerald ash-borer, and a regional salvage program is needed to secure germplasm.

## Small Trees and Shrubs

These woody plants are largely self-supporting (not usually climbing or ground-covering), but do not generally exceed 10 m or reach into forest canopies. They are divided provisionally into three groups, but there is much intergradation and further variation in growth form. Further division can be based on closed forest versus open woodland species (parallel to larger trees).

**A. Small Trees:** these tend to produce single dominant stems, and often reach 4-8 m in height: pawpaw\*, sandbar willow\*, hairy sumac\*, hawthorns (most species), crabapples (most species), plums\*, Carolina buckthorn, Russian olive\*, redbud, hornbeam (and hophornbeam), flowering dogwood, black-haw viburnums\*. Several of these (\*) can produce vigorous lateral suckers, especially at woodland edges, but except for pawpaw, these suckers do not generally persist in understories. Most species are relatively unpalatable or thorny.

**B. Large Shrubs:** these tend to produce many stems from clumps or lateral suckers, and generally become only 2-4 m tall: spicebush, witch-hazel, bladder-nut\*, shrubby willows\*, spindle\*, burning-bush\*, smooth sumac\*, wafer-ash\*, prickly-ash\*, Eurasian buckthorns (\*), hazel\*, osier dogwoods\* (most species), buttonbush\*, privets\*, arrow-wood viburnums (\*), elder-berry\*, bush-honeysuckles. Most species (\*) produce lateral suckers, and in several cases these persist in understories. Few species are highly unpalatable, and only prickly-ash has thorns.

**C. Small Shrubs:** these usually produce many low branches or lateral suckers, and become only 1-2 m in height (or 4 m in lowland cane): barberries, gooseberries, leatherwood, shrubby St. John's worts, aromatic sumac\*, ninebark, roses\* (most species), raspberries\* & blackberries\* (*Rubus* spp.), ravine buckthorn\*, hydrangea\*, coralberry\*, cane (*Arundinaria gigantea*)\*. Laterally suckering species (\*) are concentrated in more open disturbed woodland. The "canes" of some species (*Rubus*, *Arundinaria*) live only ca. 2-5 years, with branching but no true extension growth after the first year. Some are highly unpalatable; several are thorny or spiny.

**Typical Habitats.** Small trees and shrubs can potentially cover almost the full range of natural habitats in the central Bluegrass, except for rivers and streams, plus scattered small ponds and rock outcrops. Dense thickets and shrubberies, including canebrakes, appear to have covered ca. 1-10% of the landscape before settlement.

**Local Occurrence.** Most of the originally widespread native small trees and shrubs are now uncommon or rare, due to extensive clearance of the original woodland, grubbing out of woodland-pastures, and cleaning out of fencerows. The only widespread to locally abundant species in the modern landscape are four bird-dispersed, root-suckering species with generally low stature: raspberry, blackberry, elderberry and coralberry. At the farm, or nearby (on similar farmland within five miles), other native species have been found in small numbers, scattered thinly or restricted to patches: pawpaw (patches in deeper woods), spindle (scattered widely), wafer-ash, prairie rose, common plum, downy hawthorn (locally frequent in open woods), cock-spur hawthorn, redbud, Carolina buckthorn, roughleaf dogwood, smooth black-haw, cane (one roadside patch known in Harrison County).

**Problematic Aliens.** The most seriously invasive species are burning bush, multiflora rose and Amur bush-honeysuckle. Others with potential for local problems at least include the Japanese barberry, Siberian crabapple, Dahurian buckthorn, Russian olive, common privet. Amur bush honeysuckle is one of the most serious problems for restoration of native woodlands.

**Restoration Notes.** During initial restoration, rather than relying of relatively expensive manual, mechanical or chemical control of these species, it will probably be useful to try prescribing intensive browsing by livestock in confined spaces during restricted seasons. Most of the invasive shrubby species are relatively palatable under certain conditions, at least to goats. Moreover, in the long-term we know that naturalistic browsing regimes will be needed, using livestock or ideally managing native ungulates. See also notes under "trees".

**Conservation Targets:** small trees (A) & large shrubs (B) in general; focus on cane among small shrubs (C).

## Vines and Subshrubs

**Vines.** These plants are able to twine and climb onto other plants, especially trees and shrubs, or onto rockfaces and other structures, but several can also grow horizontally and cover ground if competition is lacking.

**A. Attaching Woody Vines** (“lianes”): these often climb to 8-10 m or more, generally (except kudzu) with tendrils (\*) or adventitious roots (#): coon-grape\*, Virginia creeper\*, grape-vines\*, purple winter-creeper#, poison-ivy#, cross-vine\*, trumpet-creeper#, English ivy#, woody greenbriars\*. In Virginia creeper and cross-vine, the tendrils become attached with padded holdfasts. In most cases (perhaps not greenbriars), these species are also able to grow horizontally on the ground but without flowering. All species have small bird-dispersed fruits.

**B. Twining and Scrambling Vines** (to be separated for some purposes): these plants usually reach only 2-8 m above the ground, with no tendrils or adventitious roots, and woody growth often limited to lower parts or almost lacking: Japanese clematis, Virgin’s bower, moonseeds (\*), bittersweets, hops\*, wisterias, kudzu, native honeysuckles and Japanese honeysuckle. Plants can also spread on the ground, and in a few cases (\*) there are rhizomes; kudzu is distinct in having large tubers (?). At least in southern regions, some of these species—or related species—are able to climb considerably higher, with twining woody stems that become much thicker: Mississippi moonseed (*Calycocarpum*), Asian bittersweet, Japanese wisteria, kudzu, and Japanese honeysuckle; these should be considered a distinct “twining woody” subgroup (1), versus the “scrambling subwoody” remainder (2). Note also the tendency of some small shrubs (especially roses and briars) to behave as prostrate or climbing vines in some situations.

**C. Perennial Herbaceous Vines:** these have no woody development, but often climb to 2-4 (8) m above ground: leather-flowers, climbing buckwheats, climbing milkweeds (*Cynanchum*, *Gonolobus*, *Matelea*), woodland passionflower, bindweeds\* (*Convolvulus*, *Calystegia*), potato-yam#, wild-yam\*, herbaceous greenbriars#. Tendrils are produced only in herbaceous greenbriars. In several cases, plants overwinter as rhizomes (\*) or tubers (#).

**D. Annual Herbaceous Vines** (or perhaps biennial in some cases): these have no overwintering organs other than fruits and seeds, but they have various ways to establish and climb to various heights each year (mostly 1-4 m): common passion-flower, Japanese hops, hog-peanut, vetches (biennial in some cases), bur-cucumber, morning-glories, dodders. Tendrils are produced only in the exceptionally high-climbing bur-cucumber (sometimes 5-8 m). Haustoria attach the parasitic dodders to their hosts. In Japanese hops, there are abundant retrose prickles (similar to some dewberries). In hog-peanut, there are subterranean cleistogamous flowers that produce fruits acting like tubers.

**Miscellaneous Subshrubs and Similar Forms.** A few additional small or short woody, semi-woody or vining plants have unusual life-forms and must be noted separately. These are generally just 0.1-0.4 m in height. The following species occur in the central Bluegrass, but only the first (1) is common. For some purposes, most of these species (except 1) could be grouped with ground-covering “Low Perennial Herbs” (see below).

(1) Epiphytic Hemiparasite: mistletoe (*Phoradendron serotinum*).

(2) Cactus: prickly-pear (*Opuntia humifusa*)

(3) Stoloniferous Subshrubs: “mountain-lover” (*Paxistima canbyi*) and “cleft-phlox” (*Phlox bifida*).

(4) Stoloniferous Sprawler: “running strawberry-bush” (*Euonymus obovatus*).

(5) Stoloniferous Cane: dewberry (*Rubus flagellaris*, sensu lato); perhaps also rhizomatous; could be affiliated with some prostrate subwoody vines.

**Typical Habitats.** Vines of various types can potentially cover almost the full range of natural habitats in the central Bluegrass, except for rivers and streams, plus scattered small ponds and rock outcrops. Grape-vines, in particular, were probably rather frequent in the more open woodlands and thickets of the region.

**Local Occurrence.** Native species that are now widely scattered to locally abundant in the region include: (a) Virginia creeper, common grapevine, poison-ivy, trumpet-creeper; (b) moonseed; (c) climbing buckwheat, common climbing milkweed, common bindweeds; (d) morning-glories, common passion-flower, bur-cucumber, some dodders; (e) mistletoe. Other species found at the farm include: (a) cross-vine, bristly greenbriar; (b) virgin's bower; (e) common dewberry. Additional species that may have been much more widespread include: (b) American bittersweet, American hops; (c) woodland passionflower, common wild-yam, eastern herb-greenbriar; (d) hog-peanut; (c) prickly-pear. Hog-peanut ("peavine") was one of the most abundant species in the "herbage" of the original woodlands, but it has been virtually eradicated, probably with the help of hogs rooting in the woodland during early settlement. The curious absence of bittersweet from much of the region might also be attributed to livestock in the past, or perhaps to increased deer populations, or perhaps to the alien "euonymus scale-insect", which has been damaging most members of the bittersweet family (Celastraceae) in the region.

**Problematic Aliens.** The most seriously invasive species in the central Bluegrass are (a) purple winter-creeper and (b) Japanese honeysuckle. Other aliens are generally more local or more serious in other regions: (a) English ivy; (b) Japanese clematis, kudzu, Asian bittersweet; (c) potato-yam; (d) Japanese hops, some vetches. The winter-creeper, due to its ability for covering ground in the shade and climbing up trees, is becoming the most serious alien problem for restoration of woodlands in this region, even more than Amur bush-honeysuckle. For further discussion, see notes above related to the honeysuckle, and elsewhere within this document.

**Restoration Notes.** Most of the formerly widespread species appear to recover and spread fairly readily. But some of the less common to rare native species that have declined greatly will need special efforts in propagation. The hog-peanut, in particular, will need extensive trials and experimentation for determining how best to reintroduce it. See also notes under "trees" and "small trees and shrubs".

**Conservation Targets:** focus on propagation and planting of bittersweet (B), greenbriars (C), and especially hog-peanut (D)

**Low Perennial Herbs** (mostly 0.1-0.4 (0.8) m tall)

**A. Determinate Spring Woodland Herbs:**

**Characters:** flowers (or spores) usually produced in Mar-May; fertile stems mostly 0.2-0.4 m tall, usually with leaves absent or highly reduced leaves, or with only 1-3 fully developed leaves (the subtended buds suppressed or absent); little or no fresh leafy growth produced during summer-fall, original leaves persisting in some cases, but usually not evergreen (except *Hepatica*); usually with rhizomes, bulbs, corms or tuberous roots, often dormant in summer and fall. These varied forms can be divided in various ways; for some purposes, subgroup 1a could be transferred to 2.

**Subgroups and Examples.**

**(1) Leaves absent or highly reduced on fertile stems;** plants becoming completely dormant during summer-fall, except in species with creeping rhizomes (which could be transferred to 2).

(1a) Leaves cordate or trifoliate, usually without deep lobing (except later leaves in some violets), produced directly from rhizomes and persisting into summer; rhizomes present, short to moderately long; plants mostly toxic, acrid or very bitter: wild ginger, hepaticas, twinleaf, bloodroot, stemless blue violets, barren strawberry.

(1b) Leaves deeply lobed or compound, except for basal leaves in some cases, withering rapidly or (?) somewhat persistent; growing from small bulbous offshoots, small tubers or tuberous roots, but without elongating stolons or rhizomes; plants mostly toxic or peppery: ?larkspur, rue-anemone, ?lesser crowfoots, lesser celandine, dicentras, some cardamines (*bulbosa*, *douglasii*, *angustata*), harbinger-of-spring.

(1c) Leaves broadly lanceolate to linear, undivided, withering rapidly in Apr-Jun; growing from corms, taproots or bulbs, with offshoots in some cases (stoloniferous in trout-lilies, branched root in bluebells), but without rhizomes; plants mostly palatable and not toxic (except some bulbs of alien species): spring-beauty, bluebells, trout-lilies, daffodils & allies, ramps & some onions & allies, hyacinths & allies.

**(2) Leaves well-developed on fertile stems;** plants usually with original leaves persisting into summer or fall (to a lesser extent in trilliums); leaves deeply lobed to whorled.

(2a) Without typical rhizomes or basal offshoots, but usually with taproots, thickened to tuberous roots, or corms; fertile stems mostly terminating in spikes or umbels, flowers small: grape-ferns & allies, false rue-anemone, early rue, some cresses (taproots), ?eulophus (tuberous but somewhat running roots), jack-in-the-pulpit (corm), carrion-flower (tuberous).

(2b) With short stout caudex-like rhizomes (\*) or basal offshoots (#): maidenhair fern (\*), common anemone (\*), wood-geranium (\*), wood spurge (#), some cresses (?), some violets (?), trilliums (\*).

(2c) With running rhizomes (rhizome constricted at intervals in *C. concatenata*): common fragile fern\*, [wood-anemone\*], goldenseal\*, mayapple\*, some cardamines\* (*diphylla*, *concatenata*), [whorled pogonia\*].

**Typical Habitats.** In the wild, all species are typical of closed forest with deep shade, though a few are able to persist locally (e.g. mayapple) or spread widely (e.g. common blue violet) in more open vegetation. Most species are somewhat toxic, acrid, peppery or medicinal (except for the blue violets and those that wither earlier), and they may resist browsing to a certain extent but not frequent trampling or rooting.

**Local Natives.** Native species have generally disappeared from the region, even in largely native vegetation, except for about four widely scattered or locally abundant species: rattlesnake-fern, lowland lesser crowfoot, spring-beauty, cleft tooth-wort, blue violets. At the farm, at least a dozen additional species have been found in small patches: dissected grape-fern, common fragile-fern, upland lesser crowfoot, Dutchman's-breeches, squirrel-corn, wood-geranium, common toothwort, woodland bittercress, harbinger-of-spring, wood-spurge, yellow trout-lily, white trout-lily, sessile trillium, wild hyacinth. Up to seven more may well have occurred widely before settlement: wild ginger, larkspur, false rue-anemone, twinleaf, bloodroot, jack-in-the-pulpit, wild onion.

**Problematic Aliens.** There are few widespread aliens in this group, except for some of the horticultural lilioids with bulbs; most are not aggressive invaders. The lilioids do cause local problems; see also Star-of-Bethlehem

under “short-tussock graminoids”. Also, lesser celandine has become locally abundant in some urban-suburban areas (especially the Louisville parks). Due to their general dormancy, with underground storage, these species are difficult to control and need constant attention within natural areas.

**Restoration Notes.** Restoration of less disturbed, shady woodland will generally be essential for reintroduced species (e.g. wild ginger, larkspur, jack-in-the-pulpit). In the long-term, sugar maple should provide much of this shade, but in the short-term faster growing species can also serve (e.g. boxelder, white ash).

**Conservation Targets:** most native species will deserve propagation, especially less common species that may still spread relatively fast during initial restoration of shady woodland: fragile-fern, wild ginger, twinleaf, bloodroot, larkspur, false rue-anemone, mayapple, wood-spurge, sessile trillium, wild onion. Trout-lilies and wild hyacinth may be slower to grow but they are, nevertheless, a priority for horticultural work.



## B. Short Spring-Summer Perennials (mostly creeping)

**Characters:** flowers (or spores) mostly produced in Apr-Aug; fertile stems mostly 0.1-0.4 m tall, mostly with several well-developed leaves; plants mostly with stolons, rhizomes, running roots or taproots; sometimes producing fresh leafy tufts through summer/fall, the basal leaves often persisting through most of the year, sometimes strongly evergreen.

### Subgroups and Examples.

(1) **Early flowering species of mesic or subxeric woodland (mostly shorter rhizomatous):** flowering in Apr-Jun; mostly with rhizomes (\*) of short to moderate length, sometimes with stolons also (#); leaves mostly compound to highly lobed and alternate (or simple to somewhat lobed and mostly opposite); largely restricted to woodland; probably to be subdivided further, some perhaps transitional to “determinate spring woodland herbs”: [ground-pine] ?beech-fern, ?columbine\*, some buttercups (\*), ?yellow poppy\*, wood chickweeds\*, some cresses (?*Iodanthus*—or perhaps biennial), wood stonecrop, most yellow-sorrels (\*), some violets (*pubescens*, ?*canadensis*\*), Jacob’s ladder, some phloxes\*, some bedstraws & bluets, woodland milkweed, some skullcaps\* (?*ovata*), running waterleaf\*, ?sarsaparilla, ?ginseng (taproot), ?gregarious sanicle\*, ?lesser wood-parsnip, ?valerian\*, woodland ragworts# (*aureus*, *obovatus*).

(2) **Stoloniferous species, mostly with intermediate flowering, mostly in disturbed woodland or edges (especially flooded or trampled):** flowering mostly in May-Jul; mostly with extensive stolons running close to ground (some also with short rhizomes/caudices); leaves either low, simple and opposite, or more erect, trifoliate and alternate (sometimes with no leaves on flowering stems-i): [some clubmosses, spikemosses@] some buttercups, ?some chickweeds & allies, strawberries & allies (i), some clovers (i) & allies (\$), crownvetch, moneywort@, ?some phloxes, glade petunia\$, fogfruit@, some skullcaps (*nervosa*), ?glade savory, gill-over-the-ground, selfheal, ?pusseytoes (i).

(3) **Later flowering species of open woods and fields (mostly longer rhizomatous):** flowering mostly in Jun-Sep; mostly with rhizomes (or creeping roots in red sorrel), but without extensive stolons; leaves mostly compound, lobed or cordate-sagittate, mostly alternate; mostly in thin woods and openings: [ground-cedar], red sorrel (\$), running yellow-cress (*sylvestris*) @, ?motherwort (*cardiaca*), crown-vetch, ?lesser vervain\$, ?upland ragwort (*anonymus*), ?ox-eye daisy, yarrow.

**Typical Habitats.** Although covering a wide range of habitats, most species do particularly well in disturbed transitions between shady and open habitats. Some can even be found in old residential lawns that have not been chemically treated (creamy violet, false strawberry, running buffalo-clover, European self-heal, gill-over-the-ground), together with a few of the more determinate spring flowers (spring-beauty, common blue violet).

**Local Natives.** Native species have generally disappeared from the region, even within largely native vegetation, except for three widely scattered or locally abundant species: creamy violets, wild-strawberry, self-heal. At the farm, only two additional species have been found in small patches: running buffalo clover (an endangered species) and woodland bedstraw. However, at least a dozen more may well have occurred widely before settlement: including columbine, common woodland buttercup, wood-chickweed, purple-rocket, common stone-crops, woodland yellow-sorrel, hairy yellow violet, woodland phlox, Jacob’s ladder, running waterleaf, lanceolate bluets, gregarious sanicle.

**Problematic Aliens.** Unfortunately, aliens in this group have become locally abundant, especially false strawberry and gill-over-the-ground in woodlands, and several others in open areas (buttercups, clovers, crown-vetch, red sorrel, running yellow cress, ox-eye daisy, yarrow). In addition, several aliens of more weedy biennial or annual types (see below) often competing directly for space with the clover.

**Restoration Notes.** Experiments with disturbance regimes and alien reduction within woodlands and grasslands will be needed for recovery of some rarer species, especially the endangered running buffalo clover, which formerly grew along paths in seasonally browsed woodland.

**Conservation Targets:** focus on propagation of early flowering woodland species (A), especially buttercups, wood-chickweed, woodland phlox, woodland bedstraw, running waterleaf, gregarious sanicle; also, pursue

research on stoloniferous species in relation to disturbance regimes, for recovery of running buffalo clover.

### C. Rosette Spring-Summer Perennials

**Characters:** flowers (or sporangia) produced mostly in Apr-Jun (or to Sep in some orchids); plants mostly 0.1-0.4 m tall, usually forming more or less overwintering rosettes of basal leaves with taproots but no pronounced stolons, rhizomes, corms or bulbs (some with short stout caudex-like rhizomes\*); basal leaves relatively large, often unlobed to partially lobed, cauline leaves usually absent (i), reduced (ii), or more deeply divided (iii). Note some later flowering species have basal leafy tufts; distinction needs to be clarified. This is a varied miscellaneous group, and the definition of subgroups should be developed further; woodland ferns should probably be distinguished.

#### Subgroups and Examples

**(1) Typical of relatively undisturbed woodland (often in rocky ravines);** leaves large, pinnate-bininnately divided: woodferns (especially *carthusiana*\*), Christmas fern.

**(2) Typical of relatively undisturbed woodland (often in rocky ravines);** leaves mostly moderate-sized and mostly undivided: ?some pinks (*Silene wherryi*), some cresses (*Draba ramosissima*, ?*Boechera perstellata*\*) (iii), saxifrages (i), alumroots & allies (ii\*), water-pimpernel (ii), shooting-star (i), broomrapes (ii), rosette-waterleaf (ii), wild comfrey (ii), showy orchid (ii).

**(3) Typical of thin (often disturbed) woodlands or grasslands;** leaves mostly rather small or pinnately lobed-divided, mostly rather resistant to trampling, sometimes with prostrate leaves and relatively flexible petioles: ?ebony spleenwort, docks (ii), avens (iii), ?alsike clover (ii), some plantains (i), lyre-leafed sage (iii), chicory (ii), dandelion (i), ?ladies-tresses orchids (ii)

**Typical Habitats.** These species occur in various woodland or grassland habitats. Some are restricted to rocky or riparian habitats, or to certain saprophytic or parasitic associations. But others typically occur on more or less disturbed ground, with occasional trampling or mowing during summer and winter—plus brief opportunities for flowering during intervals between disturbances.

**Local Natives.** Five native species are widely scattered to locally abundant in the region: ebony spleenwort, broad-leaved plantain, early & common avens, lyre-leafed sage. Five additional species have been found at the farm: rich woodfern, Christmas fern, water-pimpernel, early and common ladies-tresses orchids. It is possible that a few others were more widespread before settlement, but they are mostly restricted to rockier or drier slopes (e.g. marginal woodfern, blunt cliff-fern, rosette-waterleaf, wild comfrey, showy orchid).

**Problematic Aliens.** Three aliens of sunny habitats—English plantain, dandelion and chicory—have become abundant, and may compete for space with some natives in old fields.

**Restoration Notes.** Horticultural trials, experiments with various disturbance regimes, may be needed to understand how recovery of some species should proceed, especially the orchids and some of the woodland species (especially rich woodfern, water-pimpernel, perhaps showy orchid).

**Conservation Targets:** restrict initial attention to a few selected woodland species that deserve propagation and recovery trials, in order to improve understanding of their ecology: such as rich woodland fern, water-pimpernel, wild comfrey, showy orchid.

## Medium Perennial Herbs

**General Characters** (compare with “low” or “tall” perennials): stems mostly up to 0.4-1 (2) m tall, with many leaves or a few highly divided large leaves, and in some cases branching freely; flowers produced mostly in late spring to late summer (May-Aug), on various types of inflorescence and with various colors (often blue in contrast to taller perennials), the perianth often reduced in various ways (sometimes wind-pollinated).

### A. Distichous Woodland Perennials

**Characters:** leaves ovate-lanceolate to lanceolate, more or less distichous along erect or arching stems; rhizomatous; mostly palatable to generalist herbivores. This small group consists only of a few relatively broad-leaved lilioids, with the possible addition of some composites (see also “summer perennials”) and grasses (see also “woodland graminoids”).

**Regional Examples:** ??blue-stem goldenrod (*caesia*), false hellebores, Solomon’s seals & allies, bellworts, ?larger ladies-slippers (but not truly distichous or rhizomatous), some spiderworts & allies, ??beech-grass (*Brachyelytrum*), ??wood-oats (*Chasmanthium*).

**Typical Habitats.** All species are typical of mesic to subxeric woodlands or edges, mostly on or near steeper slopes. Most or all species are somewhat palatable to generalist herbivores, and often absent from browsed woods.

**Local Natives.** Away from more forested ravines and riparian corridors, these species are rare or absent in the region, except perhaps for Solomon’s seal (especially the polyploid “*commutatum*” form). None have been found at the farm. However, some could have been fairly widespread before settlement along larger streams (including blue-stem goldenrod, broad-leaved spiderwort, wood-oats). It is likely that the common presence of hogs in woodlands after settlement led to much reduction in rhizomes as well as herbage.

**Problematic Aliens.** There are no alien species in this group.

**Restoration Notes.** These species are slow to spread from seed (except perhaps wood-oats), but plantings can be gradually established in shady woodland at the farm.

**Conservation Targets:** focus on this small group in general, for propagation and recovery on trial plots in shady mesic woodland and edges; especially the common Solomon’s seals; see also allied grasses, especially wood-oats.

## **B. Summer Woodland Perennials with Compound or Lobed Leaves**

**Characters:** plants usually 0.6-1.2 (2) m in height, mostly without extensive rhizomes or stolons and pronounced basal leafy tufts; mostly without special underground storage or taproots; leaves alternate, compound or deeply lobed, the largest ones usually born near the middle of fertile stems or on long erect petioles from the base (the fertile stems naked in a few cases), often becoming relatively horizontal and “frondose”; flowers mostly small or reduced, whitish or yellowish, in dense panicles, spikes, umbels or composite heads, displayed well above the leaves. A few later flowering coneflowers and other species may be tentatively included as the second subgroup.

### **Subgroups and Examples:**

(1) Flowering in May-Jul (Aug); flowers often pollinated by flies; with little or no rhizome: [?tall larkspur] doll’s-eyes, black cohoshes, most rue, ?tall anemone, blue cohoshes, false goat’s beard, goat’s-beard, ?some tick-trefoils (*cuspidatum*, *nudiflorum*), cicelies, greater wood-parsnip, golden alexanders, ?*Taenidia*, ?honestwort, green dragon.

(2) Flowering in Aug-Sep; flowers more showy, not pollinated by flies; more or less rhizomatous, often with basal leafy tufts; perhaps tending to “tall perennials”: ?sensitive-fern, ??monkshood (a weird semi-twining plant with large blue flowers and turnip-like roots connected by short-runners), ?lobed river-mallow (*Napaea*), ?lowland coneflower, ??gray-headed coneflower, ??some wood-lettuces (*altissima*).

**Typical Habitats.** Most species are typical of mesic woodlands on fertile soils, especially in areas with more light under canopy gaps, in gullies or along streams; a few occur in subxeric woods, edges and grasslands. Most species (except tick-trefoils) are relatively unpalatable or moderately toxic to generalist herbivores. However, most species (except the coneflowers) probably have low tolerance for even occasional trampling, flooding, burning or other damage during the growing season.

**Local Natives.** Away from forested ravines and riparian corridors, these species are generally absent, but a few of the more riparian species do occur in small patches: smooth cicely, golden alexanders, honestwort, lowland coneflower. At the farm, only single patches of honestwort and golden alexanders have been found. Based partly on old records and modern remnants, it is likely that some species now largely confined to ravines and hills were much more widespread in current farmland before settlement: including blue cohosh, wood-parsnips (bipinnate & trifoliolate), gray-headed coneflower, green dragon.

**Problematic Aliens.** There are no naturalized aliens in this group.

**Restoration Notes.** Selected plantings can be tried at the farm in suitable habitat, in order to observe if and how such species can be recovered.

**Conservation Targets:** focus on this small group in general, for propagation and recovery on trial plots in shady mesic woodland and edges; especially doll’s eyes, blue cohosh, sweet cicely, golden alexanders, lowland coneflower, green dragon.

### C. Summer-Fall Woodland Perennials with Simple Broad leaves

**Characters:** leaves opposite or less often alternate, simple, unlobed, ovate to broadly lanceolate; flowers mostly produced in May-Aug (some to Oct), large to small or reduced, of various types and colors, in axils of leaves or in various bracteate inflorescences, spikes or heads (but not umbels or large composite heads). Note that there is some gradation into “summer-fall grassland perennials”, especially within some groups of closely related species.

#### Subgroups and Examples

(1) **Non-running (or with only short offsets):** flowering mostly May-Aug; usually without basal tufts: ?four-o’clock, green-violet, nose-burn (twining), water-hemp, ?turtle-head, ?beard-tongues (perhaps tufted), ?some yellow-foxgloves, most wild-petunias, lopseed, horse-gentians, ?some rosinweeds (true *latifolium*), wood joe-pye-weed, white snakeroot, ?pink mistflower.

(2) **Running without basal tufts (rhizomatous):** flowering mostly June-Sep: wood-knotweed\*, bloodleaf\*, enchanter’s nightshade\*, wood nettle\*, riparian loosestrife\*, some skullcaps\* (*incana*), most woundworts\*, white wood-mint\*, woodland bergamot\*, ?common water-horehound#, ?some sunflowers (*microcephalus*), some goldenrods\* (*flexicaulis*), ?some asters\* (*prenanthoides*, ?*phlogifolius*), ?blue mist-flower\*.

(3) **Short-running with basal tufts (short-rhizomatous):** flowering Aug-Oct, or often non-flowering for many years in deeper shade; basal leaves broadly ovate to cordate or hastate; plants tall in some cases (\$), competing with “tall summer-fall perennials” or “tall annuals”: ?some rosinweeds (*wasiotensis*\$), ?some sunflowers (*atrorubens*\$), ?broad-leaved purple-coneflower, ?some Indian-plantains\$ (*muhlenbergii*, *atriplicifolia*), some asters (*schreberi*, *divaricatus*, *cordifolius*, *shortii*), some goldenrods (*arguta*, *harrisii*, *ulmifolia*, *sphacelata*, ??*caesia*), ?some wood-lettuces (*altissima*\$).

**Typical Habitats.** Most species are typical of mesic to hydric woodlands or edges, especially in stream corridors; some occur in subxeric woods and edges, but only a few typically occur in full sun (blue mist flower). Most species are moderately or highly palatable to generalist herbivores (except perhaps white snakeroot), but a few have stinging hairs.

**Local Natives.** Only five native species are widely scattered to locally common in the region: wood-knotweed, lowland wild-petunia, lopseed, white-snakeroot, blue mist-flower. At the farm, two additional species have been found: enchanter’s nightshade and lowland beardtongue. Several others probably occurred much more widely in the region before settlement: including wood-nettle, water-hemp, broad-leaved horse-gentian, downy beardtongue, white wood-mint, zig-zag goldenrod, Short’s aster, wood joe-pye weed.

**Problematic Aliens.** There are no invasive aliens in this group, except perhaps the mints in transitions to sunny subaquatic situations.

**Restoration Notes.** Several species deserve to be priorities for restoration throughout large areas of woodland, especially those that can form dense colonies to exclude alien biennials and annuals (see below). Prioritized species should include wood-nettle and white-snakeroot, in particular, since there are clues that these were locally abundant before settlement. White-snakeroot is somewhat immune to browsing, well-dispersed, and remains locally abundant in the landscape. In contrast, wood-nettle is relatively palatable despite its stinging hairs, and its rhizomes were probably much reduced by hogs (as in the Great Smoky Mts. where often replaced by white-snakeroot); it is confined to scattered sites along larger stream corridors.

**Conservation Targets:** focus initially on propagation and reintroductions of species able to spread relatively fast in restored woodland, especially enchanter’s nightshade, wood-nettle, zig-zag goldenrod, Short’s aster, white snake-root; several other less common species will deserve some attention for special ecological, botanical or horticultural interest (e.g. green violet, white wood-mint, woodland bergamot, pink mist-flower).

## D. Summer-Fall Grassland Perennials (usually with narrow or lobed leaves)

**Characters:** plants mostly with tuberous roots, taproots, running roots, rhizomes or stolons; leaves alternate or less often opposite, mostly simple or less often 3-7-compound or whorled, mostly narrowly lanceolate (especially in sunnier or drier sites but more ovate in some cases); flowers usually produced in Jun-Aug (Sep), mostly of moderate size, of various types and colors, in axils or leaves or various bracteate inflorescences, spikes, umbels or heads. Note that there is much gradation into “summer-fall woodland perennials”, especially within some groups of closely related species; differences in morphology and habitat are often unclear. Species with basally-disposed leaves, grading into “rosette” plants, deserve to be a subgroup.

### Subgroups and Examples:

(1) **Non-running:** often with taproot more or less developed (especially the milkweeds), and sometimes tending towards “rosette” plants or biennials; leaves sometimes 3-5-palmately divided (not pinnate); sometimes relatively palatable (especially the legumes): some pinks &ampions (!*stellata*), ?water-docks (*verticillatus* with taproot/rosette, *altissimus* without), common St. John’s worts, palmate meadow cinquefoil, red clover (short-lived), alfalfa (short-lived), most tick-trefoils, most lespedezas, some bedstraws, some milkweeds (*incarnata*, *viridis*, *tuberosa*), ?some beardtongues, ?some yellow-foxtongues, ?tall gromwell, ?some rosinweeds (typical *trifoliatum*, *terebinthaceum*), ?some coneflowers, sneezeweed, ?some goldenrods (*speciosa*, *erecta*, *hirsuta*), ?some asters (?some *laevis*), false boneset, elephant’s foot.

(2) **Running Terrestrials:** mostly with rhizomes (\*), or occasionally stolons (#) or running roots (\$), never (?) with taproots; leaves sometimes pinnately lobed-divided (not palmate or whorled); sometimes relatively toxic or prickly: soapwort\*, willowherb (\*), ??glade St. John’s worts (\*), agrimonies (\*), ?common moneyflower (\*), butter-and-eggs\*, maddog skullcap\*, ?germander\*, ?blue wood-mint\*#, common bergamot\*, common dragon-head\*, ?most mountain-mints\*, common vervain (\$), ?tall hydrolea\*, some ground-cherries\*, yellow-berried nightshade\*, ?some sunflowers\* (*hirsutus*), ?some coneflowers# (*speciosa*, *tenax*), ?gray-headed coneflower (\*), woodland coreopsis\*, running wormwood\*, some goldenrods\* (*juncea*, *nemoralis*), some asters\* (?*urophyllus*, ?*laevis*, *patens*, *ontarionis*, *pilosus*), some bonesets\* (*album*, *pubescens*, *altissimum*), running thistle (\$).

(3) **Running Subaquatics** (see also “aquatic plants”): mostly with stolons (#) or rhizomes (\*); leaves often relatively narrow or with variable pinnate lobing; often sharp, peppery or aromatic, but not highly toxic: some smartweeds\*, ditch-stonecrop\*, water-cress#, mermaid-weed\*, water-primroses#, water-willow\*, meadow loosestrife (*lanceolata*), riparian dragon-head\*, ?some mints\*, ?most water-horehounds\*#

**Habitats.** Most species are typical of thin woodlands or grasslands, on mesic to xeric or hydric sites; few are typical of deep shade. There is much variation in palatability and toxicity, though few species are highly toxic. Some species appear relatively tolerant of browsed or grazed conditions (some milkweeds, ground-cherries, yellow-berried nightshade, most thistles).

**Local Natives.** Nine native species are widespread in the region, mostly in the running subgroup, and these may have increased since settlement: water-primrose, common tick-trefoil, germander, common bergamot, smooth & hairy ground cherry, yellow-berried nightshade, common & downy meadow aster, elephant’s foot. At the farm (or nearby), five additional species have been found, mostly in small numbers: hairy agrimony, green & orange milkweeds, common monkey-flower and blue wood-mint. At least five other species may have been more widespread before settlement. Species that are rare or expected at the farm include some that are typical of transitions to woodland or riparian vegetation: starry campion, willowherb, agrimonies, beardtongues, running coneflowers. There is a relatively low diversity of native grassland species in the central Bluegrass, and no evidence of extensive grassland before settlement. In contrast, regions of the state where extensive grassland did exist have at least two to three times as many native grassland species; this is summarized further below (under “tall perennials”).

**Problematic Aliens.** Alien species are relatively common, and some present serious problems for restoration of native grassland at some site, especially sericea lespedeza and running thistle; other widespread species include common St. John’s wort, palmate meadow cinquefoil, soapwort, butter-and-eggs.

**Restoration Notes.** Various experimental treatments will be needed to determine the best prescriptions to promote native grassland species.

**Conservation Targets:** focus initially on somewhat restricted, uncommon or rare species that can be readily propagated and widely reintroduced to open woodlands, old fields or other restored grasslands, especially agrimonies, milkweeds, germander, blue wood-mint, common bergamot, beardtongues, running coneflowers, gray-headed coneflower; several other species will deserve attention in relatively dry or damp habitats, or for other particular interests.



## Tall Summer-Fall Perennials (“forbs”)

**Characters:** usually reaching (0.5) 1-2 (4) m in height, with withering of lower leaves before flowering; mostly flowering in Jul-Oct, mostly with large showy inflorescences (white, pink-purple or yellow); leaves various, mostly simple and unlobed, but often hastate or whorled.

### Subgroups and Examples

**(1) Non-running:** without rhizomes, or sometimes with short ones (\*): often with taproots, tuberous roots or bulbs: pokeberry, [?royal catch-fly], purple loosestrife, swamp mallows, bundle-flower, senna, ?some tick-trefoils (*cuspidata*, *sessilifolia*), ??some lespedezas (*capitata*, *hirta*), riparian phlox (\*), figwort, ?mullein foxglove (a hemiparasite), giant hyssop, marsh vervain, ?water-hemlock, ?some rosinweeds (*integrifolium\**, *laciniatum*), tall wood-rosin, ox-eye sunflower, wingstems, tall coreopsis, ironweeds, ??some Indian plantains, tall purple aster (\*), common joe-pye-weed, some bonesets (*serotinum*, *perfoliatum*), giant wood-lettuce, Michigan lily.

**(2) Running:** mostly with rhizomes, some with running-roots (but no stolons); no taproots or other expanded storage organs: Japanese knotweed, river mallow, ?Queen-of-the-prairie, tall nettle, ?broad-leaved scurf-pea, dogbane, common milkweed (running roots), ?Culver’s root, rosinweeds, most sunflowers, hastate Indian-plantain (or perhaps running roots), some goldenrods, some bonesets (*altissimum*), ??asparagus, ??reed-grass.

**Typical Habitats.** Most species typically occur in thin woodland or grassland, especially on damp or wet, fertile soils. There is much variation in palatability, but only a few species are strongly toxic (pokeberry, water-hemlock). Some species are highly palatable and may have been greatly reduced by livestock after settlement (including river mallow, tall nettle, bundle-flower, scurf-pea). Wood-lettuce tubers and lily bulbs may well have been relished by free-ranging hogs, but the toxic taproots of pokeberry were probably avoided.

**Local Natives.** A dozen native species are widely scattered and at least locally common in the modern landscape, especially in old fields: pokeberry, senna, dogbane, common milkweed, lowland rosinweed, ox-eye sunflower, meadow sunflower, wingstems, common old-field goldenrod, tall purple aster, marsh boneset, common ironweed. Almost all of these species occur at the farm, or nearby, plus two others that are more concentrated along riparian corridors, lowland phlox and lowland goldenrod. At least a dozen additional species may have been widespread before settlement but are now rare or absent on uplands, and survive mostly in less farmed riparian corridors and hills, or in isolated wetland remnants: tall nettle, bundle-flower, broad-leaved scurf-pea\*, figwort, giant hyssop, marsh vervain, tall wood-rosin, broad-leaved woodland sunflower, hastate Indian-plantain\*, giant wood-lettuce\*, Michigan lily\*, ?reed-grass. Some of these (\*) are endangered or threatened within the whole Central Ohio Valley.

**Problematic Aliens.** Japanese knotweed is a widespread potentially problematic alien species in this group, which needs to be monitored and controlled within natural areas. Purple loosestrife can be a serious problem in wetlands, but has not spread widely into Kentucky yet.

**Restoration Notes.** Various experimental plantings can be made at the farm in order to assess the potential of the rarer species for restoration, including their responses to browsing, burning or other means for maintenance of more open vegetation.

**Conservation Targets:** engage in mass-propagation of some reasonably common species that deserve to be widely enhanced in “native grassland”, especially senna, lowland phlox, lowland rosinweed, ox-eye sunflower, meadow sunflower, some wingstems, lowland goldenrod, tall purple aster. There should also be initial attention to some infrequent or rare species that can be readily propagated and used in trials at recovery within thin woodlands and grasslands, especially tall nettle, bundle-flower, broad-leaved scurf-pea, figwort, giant hyssop, lowland rosinweed, tall wood-rosin, giant wood-lettuce, and perhaps reed-grass. Some other rare species will deserve further research into ecological background and horticultural methods.

## **Monocarpic Perennials and Biennials**

**General Characters:** living through two or more growing seasons, monocarpic (dying after flowering and seeding) or frequently monocarpic (many species are not well studied); almost all insect-pollinated (exc. hairy plantain, spiny amaranth); usually with taproots or rosettes of leaves. In many cases, life-histories may within a species, from perennial to biennial to annual, with potential relationships to climate, habitat, season of dispersal and germination.

### **A. Short Creeping or Rosette Biennials (or similar monocarpics)**

**Characters:** flowers produced mostly in May-Jun but often extending later, small to medium-sized, not in showy inflorescences; plants mostly short, ca. 0.2-0.4 m tall, with short creeping stems or a rosette of basal leaves; life-histories probably variable (mostly opportunistic and perhaps not strictly biennial). These species should probably be transferred to winter annuals; they combined for provisional analysis in the tables.

**Regional Examples:** some geraniums, common mallow, ?black medick (perhaps winter annual), hairy plantain (with pronounced rosette).

**Typical Habitats.** These species typically occur on mesic-subxeric sites in sunny, highly disturbed ground (often trampled).

**Local Natives.** The only native species is hairy plantain, which is widely scattered in the region but not nearly as common as the more perennial broad-leaved plantain. Hairy plantain is typical of drier soils, and it tends to decline rapidly on damper sites unless there is intensive trampling or browsing.

**Problematic Aliens.** Common aliens with similar ecology include black medick, common mallow and some small geraniums, but these mostly creep along the ground and are not true rosette plants.

**Restoration Notes.** See above.

**Conservation Targets:** none.

## **B. Early-summer Biennials (or similar monocarpics)**

**Characters:** flowers produced mostly in May-Jun (Jul), small to moderately large, often in showy inflorescences (cymes or umbels); leaves mostly opposite and undivided, or alternate and deeply lobed to highly compound; plants without spines, prickles or particularly hairy-fuzzy foliage, but in some cases repellent to toxic; plants mostly medium-sized, 0.4-1 m tall (but up to 2-3 m in parsnip, hemlock, columbo); often strictly biennial, but probably variable in some cases. The division of these heterogeneous plants into subgroups is tentative.

### **Subgroups and Regional Examples**

(1) Leaves mostly opposite, mostly undivided: some pinks (*Silene alba*, *Dianthus armeria*), several cresses (*Physaria*, *Alliaria*, *?Iodanthus*)#, water-speedwells@, some mints (*Leonurus*, *Synandra*),

(2) Leaves alternate, mostly deeply lobed to highly compound: purple phacelia#, biennial waterleaf, some sanicles (*canadensis*, *trifoliata*), hemlock, parsnip, carrot#, early fleabane.

(3) Long-lived monocarpic perennial, with well-developed rosettes until flowering: columbo\*#

**Typical Habitats.** These species typically occur on mesic or subxeric sites in woodland, thickets or old fields, often with occasional disturbance from flooding, trampling, browsing, burning or mowing.

**Local Natives.** The only widespread native species in this region are common sanicle, which is typical of woods or thickets, and early fleabane, which is locally abundant in open woods and fields. At the farm, another species in this group may be purple rocket, typically found in damp woods near streams and trails. A few other species, that are currently uncommon or rare, may have been much more widespread before settlement, including biennial waterleaf and perhaps bladder-pod.

**Problematic Aliens.** Unfortunately, there are several common invasive aliens in this group, which often compete for space with the native biennials and other species. The most abundant aliens include garlic mustard, poison hemlock, wild parsnip and wild carrot, though only garlic mustard is persistent in shady woodlands. These aliens are particularly vigorous on damp fertile soils, and there are no similar native biennials in these habitats. Poison hemlock is an exceptionally tall vigorous biennial, and its widespread abundance is probably promoted as well by its repulsion to livestock and other herbivores. Also, poor management of fencerows and rights-of-way may be implicated; if mowing or herbiciding is too late into the flowering period, hemlock may actually be increased, since seeds may still mature on cut or damaged stems. In order to reduce hemlock within the thin woodland and thickets where it prospers, we will probably have to reestablish tall native perennial herbs, as well as dense shrubby plants such as cane. It is not clear what the best naturalistic disturbance regime should be. Conceivably intensive trampling by livestock during May would knock down stems of hemlock as they begin to flower, but during other seasons browsing alone might favor this species. Alternatively, mowing, herbiciding or burning could be useful during fall or winter.

**Restoration Notes.** The habitats and life histories of most native species in this group are not well understood, but initial trials indicate that some of them can be readily reintroduced within appropriate habitat. A critical number of initial flowering plants may be needed to ensure enough seed-set for subsequent generations.

**Conservation Targets:** focus initially on biennial waterleaf, as a typical species in former woodlands that can be readily propagated or recovered in appropriate habitat; consider use of purple phacelia as another potential species for mass use in deeper woodlands on slopes; also, develop at least small recovery trials with the few other species (only 3-5 of them) that are less common, especially the endangered bladder-pod (*Physaria globosa*).

### **C. Late-summer Biennials (or similar monocarpics).**

**Characters:** flowers produced mostly in Jul-Aug (Sep), small to large, mostly in showy inflorescences (especially spikes or composite heads); plants mostly 1-2 (3) m tall; leaves mostly alternate, sometimes lobed or trifoliate (but not more compound); plants often with spines, prickles or fuzzy-hairy leaves (especially aliens), but none toxic (?) and several palatable (?); mostly somewhat flexible in their life-history, from winter annual to monocarpic perennial, with few strict biennials (especially among natives).

**Regional Examples:** ?Mexican tea, tall gaura, common evening-primrose, pinnate meadow cinquefoil, sweet-clovers, mulleins, ?some motherworts (*marrubiastrum*), tall white vervain, viper's bugloss (*Echium*), beggar's lice (*Hackelia*), teasle, giant blue lobelia, tall bellflower, ravine wood-rosin (*Polymnia*), common black-eyed Susan, trilobed coneflower, bur-dock, spotted knapweed, most thistles (discolor, vulgare, acanthoides, nutans), most lettuces.

**Typical Habitats.** Most species occur on mesic or subxeric sites in thickets, old fields or other open ground with occasional disturbance; few occur in deep shade. Most may be relatively tolerant of grazing, but some are palatable (especially sweet clovers, tall bellflower). These species often prosper in fields, fencerows and rights-of-way, especially after mowing, grazing or other disturbance that has occurred earlier in the year or during the previous year.

**Local Natives.** There are six widespread, locally common native species in open lands of the region: common evening-primrose, tall white vervain, giant blue lobelia, common black-eyed Susan, meadow thistle, common wild lettuce. Much less common, but widely scattered in woodlands and thickets, are tall bellflower (at farm), beggar's lice, trilobed coneflower, tall blue lettuce (at farm). There are virtually no other native species in the region, other than the peculiar "ravine wood-rosin" in rocky woody near larger streams.

**Problematic Aliens.** There are several common aliens, including spiny amaranth, sweet-clovers, mulleins, teasles, bur-docks, knapweeds, thistles and lettuces. Some of these aliens are highly tolerant of grazing. They can become serious problems for restoration in old pastures, but they do not generally occur in woodlands. Note also that common black-eyed Susan (*Rudbeckia serotina*) may have spread much into eastern regions from the Great Plains (in contrast to true *R. hirta* of Appalachian woodlands).

**Restoration Notes.** Presumably because of their general adaptation to disturbance, the native species do not seem to need much attention in restoration, but the aliens do cause problems for the native grassland perennials (see above).

**Conservation Targets:** focus on the few less common natives that can probably be rapidly established from seed in restored woodlands and grasslands: beggar's lice, giant blue lobelia, tall bellflower, trilobed coneflower, tall blue lettuce.

## Annuals

**General Characters:** living for only (2) 3-6 (9) months; in several cases, germination occurs during the previous fall or winter, before spring or summer flowering.

### A. Winter Annuals.

**Characters:** mostly with rosettes or creeping initially but mostly becoming 0.1-0.4 (0.8) m tall when mature, some species erect or reclining on others and becoming taller; flowers usually produced in Mar-May, mostly small or medium-sized (almost all insect-pollinated), mostly whitish or pinkish/bluish or mixed (yellowish only in corydalis). Species that are non-creeping, without persistent rosettes, and with erect leafy stems, could be distinguished as subgroup 2 (#); those with persistent rosettes are mostly mustards or cresses.

**Regional Examples:** corydalis\*, some chickweeds & allies (*Stellaria*, *Minuartia*, *Cerastium*) (\*), some mallows (*Erodium*), rock stonecrop, false mermaid-weed (*Floerkea*), many cresses & allies, field-pansies#, southern nettle\*#, common bedstraw\*#, forget-me-nots\*#, blue-eyed-Mary\*#, some speedwells, henbits, Miami mist\*#, wild chervils (\*)#, corn-salads (\*)#, ?purple cudweed (*Gamochaeta*).

**Typical Habitats.** These species mostly occur where there is bare soil during winter in deciduous woodlands (\*) and in disturbed open ground, especially on fertile soils. In woodlands, bare ground is widespread on more fertile soils where tree leaves rapidly decay.

**Local Natives.** There are ten native species that are widely scattered across the region, and in some cases locally common: corydalis, common pepper-cress, lowland & upland bitter-cress, pinnatifid bitter-cress, common field-pansy, common bedstraw\* (?), woodland forget-me-knot, Miami mist, woodland wild-chervil, common corn-salad (the native or alien status of common bedstraw remains uncertain). Most of these have been found at the farm, plus a few plants of southern nettle. This nettle, and a few other woodland species (large mouse-eared chickweed, blue-eyed-Mary), are more sporadic and local, but may have been much more common before settlement. False mermaid-weed also used to occur in the region, but has disappeared. The woodland species are locally dominant (especially wild chervil, common bedstraw, Miami mist, corn-salad), presenting a distinctive component in native vegetation of the Bluegrass region that is generally much more developed than elsewhere in eastern North America.

**Problematic Aliens.** Many aliens are also widespread and locally abundant in fields, and some can also become abundant in woodlands, especially common chickweed, common bitter-cress, ivy-leaved speedwell and common henbit. It is not yet clear if and how these aliens can be selectively decreased in restored woodlands, while allowing the natives to increase. However, since the aliens tend to creep in the ground at first, in contrast to the erect habit of the natives, mass seedings of some natives might be expected to reduce the aliens through competition.

**Restoration Notes.** Where the native woodland species are absent, some of them (especially Miami mist) can be readily reintroduced from seed, but further trials at recovery are needed with less common species. It is suspected that blue-eyed-Mary can only be established with a critical mass of ca. 100-1000 plants, in order to allow sufficient attraction of pollinators (especially bees). Initial trials with false mermaid-weed, suggest a similar issue with that locally extinct species.

**Conservation Targets:** focus initially on mass-propagation and reintroduction of selected robust or vigorous woodland species, especially Miami mist, but also corydalis, corn-salad and woodland wild-chervil; also, conduct research and develop methods for reintroduction of uncommon to rare species, large mouse-eared chickweed, southern nettle, blue-eyed-Mary and false mermaid-weed.

## **B. Short Summer Annuals**

**Characters:** usually somewhat decumbent to creeping (or with rosettes#), the leaves mostly below 0.2 m, but stems often 0.2-0.4 m when flowering; flowers produced mostly in May-Jul (Aug), mostly small (almost all insect-pollinated), mostly whitish to pinkish/bluish. Species that stay close to the ground, even when flowering, should probably be segregated as “creeping summer annuals” (&).

**Regional Examples:** some chickweed allies (*Arenaria serpyllifolia*&, *Holosteum umbellatum*), some knotweeds (*Polygonum erectum*, *aviculare*&), carpet-weed&, purslane&, some geraniums (*dissectum*, *molle*), some mallows (or perhaps only *Modiola*), tooth-cups@ (*Ammania*, *Rotala*), some spurges& (*Chamaesyce*), pellitory, ?some clovers (*dubium*), some hyssops & allies (*Gratiola*@, *Leucospora*, *Lindernia*@), early toadflax (*Linaria canadensis*), some speedwells, narrow-leaved plantain&, pineapple-weed, some dayflowers (*communis*, *diffusa*@).

**Typical Habitats.** These species occur mostly in the open; none are typical of woodlands. Some are typical of exposed shores (@).

**Local Natives.** There are only three widespread native species on uplands: erect knotweed, short & tall creeping spurge. Two others are less frequent but widely scattered (not found at farm): pellitory, field hyssop, narrow-leaved plantain. These natives are fairly common to locally abundant within suitable habitat, despite their frequent co-occurrence with alien species. Other natives in the central Bluegrass are mostly associated with shore-lines, ponds and puddles, and few are typically present on uplands (perhaps the tooth-cups).

**Problematic Aliens.** The most common aliens include pavement knotweed, carpet-weed, purslane, field speedwell and common dayflower.

**Restoration Notes.** There are no special concerns about persistence of the native species.

**Conservation Targets:** none.

### **C. Medium Summer Annuals.**

**Characters:** mostly ca. 0.3-1 m, but often shorter < (especially in stunted situations) or occasionally taller >, middle leaves usually not much withered when mature; flowers produced mostly in (May) Jun-Aug (Sep), small or medium-sized (mostly insect-pollinated), of various colors (often yellowish).

**Regional Examples:** the few woodland species (\*) might be distinguished as subgroup 1 (see also the rare species *Acalypha deamii*, *Euphorbia obtusata*): rocket larkspur, (>) several smartweeds & allies (\*), some amaranths, meadow geranium, some mallows (*Hibiscus trionum*, *Malvastrum hispidum*, *Sida spinosa*, *Anoda crista*), clammy waxweed <, some yellow-cresses <, several spurges & allies (*Phyllanthus*, *Croton*, *Acalypha*, *Euphorbia*), clear-weed\*, common hop-clover, piedmont bedstraw <, later toadflax <, pennyroyals & allies (*Isanthus*, *Hedeoma*, *Perilla*), black-berried nightshade, field gromwell, hedge-parsely, Venus'-looking-glass, common lobelia\*, >some tickseeds/bur-marigolds, wormwood, >fireweed, >fleabanes & allies, corn-flower, >sowthistles

**Typical Habitats.** These species are mostly typical of open lands, especially with disturbed ground, but a few are typical in more or less shady woodlands (\*), where they are most common along trails on damp soils or in floodplains.

**Local Natives.** There are about 11 native species that are widespread in the region: field geranium, clearweed, common white smartweed, common & broad-leaved mercury, black-berried nightshade, common lobelia, common tickseed, fireweed, summer & fall fleabanes. Less common natives in the region are mostly concentrated on drier or riparian sites, and may not have been widespread before settlement.

**Problematic Aliens.** Several aliens are also common, in fields and woods, and often compete with the natives. In woodlands, the most serious problems are presented by common purple smartweed (*Persicaria longisetum*) and locally "beef-steak plant" (*Perilla japonica*). These problems are parallel to the problems with alien winter annuals (see above).

**Restoration Notes.** The native species are mostly secure, and, despite local problems with alien competition, little or no special action is currently needed. On restricted rocky soil—or sometimes nearby roadsides—there are a few less common to rare species, including the locally endangered glade mallow (*Malvastrum*).

**Conservation Targets:** no obvious priorities, unless rocky glades are incorporated; see also some rare woodland species to the north (*Acalypha deamii*, *Euphorbia obtusata*).

## **D. Tall Summer Annuals.**

**Characters:** mostly ca. 1-3 m tall, often forming dense stands; leaves usually broad-based, unlobed to lobed or somewhat compound (often more or less palmate in taller species), the lower to middle ones often withering at maturity; flowers produced mostly in Jul-Aug (Sep), highly reduced (wind-pollinated), or relatively large, showy (insect-pollinated), usually whitish-pink or yellowish-orange; leaves or seeds ranging widely from highly palatable (goosefoots, amaranths, sunflowers) to intoxicant or deadly (castor-bean, hemp, jimsonweed); seeds mostly rather large (for herbaceous species), the larger ones sometimes in spiny capsules.

**Regional Examples:** most goose-foots, some amaranths, {cotton} {okra} velvet-leaf, {castor-bean} {hemp} jewelweeds, jimsonweed, {sesame} {tobacco} common sunflower, bur-marigolds & allies, ragweeds & allies, cockle-bur, tall ragwort, ?fireweed, ?fall fleabane.

**Typical Habitats.** These species are mostly restricted to open sites, especially on disturbed fertile soils in fields or floodplains. However, the jewelweeds (especially yellow) occur in woodlands on moist to damp uplands and on lowlands.

**Local Natives.** There at least four widespread to locally abundant native species: orange jewelweed, common & giant ragweed, cocklebur. Common amaranth and common sunflower might also be considered native, though probably adventive from the south and west, respectively. Other natives occur in deeper mesic woods (yellow jewelweed), river-bottoms (sumpweed) or wetlands (bur-marigolds).

**Problematic Aliens.** Alien species from Eurasia do not generally persist and increase in restored vegetation; common goose-foot is the most common one.

**Restoration Notes.** The native species are not imperiled at all, but attention could be given to reintroduction of yellow jewelweed into more shady woodlands on uplands, and perhaps some of the bur-marigolds into restored damp or marshy grasslands.

**Conservation Targets:** restrict initial attention to local reintroduction of yellow jewelweed.



## Aquatic Plants

**General Characters.** In these plants, roots are usually under water; leaves are usually floating or submersed for part of growing season; flowers are moderately to very large (yellow, white or pink), especially species rooted in shallower water, or highly reduced, especially species floating in deeper water. The only widespread native species are a few species of arrowheads & allies (mostly on shores), pondweeds & allies (mostly submersed), and duckweeds & allies (mostly floating). Several other native species have probably declined greatly since settlement, especially in more extensive wetlands and river corridors. There are a few locally abundant aliens (*Potamogeton nodosus*, *Najas minor*, *Myriophyllum spicatum*). On uplands, a few uncommon to rare species may be considered for introductions at more or less artificially ponded sites; before settlement, beaver-ponds might have supported them. Such species include lizard-tail, yellow water-lily, white water-lily, yellow marsh-marigold, some spearfoots, some smartweeds, and reniform mud-plantain. In deeper springs and medium-sized streams, introductions of the submersed aquatics might be tried, especially white water-crowfoot.

**A. Perennial Subaquatics:** mostly ca. 0.3-1.2 m above ground, usually emergent in growing season with leafy stems above water; leaves entire, cordate-ovate, with basal sheath; rhizomatous; aromatic or toxic.

**Examples:** lizard tail, yellow marsh-marigold, [?bog-bean]; note also various “shoreline emergents”, etc., in other classes; to be considered further.

**B. Floating Perennial Aquatics:** stems not usually emergent above water, but sometimes reclining on exposed shores later in growing-season; leaves usually cordate, peltate or sagittate (otherwise entire), usually absent on flowering stems, usually floating during part of year; flowers moderately to very large (usually yellow, white or pink) or reduced; plants mostly rhizomatous, sometimes stoloniferous, sometimes tuberous; see also “subaquatic” marsh/shoreline emergents under other classes of herbs.

**Examples:** [water-clover] yellow water-lily, white water-lily, lotus-lily, some spearfoots (*Ranunculus ambigens*—with stolons not rhizomes; *sceleratus*—without either?), ?water-smartweed (*Persicaria coccinea*), arrow-arum, water-plantain, most arrow-heads, frog’s-bit (sometimes breaking loose from stolons), ?spotted pondweed (*Potamogeton pulcher*), pickerel-weed (violet-blue), ?reniform mud-plantain (*Heteranthera reniformis*—without rhizomes/stolons).

**C. Heteromorphic Rooted Aquatics** (floating & submersed): usually with cordate to ovate floating leaves and linear to filiform submersed leaves; stems sometimes spongy-floating (^); flowers moderately large (yellow, white, pink) or reduced; plants usually without well-developed rhizomes, stolons or tubers (?), often annual (at least *Ranunculus pusillus*, *Sagittaria calycina*).

**Examples:** some spearfoots (esp. *Ranunculus pusillus*, *R. flabellaris*), feather-foil (*Hottonia inflata*^). some arrow-heads (*Sagittaria calycina*^, *S. graminea* & allies), ?some pond weeds (esp. *Potamogeton diversifolius*); perhaps some mermaid-weeds (esp. *Proserpinaca pectinata*).

**D. Submersed Rooted Aquatics:** with filiform leaves (a) or broader leaves (b), but not both.

### Subgroups & Examples.

(1) Without rhizomes: [quillwort] white water-crowfoot (a) (*Batrachium*), tape-grass & allies (b) (*Vallisneria*), water-milfoil (a) (*Myriophyllum*), several water-nymphs (a) (*Najas*).

(2) With rhizomes: several pond-weeds & allies (ab) (*Potamogeton*, *Stuckenia*).

(3) With thalloid holdfast discs: [benthic filamentous red-algae] river-weed (a) (*Podostemum*).

### E. Floating Unrooted Aquatics

**Examples:** [mosquito-fern] duck-weeds, water-meals

### F. Submersed Unrooted Aquatics

**Examples:** [filamentous green algae] horn-worts (*Ceratophyllum*), ?water-weeds (*Elodea*—often broken loose)

**Conservation Targets:** restrict attention a few local trials in some ponds or stream; see notes above.

## Perennial Graminoids

**General Characters:** usually with linear leaves, often ascending from near the base of stems. Although this class is dominated by grasses and sedges, there are other monocots to be included, and perhaps even some dicots (*Stellaria graminea*, *Galium aparine*) and fern-allies (*Equisetum*) to be considered. Note that “determinate spring woodland perennials” (see above) include a few with graminoid leaves but withering and becoming dormant in summer and fall; the species included below retain leaves for most of the year.

### A. Woodland Perennial Graminoids

**Characters:** usually with small tussocks and several cauline leaves, often twisting over to become somewhat horizontal; often (\*) with short to moderately long (“knotty”) rhizomes, sometimes making fairly extensive open swards (\*\*) but not rapidly extending; mostly cool-season species, flowering May-Jul (except *Muhlenbergia* and cleistogamous phases of *Dichantherium*); see also “distichous monocots” where some of the species listed here have similarities. The division into four subgroups is tentative; further information on habits is needed, especially rhizomes.

#### Subgroups and Regional Examples

(1) flowering May-Jul; leaf blades broad and long; mostly in deeper woodland or edges, few prospering in full-sun: ?beech-grass (*Brachyelytrum erectum*\*), beak-grain grass (*Diarrhena americana*\*), ?wild-oats\* (*Chasmanthium latifolium*\*\*), blackseed ricegrass (*Piptatherum racemosum*\*), ?midwestern melic-grass (*Melica nitens*\*\*), ?woodland reed-grass (*Cinna arundinacea*), woodland brome (*Bromus pubescens*), most wild-ryes (*Elymus* spp.).

(2) flowering (Apr) May-Jul; leaf blades narrow and long, mostly in deeper shade or edges, few prospering in full-sun: southeastern melic-grass (*Melica mutica*\*), woodland bluegrass (*Poa sylvestris*), woodland fescue (*Festuca subverticillata*\*?), lowland wedge-scale (*Sphenopholis intermedia*),

(3) flowering May-Aug: leaf blades broad and short, not twisting over; from thin shade to full sun: some broad-leaved early-panics (?*clandestinum*\*\* , *boscii*).

(4) flowering May-Sep; leaf blades narrow and short, not twisting over, mostly in thin woods, edges or grassy open woods, some prospering in full-sun: most woodland muhly-grasses (e.g. *Muhlenbergia sylvatica*\*\*), several early-panics (e.g. *dichotomum*, *acuminatum*)

**Typical Habitats.** These species are all typical of more or less mesic woodlands, including transitions to subxeric or subhydric sites, and transitions to more open woodland.

**Local Natives.** There are four widespread to locally abundant species in the region (*Elymus macgregorii*, *E. virginicus*, *E. villosus*, *Dichantherium clandestinum*). Another two are widely scattered but restricted to better woodland remnants (*Poa sylvestris*, *Festuca subverticillata*). These are all known at the farm. The remainder are mostly concentrated in larger ravines or riparian corridors, but most of them may well have been much more widespread before settlement (especially *Chasmanthium latifolium*, *Sphenopholis intermedia*, *Bromus pubescens*).

**Problematic Aliens.** There are no naturalized alien species in the region.

**Restoration Notes.** Most of these species can be readily established from seed sowed in suitable habitat, but seed production will be a slow process in some cases.

**Conservation Targets:** focus initially on mass propagation and introduction of species that do already recover in protected woodlands, especially woodland bluegrass, woodland fescue, the wild-ryes and common broad-leaved early-panic; also, conduct smaller trials with less common to rare species, especially wild-oats, lowland wedge-scale and woodland brome.

## B. Tall Running Graminoids

**Characters:** culms usually (0.5) 1-2 (3) m tall, in small tufts or single, from long or thick rhizomes or tuberous roots (#); mostly subaquatic emergents (@) or common along shores; mostly cool-season species in photosynthetic (C3), but mostly flowering May-Jul; mostly non-toxic to palatable, at least in fresh-growth (except the aromatic sweet-flag), though often highly siliceous. Some of these species (?) tend towards the “distichous perennial woodland” group, and might be transferred or subdivided.

**Regional Examples:** [scouring-rush@] sweet-flag@, cat-tails@, bur-reeds@, ?meadow spiderwort (*Tradescantia ohiensis*), daylilies#, some irises & allies(@), {?asparagus} running marsh-sedge@ (*Dulichium arundinaceum*), some bulrushes@ (*Schoenoplectus*), ?some sedges@ (?frankii, *lupulina*, *lupuliformis*), ?common reed (*Phragmites communis*), ?common cut-grass (*Leersia oryzoides*@), ?larger manna-grasses@, ?reed canary-grass (*Phalaris arundinacea*—but see also “distichous monocots”), ?some broad-leaved early-panic grasses (?clandestinum, *scoparium*), Johnson grass (*Sorghum halepense*), gama grass (*Tripsacum dactyloides*).

**Typical Habitats.** These species are mostly typical of sunny, seepy (subhydric) or marshy (hydric) sites, though usually with some seasonal drying.

**Local Natives.** Only three clearly native species are widespread in the region: common cat-tail, soft bulrush, common head-sedge (*Carex frankii*). At least four additional species may have more widespread before settlement (*Iris shrevei*, *Carex lupulina*, *C. lupuliformis*, *Phalaris arundinacea*). However, the native versus alien status of some species remains somewhat tentative (including *Phalaris*).

**Problematic Aliens.** One unusual alien species presents serious problems, since it is an aggressive, persistent, warm-season runner in upland grasslands: Johnson grass. At least three other alien species are well established in small patches, but do not spread much by seed: sweet-flag, daylily (on drier ground), yellow iris, common reed.

**Restoration Notes.** The native species may be readily established in appropriate wet habitats using transplanted rhizomes as starts. Most species in this group are relatively palatable, and may be much reduced by certain browsing regimes. However, sweet-flag is avoided in pastures. Johnson-grass can be reduced by intensive cattle-grazing in early summer, but it is reported to be somewhat cyanogenic.

**Conservation Targets:** restrict attention to introductions of the few uncommon species within appropriate wetlands (especially blue flag and larger head-sedges); also, consider native versus status of reed canary-grass and its potential role in restoration of subaquatic grasslands.

### **C(a). Medium Running Graminoids**

**Characters:** plants usually up to ca. 0.3-0.6 m tall, from stolons (#) or rhizomes (\*) or both (\$); usually not forming large tussocks but often forming dense uniform swards; cool-season (C3) or warm-season (C4); more or less palatable (perhaps none toxic). Some species are subquatic emergents and tend towards “taller running graminoids” (@). Note also “small running graminoids” to be defined below; some of these species should probably be transferred.

**Regional Examples:** [horse-tail] ?some flatsedges\* (*strigosus*, *esculentus*), some sedges\* (?*frankii*), lesser cut-grass (*Leersia virginica*\$), smaller manna grasses (*Glyceria* spp.#@), smooth running-brome (*Bromus inermis*\*), quack-grass (*Elymus repens*\*), barn-yard grass (*Eleusine*#), Bermuda-grass (*Cynodon*\$), nimble-will (*Muhlenbergia schreberi*\$), lens-grasses (*Paspalum* spp.#).

**Typical Habitats.** These species occur in various habitats, but mostly in thin woodland to open grassland, and mostly on damp to wet ground that is often disturbed by flooding, trampling or mowing.

**Local Natives.** There are about six widely scattered to common native species in the central Bluegrass: common flatsedge, yellow nutsedge, common ricegrass, manna-grass, nimble-will, lens-grasses. Common rice-grass and nimble-will may have been locally abundant in the original woodland. Virtually no others are thought to have been widespread before settlement.

**Problematic Aliens.** There are four common to locally abundant aliens which may present serious problems if relatively short “native” grassland is desired: smooth brome, quack-grass, barnyard-grass and Bermuda-grass.

**Restoration Notes.** The native species appear to be generally widespread, well-dispersed, and recover well in native vegetation without special aid. The aliens will gradually disappear in old field succession, but quack-grass can remain locally dominant for several years (perhaps aided by its poisonous “allelopathic” effects).

**Conservation Targets:** none.

### **C(b). Tillering Tufted Graminoids (mostly medium sized)**

**Characters:** plants usually intermediate in size, up to ca. 0.3-1 m tall, generally transitional from taller tussocks (E) to shorter running forms (C); potentially forming dense tussocks, but also sending out rhizomes (\*) or stolons (#) of various lengths, which allow turf-formation in some cases, when grazed or mowed; mostly cool-season species, flowering in Apr-Jun, but a few later; mostly palatable and productive forage for livestock.

**Regional Examples:** ?some sedges (?*vesicaria*), some bluegrasses (*Poa pratensis*\*, *P. trivialis*#, *P. compressa*\*), orchard grass (*Dactylis*#), ?timothy grass (*Phleum*), ?tall meadow fescue (*Schedonorus arundinaceus*#—also making large tussocks), perennial rye-grass (*Lolium multiflorum*#), redtop bent-grass (*Agrostis gigantea*\*), ?common meadow panic-grass (*Panicum anceps*\*), ?perennial foxtail (*Setaria parviflora*—with only short rhizomes\*).

**Typical Habitats.** These species are all typical of open grasslands, though a few (the bluegrasses) can prosper locally in thin woods on fertile soils.

**Local Natives.** The only widespread native species for certain is common meadow panic-grass. Perennial foxtail may also be locally native—or perhaps just adventive from the south. It has been suggested that native races of the bluegrasses exist in the Bluegrass region and elsewhere in eastern North America, but prevailing botanical opinion does not favor this hypothesis; there has not yet been a full investigation of genetic evidence for or against.

**Problematic Aliens.** The predominant species in this group are generally alien, especially in regular pastures: common (Kentucky) bluegrass, orchard grass, timothy, fescue, ryegrass, redtop (bent-grass). The relatively low occurrence of native species of this type in eastern North America presumably reflects a longer history of adaptation by grasses to large grazing animals in Europe.

**Restoration Notes.** The only native species (or possibly native species) are secure and generally prosper in old fields, with or without much restoration. The common alien species are often reduced by herbiciding, before various plantings of so-called “native” grasses, such as the common “prairie” species (see below under “taller tussock graminoids”).

**Conservation Targets:** perhaps none; however, the possible native versus alien status of races within common bluegrass needs attention.

### **D. Small Running Graminoids**

Plants mostly 0.1-0.2 (0.4) m tall or somewhat larger when flowering; mostly in wetlands and not typical of the central Bluegrass; to be defined further.

(1) Cool-season: some sedges (*pensylvanica*, *eburnea*).

(2) Warm-season; mostly on shore-lines of larger waterbodies, or widespread aliens in weedy situations: several sedges-allies (some *Eleocharis*, some *Cyperus*, *Kyllinga*), Bermuda-grass (*Cynodon dactylon*), ?nimble-will (*Muhlenbergia schreberi*), shore-line lovegrasses (*Eragrostis hypnoides*, *E. reptans*), shoreline lens-grasses (*Paspalum fluitans*, *P. dissectum*).

## **E. Tall Tufted Graminoids**

**Characters:** plants usually up to (0.5) 1-2 (3) m tall; leaves concentrated low on stems, ascending; tillering slightly in some cases, with short rhizomes, but generally declining in frequently mowed or overgrazed sites (?); cool-season (C3) or warm-season (C4).

### **Subgroups and Regional Examples**

(1) Mostly on damp-wet sites; all cool-season; relatively unpalatable; rushes and sedges: common meadow rush (*Juncus effusus*), some bulrushes (*Scirpus atrovirens*, *cyperinus*), some fox-sedges (*Carex conjuncta*, *vulpinoidea*, *squarrosa*, *typhina*).

(2) Mostly on moist-dry sites; mostly warm-season (except perhaps two aliens); mostly palatable, at least until early summer: ?some sedges (*Carex annectans*), ?tall meadow fescue (*Schedonorus arundinaceus*), ?tall oat-grass (*Arrhenatherum elatius*), ?grease-grass (*Tridens flavus*—with very short rhizomes), some dropseed grasses (*Sporobolus compositus*), most bluestem and broomsedges (*Andropogon* spp.), switch-grass (*Panicum virgatum*), Indian grass (*Sorghastrum nutans*).

**Typical Habitats.** All species are typical of full sun, and may be divided into the two subgroups, as above.

**Local Natives.** There are only six widespread to locally abundant species in the central Bluegrass: black bulrush, upland & lowland fine fox-sedge, fox-sedge, grease-grass, common broom-sedge. A few others are typical of local to peripheral wetlands and grasslands, but were probably not widespread before settlement (e.g. common meadow rush, soft-stem bulrush, common dropseed). The general absence of common “prairie” grasses (Indian grass, big bluestem, little bluestem) is notable, supporting other evidence that native grassland was not extensively developed before settlement.

**Problematic Aliens.** There are virtually no common alien species in this group, unless fescue is considered “large tussock” in a transitional sense. Fescue can form large tussocks under some conditions, as well as tillering, and, without chemical control, it interferes with establishment of warm-season prairie species.

**Restoration Notes.** The native species are all fairly widespread and secure, generally prospering in old fields. There is a danger that excessive use of herbicides to reduce fescue and other aliens could also reduce the native species.

**Conservation Targets:** none.

## F. Medium Tufted Graminoids

**Characters:** stems usually 0.2-0.8 m tall, in small to large tussocks; leaves concentrated low on stems, mostly ascending; in various wooded or open habitats, often disturbed to various degrees; mostly cool-season species, flowering in Apr-Jun (lovegrass later); bulbous bases present in some cases (especially the lilioids#). See also “small tufted graminoids” to be defined below, where some of these those probably be transferred.

### Subgroups and Regional Examples:

(1) Cool-season: ?Star-of-Bethlehem#, onion-grass#, blue-eyed grass, some rushes (*Juncus tenuis*), upland bulrush (*Scirpus pendulus*), most sedges (see below), bulbous bluegrass# (*Poa bulbosa*), ?timothy-grass# (*Phleum pratense*), ??narrow-leaved early panic-grass (*Dichanthelium acuminatum, dichotomum*).

(2) Warm-season: showy lovegrass (*Eragrostis spectabilis*)

**Typical Habitats.** This group is dominated by sedges, with many species. They occur in a wide range of habitats, but most frequently in thin woods or brushy old fields.

**Local Natives.** There are about 10-20 widely scattered to common native species in the region: blue-eyed grass, path-rush, upland bulrush, little-spike-sedges (*texensis, rosea, mesochorea, aggregata, sparganioides*), fine fox-sedges (*annectans*), scale-sedges (*normalis, molesta*), tufted-sedge (*jamesii*), common lax-sedge (*blanda*), lime-sedge (*granularis*), wrinkled-sedges (*oligocarpa, grisea*), graceful-sedge (*davisii*), lime-swale-sedge (*shortiana*), showy love-grass, lesser early-panic. Only a few additional sedges may have occurred widely before settlement (perhaps *communis, hirtifolia, laxiflora*).

**Problematic Aliens.** In contrast to the numerous natives, there are few aliens. However, onion-grass is common, especially in grasslands, and Star-of-Bethlehem is a widespread local problem, especially in woodlands. Both species need to be monitored and controlled in natural areas, but control is probably difficult because of their persistent budding bulbs.

**Restoration Notes.** It is remarkable that most of the native species typical of the region are still relatively frequent. Almost all species that were probably widespread before settlement have been found at the farm. Apparently, their ecology has been more or less compatible with the disturbance regimes that followed settlement. Most of them are somewhat resistant to grazing—not being highly palatable—and they generally produce frequent seed if unmowed until Jun-Jul (the common season for haying or otherwise mowing rough pastures). Even without fresh seed, they may survive for many years with or without occasional grazing or mowing. A few of the sedges, and most of the non-sedge species (especially path-rush), are relatively resistant to trampling.

**Conservation Targets:** no obvious priorities, but small initial experimental introductions with various sedges in various habitats would provide interesting, useful research.

## G. Small Tufted Graminoids

Plants mostly 0.1-0.3 (0.4) m tall; to be detailed further (transferred from “medium tufted”).

(1) Cool-season: blue-eyed grass, some rushes (*tenuis*), ?some bulrushes (some *pendulus* is quite small in Kentucky), several sedges (*texensis, rosea, mesochorea, cephalophora, eburnea, blanda, laxiflora, granularis, oligocarpa, grisea, jamesii, ...*), “poverty grasses” of various types.

(2) Warm-season: few natives (?).

## Annual Graminoids

### A. Erect Annual Graminoids

**Characters:** small tufts, sometimes decumbent at first but not stoloniferous and not remaining decumbent when in flower; cool-season or warm-season. A “tall annual graminoid” group should probably be segregated for species that usually exceed 1 m (e.g. *Panicum dichomiflorum*, *Urochloa texana*, *Echinochloa muricata*, *Paspalum dilatatum*, *Setaria faberi*, *Zea mays*).

**Regional Examples:** some spike-rushes (?*Eleocharis obtusa*), some flatsedges (*Cyperus odoratus*), many grasses (in *Aristida*, *Poa*, *Vulpia*, *Alopecurus*, *Bromus*, *Hordeum*, *Eragrostis*, *Sporobolus*, *Panicum*, *Echinochloa*, *Setaria*, *Arthraxon*, *Microstegium*).

**Typical Habitats.** These species are all typical of full sun, except for the East Asian *Arthraxon* and *Microstegium*, which tend to occur in partial to moderate shade and could form a distinct subgroup. These species occur on a wide range of soils, from rocky glades to roadsides to shorelines, usually with regular exposure of bare ground due to the nature of the substrate, or due to disturbance, or both.

**Local Natives.** There are at least eight widespread native species in the region: common spike-rush (*Eleocharis obtusa*), sweet flatsedge (*Cyperus odoratus*), little barley (*Hordeum pusillum*), annual lovegrasses (*Eragrostis frankii*, *E. pectinacea*), annual dropseed-grass (*Sporobolus vaginiflorus*), witch panic-grass (*Panicum capillare*), marsh barnyard grass (*Echinochloa muricata*). These mostly occur at the farm or nearby (including some in various rights-of-ways). Other native species are mostly restricted to drier or poorer soils (e.g. *Aristida oligantha*, *Panicum flexile*).

**Problematic Aliens.** There are also several aliens, some of which are locally abundant: cheat-grasses (*Bromus japonicus* & allies), annual lovegrasses (*Eragrostis cilianensis*), common bardyard grass (*Echinochloa crus-galli*), foxtail grasses (*Setaria* spp.), Chinese grass (*Arthraxon hispidus*), Japanese grass (*Microstegium vimineum*). In grassland restoration, some of the alien species can become temporarily dominant after ground is exposed, but they tend to decline as native perennials increase. In woodlands, however, Chinese grass and especially Japanese grass can become very serious problems.

**Restoration Notes.** The East Asian grasses have not yet become established at the farm, but small patches have been seen and pulled. It is likely that these species will eventually invade, without strict monitoring and control. These grasses are adapted to shade, and also avoided by generalist herbivores—*Microstegium* can accumulate due to intense pressures on the vegetation by deer or cattle. Methods for reducing these aliens have not been widely developed. Fire might be effective during summer, but habitats are often too damp or fuel too thin. Perhaps the most useful general solution will be to favor native perennial grasses and herbs, with additional sowings and plantings, and to reduce disturbances in certain places and in certain seasons. It may be wise to avoid fresh disturbance during spring, when these species germinate.

**Conservation Targets:** none.



## **B. Creeping Annual Graminoids**

**Characters:** plants up to 0.1-0.3 m tall, low-spreading and sometimes rooting on the ground; inflorescences usually remaining relatively low among the leaves or in some cases (*Digitaria*) becoming erect on naked stalks.

### **Subgroups and Regional Examples.**

(1) Stems not rooting at nodes; cool-season species, flowering in Mar-May; aliens of weedy situations: annual bluegrass (*Poa annua*), hard-grass (*Sclerochloa dura*).

(2) Stems rooting at nodes; warm-season species, flowering in Jul-Oct; weedy crabgrasses (*Digitaria* spp.).

**Typical Habitats.** As noted above.

**Local Natives.** No species are widespread in the central Bluegrass.

**Problematic Aliens.** Annual bluegrass and the crabgrasses are widespread and locally abundant, but not problems in restoration, except perhaps in high disturbed fertile soils with more horticultural settings.

**Restoration Notes.** As noted above.

**Conservation Targets:** none.

## Appendix 2: Phylogenetic Groups

**Lower Plants (Algae, Lichens, Bryophytes).** Little effort has been made so far to compile data on these plants; local work of Denny Harris, Doug Ladd, Willem Meijer and others will be reviewed and further field work will be conducted. Corticolous lichens were observed by Doug Ladd, Missouri Chapter, TNC; 30 June 2004; mostly on large trees in southern savanna (with J. Campbell); attached is the cursory lichen list—mostly these species are typical savanna/old pastured woodland species that are wide ranging and fairly non-conservative.

**FERNS & allies: Lycopodiales (clubmosses & ground-pines & ground-cedars); Selaginellales (spikemosses); Isoetales (quillworts); Ophioglossales (adder's tongues & grape-ferns); Equisetales (scouring-rushes & horsetails); Osmundales (royal-ferns & cinnamon-ferns); Hymenophyllales (filmy ferns); Schizaeales (climbing fern); Salviniiales (floating-ferns); Polypodiales (maidenhair-ferns, bracken-ferns, spleenworts, chain-ferns, sensitive-fern, fragile-ferns, beech-fern, wood-ferns, polypodies)**

**Morphology.** These are spore-producing plants, with free-living gametophytes (without seeds or flowers); see botanical manuals for their various additional morphological differences.

**Chemistry.** Secondary compounds usually include tannins and diverse phenolics, flavonoids and terpenoids; others compounds in some groups include alkaloids (generally rare but found in Lycopodiales), cyanogenics, benzophenones, and diverse glycosides or derivatives (ent-pimarene glycosides, lactone glycosides, indanones). The toxins in bracken include ptaquiloside (a norsesquiterpene with a glucose appendage).

**Economic Uses.** Very few species have been used regularly for human food. Shoots of bracken-fern are pickled and eaten in Japan, but are somewhat carcinogenic. Other ancient uses are known, including the flammability of spores from some lycopodiums, the scouring ability of some equisetums, and the fibrous thatching qualities of larger bracken-ferns. Of course many species have also become famous through horticulture.

**Life History.** These plants reproduce through free-living gametophytes that grow from spores when they germinate on moist ground. After periods that are generally unknown (probably a few months), the gametophytes produce eggs and motile sperm, which fertilize the eggs, which then grow into mature plants. All North American species are herbaceous and more or less perennial, usually with rhizomes. The mosquito-fern (a floating-fern) divides clonally for an indefinite period. Their highly varied life-forms parallel to some extent the range found within perennial flowering plants, from aquatic species, to smaller terrestrial species that have relatively short growing seasons (in spring to early summer) or that creep near the ground, to taller clumping species (e.g. cinnamon-ferns, wood-ferns) or running species (e.g. bracken-fern, sensitive-fern).

**Typical Habitat.** Most species are typical of woodlands of various types, especially on steeper rocky slopes. Some occur on subhydric to hydric or purely aquatic situations. Those of full sun are mostly on rock outcrops (especially spleenworts) or aquatics (e.g. quillworts, floating-ferns). The few in more disturbed open woodlands or grasslands tend to have running rhizomes (especially bracken-fern). Ferns and their allies (especially Lycopodiales) are generally more common and diverse on soils with lower fertility or higher acidity.

**Local Natives.** These species are generally uncommon in the central Bluegrass, except within rocky ravines. A few species, however, are more widely scattered in upland woods, sometimes including disturbed sites: **grape-fern, rattlesnake-fern, ebony spleenwort** and **running fragile fern**. Much less common are **adder's-tongue, rich woodfern** and **Christmas fern**, which have been found at only one site each within Griffith Woods. It is uncertain whether other species occurred widely before settlement, but it seems reasonable that some would have extended along more sloping ground near streams (perhaps along Gray's Run at the north side of the farm). Especially along larger streams and near rock outcrops, such species might have included **maidenhair-fern, woodland glade-fern, bulblet fragile-fern, blunt cliff-fern, beech-fern** and **marginal wood-fern**.

**Problematic Aliens.** There are no invasive alien species, though many are grown in gardens and greenhouses. The European water-clover (*Marsilea quadrifolia*) has escaped from cultivation at a few places in Kentucky.

**Conservation Targets.** Some of conservative species can probably be propagated with relatively little trouble, and could be reintroduced in restored woodland. It would be especially interesting to conduct trials with running fragile fern, using its rhizomes. Rich woodfern is rare in Kentucky, and deserves special protection; a few plants were found on a rotted log near Renaker Run, and there are plans to propagate these plants from spores.

## **GYMNOSPERMS and allies: Ginkgoales (ginkgo); Pinales (hemlock & pines, bald-cypresses, cypresses & cedars); Taxales (yews)**

**Morphology.** These are seed-producing plants, with the gametophytes produced within various kinds of cone; see botanical manuals for their various other morphological differences.

**Chemistry.** Secondary compounds usually include diverse terpenoids; others in some groups include various alkanes, phenolics, flavonoids, alkaloids (including ephedrine), lectin peptides (at least in cycads).

**Economic Uses.** Use for human food is limited, including ginkgo nuts (after careful processing), some pine nuts, and to avoid starvation in ancient times, some pine barks. Various flavors, incenses and medicines are also made. Many tree species are important sources of timber. Many are planted for various other horticultural purposes.

**Life History.** North American species are mostly trees; there are also a few shrubby species, and in western regions the herbaceous ephedra (Gnetales).

**Typical Habitats.** In Kentucky, native species occur in various woodland types, mostly at environmental extremes for forests: acidic (hemlock, some pines), xeric (pines, cedars), pyric (pines), hydric (bald-cypress).

**Local Natives.** The only native species in the central Bluegrass is **red cedar**. Before settlement, this tree was largely restricted to rocky open woods on clifftops or near eroded licks, such as the Blue Licks in Robertson County. After settlement, it has become much more common, especially as a pioneer on old fields with dry rocky soils in more hilly areas. On the relatively deep damp soils of the central Bluegrass, as at Griffith Woods, it is uncommon and although seedlings are widely scattered they generally become choked out by denser vegetation and virtually no trees survive in more shady woods. Red cedar is grazing resistant, and can accumulate in old pastures, but it is sensitive to fire, especially smaller plants.

**Problematic Aliens.** There are no invasive alien species. Although widely grown, there have been virtually no reports of established seedlings from cultivated species such as ginkgo, Norway spruce and Douglas-fir. Even white pine and other pines from different regions of Kentucky, when planted here in abundance, do not seem to spread by seed within the central Bluegrass region.

**Conservation Targets.** No species are targets; in designed natural areas, red cedar is often considered more common than it should be, and cut out.

## **MAGNOLIOIDS and allies: Nymphaeales (water-lilies); Illiciales (all-spice); Magnoliales (tulip-tree, pawpaw); Laurales (spicebush); Piperales (wild-ginger, lizard-tail)**

**Morphology.** These plants are considered relatively similar to the ancestral flowering plants, mostly with rather large simple flowers, and simple, entire-margined leaves.

**Chemistry.** Typically, plants contain ethereal oils (triterpenes) and various alkaloids, which are often toxic to mammals; in most groups, also sesquiterpenes; in some, hemiterpenoids, flavonols, leucanthocyanins; relatively little tannin or other common groups of secondary chemicals.

**Economic Uses.** The only species that have become widely cultivated for food are the fruits of Annonaceae, known as custard apples or pawpaws, and some fruits of Lauraceae, especially the avocado. The native pawpaw is being studied at Kentucky State University for commercial selections. Some species are used for flavorings. Several species have been used for medicinal purposes. Several species have become widely grown as ornamentals.

**Life History.** In eastern North America, native species include trees, shrubs, woody vines and herbaceous perennials; the Nymphaeales are floating aquatics.

**Typical Habitats.** Apart from water-lilies, native species are mostly typical of mesic to submesic woods, including transitions, edges and canopy-gaps. They are generally somewhat repellent to generalist herbivores, with toxic alkaloids or bitter terpenoids, and often tend to increase in woodland that has been exposed to repeated browsing. The understory plants become abundant in late-successional mesic forest, but the trees tend to be replaced by sugar maple or others typical of deeper shade.

**Local Natives.** In the central Bluegrass, only six species are present: **white water-lily** (uncommon in ponds), **tulip-tree, pawpaw, sassafras, spicebush** and **wild-ginger**. Except for sassafras, these are associated with mesic forest, and they are generally absent from heavily farmed landscapes. Moreover, tulip-tree and sassafras are largely restricted to more hilly sections with less calcareous soils. At the Griffith Farm, there are several pawpaw patches; but there are only two tulip-trees (with no regeneration), and the other species are absent. Spicebush and wild-ginger were probably more widespread in the original woodland, and may have occurred at the Griffith Farm.

**Problematic Aliens.** There are no invasive aliens.

**Conservation Targets.** No local species are globally or regionally imperiled, but most species within the central Bluegrass are more or less conservative within the current landscape context. Spicebush and wild-ginger, in particular, are slow to disperse and reestablish in woods where they have been removed. There needs to be a focused program for propagation and recovery.

**RANUNCULOIDS and allies: Ceratophyllales (hornworts); Ranunculales (moonseeds, mayapples, buttercups, poppies); Proteales (lotus, sycamore)**

**Morphology.** These plants are similar to the magnolioids, but their flowers mostly have more distinct petals and sepals, or are sometimes reduced; leaves are usually toothed and often compound.

**Chemistry.** These plants have diverse flavonoids and alkaloids, the alkaloids often extremely acrid and with strong physiological effects on mammals; some also have sesqui-/di-terpenoids or lactone-forming glycosides; only a few are tanniferous; they lack ethereal oils, and accumulate little or no oxalates. Tissues are often yellowish to reddish with berberin/other alkaloids in roots/stems.

**Economic uses.** No species in these groups have been widely cultivated for food, except for some East Asian fruits (Lardizabalaceae). In eastern North America, mayapple fruits are sometimes gathered for human consumption; marsh-marigold has been used for its confectionary roots; and several species have been used for medicines or poisons. Many species have been selected for ornamental gardens; several native species have been used in this regard, and further selections may be expected.

**Life-history.** Almost all native species are perennial herbs; a few are aquatics, annuals, vines, shrubs or trees.

**Typical Habitats.** Native species occur in various mesic to hydric woodland habitats, edges and openings, especially on relatively fertile soils. They are generally toxic, due to alkaloids, and resistant to browsing, sometimes accumulating in woodland that has been exposed to high populations of native herbivores like deer, or even some degree of livestock. However, intensive persistent trampling and rooting over large areas is probably detrimental in general, since most species appear slow to regrow, reproduce and disperse after such physical disturbance.

**Local Natives.** In the central Bluegrass, there are about 20 widely scattered or locally common species, but only a minority are generally common on the uplands: **moonseed, lowland lesser crowfoot, Virgin's bower, corydalis** and **sycamore**. In better woodland remnants (as at the farm\*), there are scattered patches of **common anemone, false rue-anemone, mayapples\*, squirrel-corn\*, dutchman's breeches\***. More restricted species that probably used to be much more widespread include **twinleaf, blue cohosh, columbine, larkspur, rue-anemone, wood-rues, upland lesser crowfoot, woodland buttercups, blood-root, yellow poppy**.

**Problematic Aliens.** There are only a few locally common aliens (rare or absent at the farm), including some **European buttercups, Japanese barberry** and **Clematis terniflora**.

**Conservation Targets.** No local species are now globally or regionally imperiled, but several conservative species that occur in wooded ravines and hills were probably more widespread before settlement and deserve propagation for recovery, especially those species listed above. Also, **goldenseal** has been greatly reduced due to harvesting for medicinal uses, but it is more typical of relatively dry woods in peripheral hills. There are also a few northern or mid-western species typical of lowlands or wetlands that have more or less disappeared from the central Ohio Valley, and deserve further research for propagation and recovery: **marsh-marigold, northern anemone** and **mid-western meadow-rue**.

## **CARYOPHYLLOIDS and allies: Caryophyllales (poke, spring-beauty, prickly-pear, chickweeds, chenopods & amaranths, knotweeds & smartweeds)**

**Morphology.** These plants usually have flowers with rather small to vestigial petals, few stamens (centrifugal when more), and dry dehiscent fruits; leaves are usually entire and unlobed.

**Chemistry.** Secondary compounds often include betalains (reddish “chromoalkaloid” pigments produced instead of anthocyanins), various flavonoids/quinones, and distinctive sterols; oxalates are often accumulated; in some groups, there are cyclopeptides, triperpenoid saponins, acetogenic naphthaquinones/related compounds, mucilage. Typically uncommon or lacking are tannins, alkaloids, mustard-oils and iridoids.

**Economic uses.** There are several imported modern crop plants from Eurasia: e.g. beets, chard, spinach, buckwheat. Some wild species have been used by people for food in eastern North America, as seeds (esp. *Polygonum erectum* ca. 1500-3000 years ago), fruits (prickly pear), or greens (especially poke, goosefoots & amaranths). Several species have been selected for ornamental gardens, especially from Eurasian origins; several species from eastern North America have potential in this regard (e.g. *Stellaria corei*, *Cerastium velutinum*, *Silene* spp.).

**Life-history.** All native species are herbaceous, including several vernal perennials and summer-flowering annuals.

**Typical Habitats.** Most are typical of disturbed, open, rocky or flooded habitats, especially on fertile soils, with few in mesic woodlands. Although distinctive “puckery” chemicals (betalains) are usually present, most species are relatively palatable at some stages of growth (even the more toxic poke). Few species appear adapted to more continuous browsing, e.g. the aliens, spiny amaranth and Mexican tea.

**Local Natives.** There are at least 10 widespread native species in the central Bluegrass, including several at the Griffith Farm: **poke, spring beauty, common amaranth, wood-knotweed, erect field-knotweed, common smartweed** and **climbing buckwheat**. Several more conservative species are largely confined to ravines, rocky glades, wetlands or riversides but were probably more widespread before settlement and may deserve propagation and recovery, especially **prickly pear, wood-chickweed** and **starry campion**. Spring beauty is the only species at the farm typical of woodlands, but wood-chickweed might also have occurred before extensive grazing by livestock. Although some local species of rocky ravines are globally or regionally imperiled, none of these are typical of the central Bluegrass uplands. There is, however, an old record of the **water-stitchwort** from an upland sinkhole; this species is globally endangered.

**Problematic Aliens.** The many alien species are mostly confined to fields and other open disturbed areas, including **purslane, smooth chickweed, hairy chickweeds, Deptford pink, common goosefoot, Mexican tea, spiny amaranth, Japanese knotweed, path knotweed, smartweeds** and **docks** at the Griffith Farm. However, smooth chickweed and Japanese smartweed also colonize into woodlands, especially after grazing and trampling are relaxed, and the tall Japanese knotweed is locally invasive, especially in riparian corridors.

**Conservation Targets.** See more conservative species noted above (especially prickly pear, wood-chickweed, starry campion).

**GERANIOIDS and allies: Saxifragales (witch-hazel, alumroots, gooseberries, stonecrops, water-milfoils); Vitales (grapes); Geraniales (geraniums); Crossomatales (bladder-nut); Myrtales (meadow-beauties, purple-loosestrifes, evening-primroses)**

**Morphology.** These plants are allied with rosoid groups, but generally (?) with more ovules/carpel, relatively large embryos, and leaves usually simple, palmately veined or lobed.

**Chemistry.** Tannins are often condensed and accumulated; various flavonoids and mucilage are usually produced; in some cases, there are iridoids, various alkaloids, ethereal oils. Calcium oxalate is generally present in crystals. This is no latex, resin or gum.

**Economic Uses.** A few woody species, mostly originating in Eurasia, have been widely cultivated for fruit: the currants (*Ribes*) and the grapes (*Vitis*). Some have been used for various medicinal uses (including the astringent tincture of witch-hazel). Several species have been selected for ornamental use in gardens, including some alum-roots and evening-primroses from eastern North America; there are several species that deserve further use.

**Life History.** The more common native species are mostly woody vines or shrubs. Others include perennial or annual herbs.

**Typical Habitats.** These species are usually restricted to various rocky, riparian or aquatic habitats, from deep woods to full sun.

**Local Natives.** Within the central Bluegrass, only a few natives appear to have been widespread on uplands before settlement, and have been found at the Griffith Farm or nearby: **fox grape, Virginia creeper, field- & wood-geranium, enchanter's nightshade, common evening-primrose**, and, in ponds, **water-primrose**. Several other species are typical of ravines, floodplains and ponds, generally absent at the farm, but might have occurred more widely before settlement, especially **witch-hazel, common alum-root, peppervine, bladdernut, ditch-stonecrop** and **willowherb**.

**Problematic Aliens.** Only a few aliens are common within the region: **European water-milfoil**, some **geraniums**, and, to the north, **purple loosestrife**. These are currently unknown at the farm but some occur nearby.

**Conservation Targets.** No species are globally or regionally imperiled, but several are somewhat conservative or specialized to particular habitats; it is not clear if these deserve special efforts for propagation and recovery on the uplands.



**SALICOIDS and allies: Buxales (box-spurge); Santalales (mistletoe); Malpighiales (willows & poplars, violets, passion-flowers, flaxes, St. John's worts, threadfoot, spurges); Celastrales (bittersweets & spindles, parnassias); Oxalidales (three-leaf sorrels)**

**Morphology.** These plants have ovaries usually with 1-3 carpels (often with parietal placentation), becoming capsules in fruit; leaves are mostly stipulate, simple, unlobed, serrate, with a primary vein to each tooth.

**Chemistry.** Tannins are usually present to various degrees; in some cases, there are diverse phenolics, flavonoids, xanthenes, diterpenoids, triterpenoids, alkaloids, cyanogenic compounds, or mucilage. Several groups have resinous/lactiferous canals/sacs. Oxalates are accumulated in soluble form in Oxalidales.

**Economic Uses.** Only a few species have been widely gathered or cultivated for food, mostly in other regions of the world: e.g. the passionflowers for "passion-fruit", and some Oxalidaceae for fruits, roots and leaves. In eastern North America, the common passionflower produces edible fruit of fair quality ("maypops"). Several trees and shrubs, mostly aliens, are widely grown for ornamental uses and other purposes. Several have been used for various medicinal purposes; e.g. willows have been sources of natural aspirin.

**Life History.** Native species include trees, shrubs, vines and herbs of various types.

**Typical Habitats.** These species are mostly typical of open disturbed sites, from xeric to hydric conditions, but with some herbs in more mesic woodlands. Many appear somewhat resistant to generalist herbivores, others, especially on damp fertile soils, are more palatable but may recover from browsing with vigorous resprouting (e.g. smooth violet, willows, spindles).

**Local Natives.** In the central Bluegrass, there are about 20 widespread native species, with several at the Griffith Farm (or nearby): **mistletoe, black willow, common smooth violet, creamy violet, common passion-flower** (nearby), **broadleaved mercury, common mercury, wood spurge, short & tall creeping spurge, spindle** and **common wood-sorrel**. Less widespread species include **smaller willows** (*interior, caroliniana, eriocephala*), **cottonwood, meadow St. John's wort, shrubby St. John's wort, false spurge** (*Phyllanthus*), **bittersweet**. It is also possible that some species now largely restricted to ravines used to be somewhat more widespread, e.g., **hairy wood-violet, hairy yellow violet, woodland passion-flower, greater wood-sorrel**.

**Problematic Aliens.** Some alien species are serious long-term threats for woodland restoration, especially the widely cultivated and escaped "**purple winter-creeper**", which spreads vigorously on the ground and up trees in woodland where livestock have been removed. Other serious threats, but not yet nearly as common as the winter-creeper, include **white aspen, white willow, burning bush** and locally **oriental bittersweet**.

**Conservation Targets.** No local species are globally or regionally imperiled (except perhaps *Euphorbia obtusata*). Some relatively conservative species of more wooded ravines and hills might deserve attention for propagation and recovery on the uplands, as noted above. Even some of the more widespread species deserve intensive propagation for certain purposes, e.g. spindle (for restoring shrubberies and for ornamental use) and native willows (for riparian restoration).

## **SAPINDOIDS and allies: Sapindales (buckeyes & maples, sumacs, tree-of-heaven, prickly ash); Malvales (mallows); Brassicales (floverkea, cleome, mustards & cresses)**

**Morphology.** These plants are similar to salicoids but with leaves usually compound or lobed, if simple then with palmate venation.

**Chemistry.** These plants have highly varied chemistry, often toxic or repellant. Most are rich in tannins and flavonoids; some have mucilage, [?terpenoid] saponins, various phenolics, triperpenoids/lactones, terpenoid quinones, ethereal oils, various alkaloids, cyclopropanoid amino acids/fatty acids, or glucosinolate “mustard-oils”. Gum, resin or latex canals are often present, containing these chemicals. Oxalates are not generally accumulated.

**Economic Uses.** Rutaceae have provided the widely grown fruits of Eurasian *Citrus* species; also, various “peppers” come from East Asian species of *Zanthoxylum*. Many Eurasian species in the mustard family have been developed into widely grown food plants. In North America, no species have been widely cultivated for food, but several have been used for flavor or medicinal purposes. Several species have been used for ornamental purposes, including some from eastern North America (e.g. some sumacs and mallows). More should be tried.

**Life History.** Native species are mostly trees, shrubs or tall shrubby herbs, except the mustards and their allies (Brassicales), which are all herbaceous.

**Typical Habitats.** Habitats range from deeply shady mesic forest to riparian corridors and xeric glades, but with a strong concentration on fertile soils. Most species appear relatively repellant against generalist herbivores, except for the trees of deeper woods—maples and basswoods—and some shrubby herbs of floodplains.

**Local Natives.** There are about a dozen widely scattered native woody species in the central Bluegrass, but only **poison-ivy, sugar maples, black maple, silver maple, boxelder, Ohio buckeye** and **smooth sumac** are locally common in agricultural landscapes and present at the farm or nearby. In the mustard family and allies, there are about 10 widely scattered native species but only five are widespread and present at the farm: **common pepperweed, upland bitter-cress, cleft toothwort, field-cress** and **purple-rocket**. More conservative species are now largely restricted to more extensive woodland in riparian areas, ravines and hilly areas but were probably more widespread before settlement, including **basswoods, wafer-ash, prickly-ash** and some herbaceous species, e.g., **broad-leaved toothwort**. A few other species have more or less disappeared (see below).

**Problematic Aliens.** **Tree-of-heaven** is an alien from China that is a widespread problem in woodland restoration. There are also many herbaceous aliens in the **mallow** and **mustard** (or **cress**) families that are abundant in disturbed open areas, generally far outnumbering any natives. But in woodlands, **garlic-mustard** is the only serious problem.

**Conservation Targets.** Relatively conservative species, even the more widespread maples and buckeyes, are slow to recover in protected woodland, and deserve propagation. It is hard to estimate past distributions of some rare species. **Glade-mallow** is globally rare, with scattered records from rocky fields but largely disappeared from the region. **Bladder-pod** is globally imperiled, with scattered records from the central Bluegrass, mostly in thin rocky woods and edges but also from some roadsides or streamsides on deeper soils in the uplands. **False mermaid-weed** was recorded once but has disappeared; it is a northern species associated with trails and streamsides in shady habitats. The globally rare **river mallow**, which is highly palatable, is widely scattered in eastern states but generally restricted to a few localities along larger rivers.

**ROSIDS and allies: Rosales (strawberries & blackberries & roses & plums & apples, buckthorns, autumn-olives); Urticales (elms & hackberries, mulberries, hops & hemp, nettles); Fabales (milkworts, mimosas, sennas, beans & peas)**

**Morphology.** These plants usually have regular bisexual flowers and “nettle-like” leaves, with a network of veins converging on teeth, except for the legumes (bean family), which usually have bilaterally symmetric flowers and entire, trifoliate or otherwise compound leaves.

**Chemistry.** Tannins or diverse flavonoids/glycosides are usually present to various degrees (but perhaps not both to high degrees); other common compounds in some groups include diverse phenolics, triterpenoids, lignans/sesquiterpene lactones, [?triterpenoid] saponins, chelidonic acid, mucilage, various alkaloids, cyanogenic compounds, non-protein amino acids/other unusual N-compounds. Calcium carbonate is accumulated in cystoliths of Urticales (also often silicified). Oxalates are not usually accumulated.

**Economic Uses.** Many species from Eurasia or elsewhere have been cultivated and bred for fruits (especially Rosales) or beans (Fabales). The fruits of many native species are edible, and there has been some limited selection and breeding. Some native species can be used for greens (especially nettles, perhaps some beans/peas) or edible roots (some beans/peas). Some have been used for medicinal purposes.

**Life History.** Native species include trees, shrubs and herbs of various types.

**Typical Habitats.** These species are distributed broadly over a wide range of terrestrial habitats. Many are relatively palatable, with limited chemical defenses other than tannins, and may be reduced by prolonged browsing, but the woody species often have partial resistance due to vigorous resprouting (often from lateral roots or rhizomes) or due to thorns. A few woody species appear more repellent, due to alkaloids, and may accumulate after repeated intensive browsing (e.g. coffee-tree, some buckthorns). Morphological or chemical defenses appear more frequent in species of relatively fertile soils. Many species are ectomycorrhizal or, especially in the bean family, nodulated with nitrogen-fixing microbes, and relatively high nitrogen-levels can often be maintained on less fertile soils.

**Local Natives.** In the central Bluegrass, there are over 30 widespread native species, with many found at the Griffith Farm or nearby: **wild strawberry\***, **early avens**, **common avens**, **raspberry**, **blackberry**, **dewberry**, **hairy agrimony**, **prairie rose\***, **black cherry**, **common plum\***, **downy hawthorn\***, **cock-spur hawthorn\***, **buckthorn**, **white elm**, **red elm\***, **hackberry**, **red mulberry**, **rich-weed**, **southern nettle\***, **coffee-tree\***, **honey-locust**, **redbud**, **senna**, **common tick-trefoil** and **black locust**. For others, see “targets” below.

**Problematic Aliens.** There are many aliens, mostly in open disturbed areas. Some are serious problems in old fields, but they tend to decline in deeper shade, e.g., **multiflora rose**, **Siberian crabapple**, **pie-cherry**, **autumn olive**, **white mulberry**, **clovers** (mostly European) and **lespedezas** (mostly East Asian).

**Conservation Targets.** Several uncommon local natives (\*) deserve attention for propagation, recovery or native landscaping, as well as species that have probably declined greatly since settlement, e.g., **gooseplum**, **wood-nettle**, **tall nettle** and **hog-peanut**. Hog-peanut (or “pea-vine”) was formerly one of the most abundant species in the original woodland, but now largely restricted to less disturbed stream corridors. High palatability and nutrition in most native legumes probably led to their eradication by free-ranging livestock during the period of early settlement. There are remarkably few native legumes typical of fields (only tick-trefoil and senna); none occur within most woodland remnants. The **running buffalo clover** is globally imperiled, and needs to be recovered with an intensive program of woodland restoration, propagation and disturbance experiments. At the center of its range in the central Ohio Valley, it was formerly common on fertile soils in submesic woodlands, probably associated with frequent disturbance by large herbivores. Other rare or imperiled legumes in the region that deserve propagation include **prairie mimosa** and **broad-leaved scurf-pea**. [Also, Queen-of-the-prairie may have occurred originally in the northern Bluegrass.]

## **FAGOIDS and allies: Fagales (beech & chestnut & oaks, hazel & hornbeams & birches, walnuts & hickories, bayberries); Cucurbitales (squashes & cucumbers)**

**Morphology.** These plants are somewhat similar to the rosoids but with flowers that are unisexual, usually with petals and sepals few, small or absent, and produced in spikes or “catkins”; ovaries are inferior, usually becoming one-seeded indehiscent fruits, often nutty (or with thick hard skin and many seeds in the related cucumber family); leaves are alternate, and usually with stipules down the stems.

**Chemistry.** Tannins are strongly concentrated in most cases; other secondary compounds in some cases include flavonoids, naphthaquinones, and perhaps triterpenoids of various types (also punicic acid and alkaloids in cucurbits). Cyanogenic compounds are absent (?). Calcium oxalates are perhaps rarely accumulated; but calcium carbonate and silica are in cystoliths/cell walls of cucurbits. In some cases (at least cucurbits), nitrogen is transported as citrullin/other non-protein amino acids.

**Economic Uses.** Some species have been cultivated and selected for nuts, especially the Eurasian walnuts, hazelnuts and chestnuts, or for “vegetable” fruits—the cucurbits from various regions. Among North American species, only the pecan has also been widely cultivated, but native walnuts and hickories are being gradually selected and locally cultivated. Beechnuts, acorns and hazelnuts were formerly used by native people, but have little use by humans in modern times; chestnuts, found on more acid soils, were formerly eaten to a large degree, but have largely disappeared due to disease. However, all of these native nuts are important autumnal food for several game animals. The oaks, in particular, can provide much hardwood of high quality.

**Life History.** Native species are all trees or shrubs, except for the herbaceous annual twining vines in the cucumber family.

**Typical Habitats.** They cover a wide range of habitats, from fairly mesic forest to more open xeric or hydric woodland. Most appear relatively resistant to generalist herbivores, and may accumulate in woodland that has been exposed to repeated browsing (especially some hickories, hornbeam and hophornbeam).

**Local Natives.** In the central Bluegrass, there are about 10 widespread native species, and several are widespread on uplands, including the farm (or nearby): **chinquapin oak, bur oak, shumard oak, shingle oak, black walnut, bitternut hickory, shellbark hickory** and **shagbark hickory** (perhaps also **bur-cucumber**). Others are largely concentrated in ravines and hilly areas, but probably extended more into the gentler landscapes before settlement, especially **hornbeam**, perhaps also **hophornbeam, northern red oak** and locally, on poorer soils, **beech**.

**Problematic Aliens.** There are no alien species that have become invasive, though several are commonly planted.

**Conservation Targets.** The only imperiled species is **white walnut** (or “butternut”), which has been eliminated by disease from much of its former range and deserves special attention for propagation and breeding of resistant races. Most other species are more or less conservative; although they can reproduce and spread into recovering woodland, parent trees are often absent, seed production is often erratic, and dispersal is limited. Only black walnut is widespread and prolific in its regeneration. Species that deserve most attention for propagation and recovery include beech, hornbeam and hophornbeam; these are largely restricted to ravines and hills with more extensive forest remnants.

**ERICOIDS and allies: Cornales (blackgums, dogwoods, hydrangeas); Ericales (camelias, silver-bells, diapensias, rhododendrons & blueberries, bumelia, persimmon, primroses, phloxes, jewelweeds)**

**Morphology.** Flowers mostly have petals joined at their base; fruits are mostly capsules; leaves are without stipules, usually broad, usually simple and unlobed, mostly entire or if serrate then the teeth with single veins and opaque deciduous caps or hairs (?).

**Chemistry.** Tannins are generally produced, often to high degrees; other common secondary chemicals in some groups include various phenolics, diverse flavonoids, diverse triterpenoids or related saponins; less widespread are proanthocyanidins, naphthaquinones, benzoquinones, alkaloids, mucilage. Oxalates are accumulated in raphides of a few groups. Cell walls are often calcified in Cornales. Sugars are accumulated as kestose or isokestose in some cases.

**Economic Uses.** Almost no species have been developed as a regular food crop (except perhaps for fruits of some Asian dogwoods). Several have been used for medicinal purposes; the jewelweeds are used for soothing irritated skin. Many woody and herbaceous species are widely grown as ornamentals.

**Life History.** Native species are mostly small trees or shrubs, perennial herbs or annuals.

**Typical Habitats.** These species cover a wide range of habitats from mesic woods to open xeric or hydric sites, but mostly on relatively acid, infertile soils. Many woody species are relatively resistant to browsing, due to repellent chemistry (especially tannins and terpenoids), but some species of relatively damp, fertile soils are frequently browsed, and may be reduced by prolonged exposure to large herbivores.

**Local Natives.** Within the central Bluegrass, there are only 5-10 widespread species. Only a few have been found at the farm—**roughleaf dogwood**, **river phlox** and **orange jewelweed**—but others may have occurred before settlement, especially **woodland phlox**, **Jacob's ladder** and **yellow jewelweed**. **Silky dogwood** may have been more widespread along larger streams.

**Problematic Aliens.** There are virtually no invasive aliens, except for a few Eurasian ornamentals that locally persist or escape from plantings (*Deutzia scabra*, *Philadelphus coronarius*, *Impatiens balsaminea*).

**Conservation Targets.** There are no imperiled species, but some of the more conservative species deserve special propagation and reintroduction. Rough-leaf dogwood is uncommon in more intensively farmed landscapes, but it can be easily propagated for restoration of native shrubbery, in order to replace some invasive woody aliens (especially the Amur bush-honeysuckle).

## **GENTIANOIDS and allies: Gentianales (bluets & bedstraws, gentians, pinkroot, dogbanes & milkweeds)**

**Morphology.** Flowers have petals joined at base, often with long tubes, only 4-5 stamens 4-5 (?); ovaries usually have only 2 (4-5) carpels; fruits are usually capsules/follicles or single-seeded forms; leaves usually lack stipules, and are opposite or whorled.

**Chemistry.** Secondary compounds usually include various alkaloids or iridoids or both; also, in some groups there are also tannins, various phenolics, various flavonoids, cardenolides/cardiotoxic glycosides, anthraquinones, or mucilage. Latex is well-developed in dogbanes & milkweeds. Carbohydrates are often accumulated without starch. Calcium oxalates are usually present in parenchyma.

**Economic Uses.** No species have been developed into widespread crops. Many species have been used as stimulants/inebriants, medicines or poisons.

**Life History.** Most native species are perennial, biennial or winter-annual herbs.

**Typical Habitats.** These species occur mostly in open disturbed or stressed habitats, from xeric to hydric sites, but several do occur in deeper mesic woods. Most species appear somewhat resistant to browsing due to repellent chemistry (especially alkaloids or iridoids), especially perennials typical of more open grassy areas; biennials and winter-annuals may often escape browsing—or droughts—in summer to fall. However, prolonged exposure to livestock (including rooting by hogs) has probably contributed to the reduction of some species within farmed landscapes.

**Local Natives.** In the central Bluegrass, there are only 5-10 widespread native species. Most of these occur at the farm (though some only in small numbers)—**common bedstraw**, (**woodland bedstraw**), **dogbane**, **common milkweed**, (**orange milkweed**), (**green milkweed**) and **honeyvine milkweed**—and others may have before settlement (e.g. **lance-leaved bluets**).

**Problematic Aliens.** A few clearly alien species are also locally abundant in the region, such as **piedmont bedstraw** and **periwinkle** (often spread from old plantings), but not yet at the farm. The native or alien status of common bedstraw remains uncertain; seeds that may be this species have been found in excavations of village sites from ca. 500-1000 years ago.

**Conservation Targets.** There are no known imperiled species, but some less conservative species also appear to have declined greatly within the central Bluegrass and could be targeted for propagation, reintroduction and recovery (e.g. woodland bedstraw and lance-leaved bluets). Also, a few rare species are known from drier habitats in peripheral hills (e.g. *Gentiana alba*).

**LAMIOIDS and allies: Lamiales (privets & ashes, catalpas & trumpet-creepers, figforts, water-hyssops & beardtongues & speedwells, foxgloves & broomrapes, plantains, bladderworts, wild petunias, vervains, lopseed, skullcaps & mints)**

**Morphology.** Flowers are usually 4-merous, mostly bilaterally symmetric, with petals joined at base, and only 2-5 stamens; ovaries usually have 2-4 carpels, becoming capsules or breaking into single-seeded forms; leaves lack stipules, and are usually opposite.

- **Chemistry.** Secondary compounds usually include various iridoids/cornosides; in some cases there are also various flavonoids, phenolics, diterpenoids, betaines or other quaternary methylammonium compounds, phenylpropanoids, ethereal oils, flavone glycosides, phenolic glycosides. Carbohydrates are mostly stored as stachyose or other oligosaccharides. Tannins and alkaloids are usually absent. Oxalates are usually not usually accumulated (?).

**Economic Uses.** There are virtually no important food plants (except for the olive), but there many species have been used for flavorings, medicines, inebriants or poisons. Many species with showy flowers have become widely used in horticulture. Some of the trees are highly valued for their more or less fast-growing hardwood, in some cases with special durability.

**Life History.** Most native species are perennial herbs; also, several are monocarpic (including biennials and annuals). A few are trees, shrubs or woody vines.

**Typical Habitats.** Most species occur in open, disturbed or stressed, habitats, from xeric to hydric sites, but with a concentration in lowland or wetland sites and several in deeper mesic woods, and some concentration on relatively fertile soils. Most species, especially strongly aromatic plants, are usually repellent to generalist herbivores (with iridoids or various other compounds), and several can invade the relatively bare ground of heavily grazed/trampled areas, especially on fertile soils. However, disturbance in modern farmland is generally excessive.

**Local Natives.** In the central Bluegrass, there are at least 20 widespread native species, including many at the farm or nearby: **white ash, green ash, blue ash, trumpet-creeper, smooth open beardtongue\***, **smooth sessile speedwell, broad-leaved plantain, Virginia plantain, lowland petunia, nettle-leaved vervain, petioled monkeyflower\***, **lopseed, germander, self-heal, lyre-leaved sage and blue wood-mint**. Species unknown at the farm are mostly more conservative and concentrated in wooded ravines and hills, but might have been more widespread in this area: **felted open beardtongue, blue-eyed-Mary, mullein foxglove, squawroot, broad-leaved skullcap, synandra, giant hyssop, common bergamot, white wood-mint and pennyroyal**. Several additional lowland or wetland species (+\*) are rare, but may have been much more widespread before intensive farming and grazing, e.g., **common pond-hyssop, turtle-head, water-speedwell, water-willow, marsh vervain, fogfruit, pond-pimpernel, mad-dog skullcap, smooth woundwort, lowland bergamot, water horehounds and wild mint**. On drier ground to the northwest, the curious **glade savory** is a rare species that associates with disturbed woods and might have been more widespread.

**Problematic Aliens.** Several alien species are also common in the region, especially **privets, mulleins, butter-and-eggs, lesser toadflax, speedwells, English plantain, motherworts, henbits, catnip, gill-over-the-ground, mints, beef-steak-plant**, and several others (including those associated with cultivation). Only a few of these present serious threats to woodland restoration—especially the privets and gill-over-the-ground.

**Conservation Targets.** There are no globally imperiled species in the central Bluegrass, but several are considered rare, uncommon, or conservative within the region and deserve propagation for recovery. These include several of the wetland species listed above, plus some that have probably disappeared from most uplands, e.g. blue-eyed Mary, figwort, beardtongues, skullcaps, synandra, wood-mints, bergamots.

**SOLANOIDS and allies: Boraginales (waterleafs & phacelias, gromwells & forget-me-nots & comfrees); Solanales (ground-cherries & nightshades, morning glories & bindweeds, dodders)**

**Morphology.** Flowers are 5-merous, with petals joined at base, and 5 stamens; ovaries usually have 2-4 carpels (?); fruits are usually capsules or single-seeded forms; leaves are without stipules and alternate.

**Chemistry.** Secondary compounds usually include various alkaloids or related compounds; also, in some groups there are various phenolics, various flavonoids, flavone glycosides, or naphthaquinones. Tannins and iridoids are usually absent (?). Carbohydrates are mostly stored as oligosaccharides such as fructosans (isoheptose, isokestose, inulin); nitrogenous reserves are stored as the amide allantoin in Boraginaceae. Calcium oxalates are usually present in parenchyma (and silicic acid in Boraginaceae); Boraginales usually have characteristic firm-based calcified/silicified hairs, or odorous glandular hairs.

**Economic Uses.** No species have been developed into widespread crops, except perhaps for the Eurasian comfrey (*Symphytum officinale*), which has been used as wild greens for human consumption, and for livestock food. Among native species, food can be cooked from the shoots of some waterleafs. Some species have been used as stimulants/inebriants, medicines or poisons. Several species have been used as garden ornamentals or ground cover, and some of the natives in this region still have much unrealized potential, especially “mists” (*Phacelia* spp.), “waterleafs” (*Hydrophyllum* spp.) and “bluebells” (*Mertensia virginica*) for low-maintenance wildflower gardens.

**Life History.** Most native species are perennial herbs, plus some biennials/annuals.

**Typical Habitats.** Most are typical of open disturbed or stressed habitats, from xeric to hydric sites, but several do occur in deeper mesic woods. There is a strong concentration on relatively fertile soils. Most perennial species appear somewhat resistant to browsing due to foetid or otherwise repellent chemistry (especially alkaloids); biennials and winter-annuals may escape browsing—or droughts—through dormancy in summer to fall. However, prolonged exposure to livestock (including rooting by hogs) has probably contributed to the reduction of some species within farmed landscapes. Several species are associated with somewhat disturbed woodlands or grasslands, especially along trails; disturbance in modern farmland is generally excessive for Boraginales but conducive to Solanales.

**Local Natives.** In the central Bluegrass, there are 10-20 widespread native species, with several at the farm: **Miami mist, wood forget-me-not, hairy ground-cherry, smooth ground-cherry, yellow-berried nightshade, black-berried nightshade, ivy-leaved morning-glory, small-flowered morning-glory, arrow-leaved bindweed** and **common dodder**. Several others may have been before settlement; **beggar’s lice, biennial waterleaf** and **bluebells** were probably scattered much more widely before intensive farming and grazing.

**Problematic Aliens.** A few alien species in these groups are locally common, including **Viper’s bugloss, field gromwell, jimsonweed** and **field bindweed**, but only jimsonweed has been found at the farm.

**Conservation Targets.** Some of the more conservative species should be targeted for propagation and recovery (especially the showy waterleafs and bluebells). Even the relatively common Miami mist deserves intensive recovery at selected sites, using “seed-straw” raked up from this winter-annual as it dies down in May. There are no globally imperiled species, except perhaps for **tall gromwell**, which appears to have virtually disappeared from its original dry open grassy habitats in the Ohio Valley.



**ASTEROIDS and allies: Aquifoliales (hollies); Apiales (sarsaparillas & ginsengs, umbellifers of many kinds); Dipsacales (viburnums, honeysuckles, valerians & corn-salads, teasles); Asterales (lobelias; sunflowers, wormwoods, ragworts, goldenrods & asters, everlastings, bonesets & blazing stars, ironweeds, thistles, lettuces)**

**Morphology.** Flowers are usually small, with petals are symmetric (except for the asymmetric rays of composites), usually united at bases and pointed at apices; stamens are usually 4-5, often formed into a tube with pollen pushed out by the style; ovaries are inferior, with 1-5(6?) carpels, in fruit becoming drupes/single-seeded, with short/very short embryos; inflorescences are mostly umbellate-centripetal/cymose-centrifugal or composite-centripetal, with involucre bracts; leaves are usually without stipules, and mostly alternate.

**Chemistry.** Secondary compounds are varied, including proanthocyanins, alkaloids, iridoids, triterpenoids, anthraquinones, ethereal oils; typically sesquiterpene lactones and often polyacetylenes occur in Apiales and Asterales, with resiniferous/lactiferous systems in Asterales. Flavonoids and phenolics are relatively concentrated or diverse Apiales; tannins are generally sparse or absent. Carbohydrate is stored as starch, umbelliferose or inulin.

**Economic Uses.** Many species have been used for food or flavor, and there are important crops from Eurasia and elsewhere, especially in the carrot family (Apiaceae), sunflower and lettuce tribes (Asteraceae). Among those with North America origin, modern food plants have been bred from sunflower seeds (*H. annuus*) and the roots of "Jerusalem artichoke" (*H. tuberosus*). Larger seeds of sumpweed were selected for food ca. 1000-2000 years ago. Many native species produce seed that is consumed by game birds. Wild greens have been commonly collected in several cases (e.g. bellflower, corn-salads). Several native and alien species have been used as medicines or poisons.

**Life History.** Native species are mostly herbaceous; the woody species are mostly shrubby.

**Typical Habitats.** These species occur in a wide range of habitats, from mesic woods to various open habitats. There is some concentration on relatively base-rich soils, but not as much as in the other sympetalous groups, and there is a broad range of responses to generalist herbivores (with diverse chemistry but little/no tannins).

**Local Natives.** In the central Bluegrass, there are at least 60 widespread native species, plus many more largely restricted to ravines or in peripheral hills. Many of these species occur at the Griffith Farm or nearby (though uncommon to rare in some cases): **common sanicle, (harbinger-of-spring), honewort, (golden alexanders), (smooth black-haw), elderberry, coralberry, common corn-salad, bell-flower, common lobelia** [Indian tobacco], **greater lobelia, (meadow sunflower)** [Jerusalem artichoke], **lowland wingstem, (opposite-leaved wingstem), oxe-eye sunflower, meadow coneflower, (bipinnate tickseed), common tickseed, common ragweed, giant ragweed, cocklebur, (meadow ragwort), common meadow goldenrod, common meadow aster, soft meadow aster, (tall purple aster)** [New-England aster], **(streambank aster), spring fleabane, summer fleabane, fall fleabane** [horseweed], **lowland boneset, white-snakeroot, bluemist-flower, common ironweed, common elephant's foot, meadow thistle, common wild-lettuce, (tall blue lettuce)**. Some of the remainder are more conservative and concentrated in more hilly areas or deeper woods near larger streams, but may have occurred much more widely, especially **gregarious sanicle, smooth sweet cicily, bipinnate wood-parsnip, broad-leaved woodland sunflower, tall wood-robin, lowland rosinweed, golden ragwort, fireweed, zigzag goldenrod** and **Short's aster**. Several other species are concentrated in peripheral lowlands or wetlands, but may have been much more widespread before settlement, including **water-hemlock, cardinal flower, lowland coneflower, false daisy, broad-leaved sneezeweed\***, **bur-marigolds, sumpweed, lowland goldenrod\***, **riverside aster\*** and **joe-pye weed**; a few of these (\*) occur in small numbers in low areas on the farm or nearby.

**Problematic Aliens.** Many alien species are common in the region, especially **poison-hemlock, wild-parsnip, hedge-parsely, wild-carrot, Amur bush-honeysuckle, Japanese honeysuckle, teasle, yarrow, pineapple-weed, wormwoods, bur-dock**, several **thistles, sowthistles, dandelion, prickly lettuce** and **chicory**. These aliens are mostly weeds in open areas, but the honeysuckles and poison-hemlock spread into woodlands and are serious problems for restoration.

**Conservation Targets.** Only a few species in the region are globally or regionally imperiled; these are known mostly from hills and valleys of peripheral sections, formerly in association with thin woods and glades on more rocky soils, or on wetter ground. The rarest is **Short's goldenrod** (in the adjacent Blue Licks area). [Others might include eulophus (*Perideridia americana*), prairie-dock (*Silphium terebinthinaceum*), fen wood-lettuce (*Prenanthes racemosa*).] There is, however, one regionally rare species typical of more mesic thin woods and edges—**giant wood lettuce**, which has been found at scattered sites in the region and was probably much more widespread before settlement. **Ginseng** may also deserve special attention due to its extensive overharvesting for medicinal purposes, but it is more typical of adjacent hills with less calcareous soils. In addition to special recovery programs for these species, several of the more conservative species listed above are currently concentrated in better remnants of mesic or submesic woodland.

## **AROIDS and allies: Alismatales (jacks-in-the-pulpit, duckweeds, arrowroots, pondweeds & water-nymphs); Dioscoreales (wild yams)**

**Morphology.** These monocots generally have showy trimerous flowers; carpels are separate or joined; leaves have diverse but are usually alternate, simple, entire, primarily parallel-veined, and often with a basal sheath.

**Chemistry.** Secondary compounds often include flavonoids and saponins (sometimes steroidal); in some cases, there are proanthocyanins, ethereal oils, oxalates, cyanogenics or alkaloids.

**Economic Uses.** Roots of the arrowroots are somewhat edible, and some species are cultivated in tropical regions. Aroid roots also, including jack-in-the-pulpit, can be eaten after cooking takes out the oxalates. However, there are no species in these groups that are widely cultivated in temperate regions.

**Life History.** Native species are all herbaceous and perennial (or clonally dividing).

**Typical Habitats.** These species are all aquatic (especially in slow water), except for the jacks and yams, which occur in more or less mesic woodlands. There is some concentration on eutrophic soils or waters. Terrestrial species, at least, may accumulate in repeatedly browsed vegetation, unless there is excessive disturbance from rooting herbivores. With repellent chemistry (due to various compounds) and deep storage organs, their ecology may parallel the lilioids (see below).

**Local Natives.** In the central Bluegrass, there are only about 10 widely scattered native species, with none generally abundant in the landscape: **jack-in-the-pulpit, green-dragon, greater duckweed, common duckweed\***, **water-plantain, common arrowroot\***, **southern water-nymph, common fine-leaved pondweed, hornwort** and **wild-yam**. Only two of these have been found at the farm or nearby (\*). Some of these are concentrated in peripheral ravines, lowlands or wetlands, but may have been more widespread before settlement and should be tried at the farm, especially wild yam, jack-in-the-pulpit and perhaps green-dragon.

**Problematic Aliens.** There are a few aliens that are locally abundant, but not yet at the farm: **sweet-flag, brittle water-nymph** and **potato-vine**.

**Conservation Targets.** There are no globally imperiled species in the region, but some aquatic species are threatened, endangered or locally extinct—several used to occur in the Kentucky River, but have been eliminated by the dams. It is possible that some of these species, such as **tapegrass** (*Vallisneria americana*), formerly extended up into larger streams within landscapes that have now been intensively impacted by livestock.

**LILIOIDS and allies: Liliales (lilies, bellworts, Solomon's seals, trilliums, greenbriers); Asparagales (asphodels, daffodils, onions, hyacinths, yuccas, asparagus, daylilies & hostas, irises, star-grass, orchids)**

**Morphology.** These monocots have showy, trimerous flowers, with sepals usually petaloid, inferior ovaries; seeds have hard endosperm rich in hemicellulose, protein and oil, often dispersed by ants; leaves are alternate or whorled, simple, entire and parallel-veined.

**Chemistry.** Secondary compounds often include alkaloids (not irises), steroidal saponins, chelidonic acid, mucilage; in some cases (especially irises), there are anthraquinones, terpenoids, proanthocyanins. Calcium oxalates are often accumulated.

**Economic Uses.** With Eurasian origins, asparagus (*A. officinalis*), as well as onion, garlic and their relatives (*Allium* spp.), are now widely grown for food or flavor. A few native species are somewhat edible (Solomon's seal, greenbrier, wild hyacinth), but others are slightly to highly poisonous. There are many Eurasian species that have become important horticultural ornamentals, but the native species have not yet been bred for this; the trout-lilies, trilliums and wild-hyacinth have potential, at least in shade gardens.

**Life History.** Native species are mostly perennial herbs, usually with fleshy bulbs, corms or rhizomes.

**Typical Habitats.** Most are typical of more or less mesic woodlands, or in some cases transitions to swampy sites; the orchids, however, extend into other habitats, and their minute seeds are more widely dispersed. There is probably some concentration in vegetation that has been moderately exposed to browsing, since many are somewhat repellent to generalist herbivores due to chemical constituents. Also, the deep below-ground storage organs of some species may allow rapid vernal growth, flowering/seeding and energy/nutrient-storage, then dormancy during the long exposure to stresses, disturbances and herbivory of summer and fall.

**Local Natives.** In the central Bluegrass, there are only about a dozen widely scattered or locally common native species, half of which occur at the farm: **yellow trout-lily, white trout-lily, sessile trillium, bristly greenbrier, wild hyacinth, blue-eyed grass, summer ladies-tresses and common fall ladies-tresses.** The others are **false Solomon's seal, common Solomon's seal, eastern herbaceous greenbrier, wild onion and lily-leaved twayblade.** Several additional species only occur in peripheral habitats, within ravines, in wetlands, and on more acid soils of adjacent hills. Even the widespread species are mostly restricted to deeper woods with less intensive farming history. Only blue-eyed grass and the ladies-tresses orchids are typical of fields.

**Problematic Aliens.** There are also several widespread aliens, including several escaped from cultivation. The most common invasive species are **onion-grass**, especially in sun, and **star-of-Bethlehem**, especially in shade. Locally persistent species in or near old gardens include **daffodils** and **day-lilies.**

**Conservation Targets.** No globally or regionally imperiled species are known from the central Bluegrass, except perhaps for the largely mid-western "**Michigan lily**", which has apparently become endangered within the central and lower Ohio Valley; rooting by hogs during early settlement may have essentially eradicated the large bulbs of this species, and greatly reduced some of the other species. There is also an old uncertain record of **showy orchid.** Most of the native species are more or less conservative, with slow recovery in regenerating woodland. An intensive propagation effort will be needed to recover them for restored woodlands; they are mostly slow or difficult to grow.

## **GRAMINOIDS and allies: Commelinales (spiderworts & dayflowers); Poales (cattails, rushes, sedges, grasses)**

**Morphology.** These monocots have flowers that typically lack nectaries, mostly reduced and chaffy with wind pollination; carpels often produce single seeds with mealy starch-rich endosperm; leaves are alternate, simple, entire, relatively narrow, parallel-veined, and usually with a basal sheath.

**Chemistry.** Cell-walls (especially epidermal) usually have much silica. Secondary compounds include various flavonoids; in some cases, there are also proanthocyanins, alkaloids or cyanogenics (some grasses).

**Economic Uses.** Although our modern food supply is now dominated by grain crops with foreign origins, some native species have provided edible seeds in the past. Little barley, in particular, was frequently used for food ca. 1000-2000 years ago. Although European grasses adapted to intensive grazing and mowing, such as fescue and bluegrass, are now dominant in pastures, many native species can be used to a more limited extent as forage for livestock and wildlife. During early settlement of the central Bluegrass, cane, wild ryes and other grasses were rapidly depleted by cattle and other livestock in the woodlands. The sedges generally are less valuable for forage, and may have been less reduced by livestock. Only a few native species (especially grease-grass) can be regularly grazed and mowed.

**Life History.** Almost all native species are herbaceous; most are rhizomatous perennials.

**Typical Habitats.** Most are typical of more or less open conditions, from xeric to hydric sites, but some do occur typically in mesic woodlands. There often are concentrations of species within vegetation that is prone to relatively frequent browsing or burning. Although not strongly defended with chemicals (apart from silicified cell walls), many species are able to withstand a certain degree of repeated disturbance, often by resprouting vigorously from rhizomes.

**Local Natives.** In the central Bluegrass, there are at least 50 widespread native species, with most now found at the farm: **broad-leaved cattail, path-rush, common flatsedge, softstem bulrush, black bulrush, little-spike-sedges** (*texensis, rosea, mesochorea, aggregata, sparganioides*), **fine fox-sedges** (*annectans, vulpinoidea*), **fox-sedge** (*conjuncta*), **scale-sedges** (*normalis, molesta*), **tufted-sedge** (*jamesii*), **common lax-sedge** (*blanda*), **lime-sedge** (*granularis*), **wrinkled-sedges** (*oligocarpa, grisea*), **graceful-sedge** (*davisii*), **lime-swale-sedge** (*shortiana*), **head-sedge** (*frankii*), **cane, common ricegrass, cutleaf ricegrass, common mannagrass, wood-fescue, wood bluegrass, early wild-rye, common wild-rye, nodding wild-rye, showy love-grass, greasegrass, nimble-will, greater early panic-grass, lesser early panic-grass, perennial late panic-grass, tall late panic-grass, fine late panic-grass, decumbent lens-grass, single lens-grass, perennial foxtail-grass and common broomsedge.** Other widespread species may be expected at the farm or might have occurred in the original vegetation, such as **broad-leaved spiderwort, chufa & fragrant flatsedges, common spike-rush, prairie bulrush, running head-sedges (and others), beech grass, beakgrain grass, common wood-oats, lowland wedge-grass, common wood-brome, little barley, common dropsweed and lesser lens-grass.** Other species occur largely in the peripheral habitats of wetlands, ravines and adjacent hills, and were probably less widespread before settlement. There is no evidence that the common prairie grasses, **big bluestem, little bluestem** and **Indian grass** were widespread in the region; there are only a few records from peripheral habitats.

**Problematic Aliens.** Many alien species are also widespread, especially in old fields and other open or disturbed areas. In some cases native or alien status is uncertain. Some races of the **common bluegrass** may be native, but this has not been fully researched. Several aliens are problems for restoration of native grasslands, especially the perennials **fescue** and **Johnson grass**; in the short-term, annuals like **tall foxtail-grass** can also dominate. However, the only widespread problem in woodland restoration is **Japanese grass**, which has not yet been found at the farm.

**Conservation Targets.** There are no globally imperiled species in the region, but a few that may have been more widespread are now largely disappeared (perhaps *Carex vesicaria*). More conservative species, with very slow or local recovery by themselves, include cane, the woodland grasses noted above, and perhaps some sedges (*?communis*, *hirtifolia*, *laxiflora*). Somewhat less conservative are woodland bluegrass, woodland fescue, and some other sedges (e.g. *oligocarpa*, *jamesii*, *rosea*), which seem to recover gradually within regenerating woods. More frequent, the wild ryes, and some other sedges (e.g. *sparganioides*, *davisii*, *normalis*), are often able to survive and repopulate in more peripheral habitats, such as fencerows and transitions from old fields. Selected rare to conservative and more frequent species like these will be needed for propagation and large-scale restoration.