Vegetation Classification and Mapping

The following broad classes (A to I) follow usage of JC during the 1990s for NPS at Mammoth Cave National Park and Big South Fork NRRA, and.for USFS in Daniel Boone National Forest. For internal 'crosswalk' notes on these JC-coded classes are inserted below in brackets after headings. In brackets "JC" = codes developed by the auther; "KHP" = Kentucky Natural Heritage Program names; "NVC" = National Vegetation Classification types (their "CEGL" numbers) of NatureServe (2014). Species noted in parentheses are rare or absent in the project area, but they are present elsewhere on nearby WKU land.

A. Rheic zones: not distinguished from riparian woods (B) in vegetation map [JC Class 01; KHP generic "gravel/cobble bar"; NVC 4331, 4286, 6480, 4739]. These are narrow (1-5 m wide) openings on rocky banks, ledges, bars, spits and riffles with varied vegetation. Water-willow (*Justicia americana*) is locally dominant in more gradual transitions from gravel bars to flowing water. The transition to forest often have dense stands of wild oats (*Chasmanthium latifolium*). The riverbed itself has at least one notable vascular aquatic plant—*Podostemum ceratophyllum*. Other aquatics to be expected are *Potamogeton* spp.—*P. nodosus* was noted here in riffles along/near the Bush/Goebel tract, and *P. foliosus* was collected by Braun (1943) in the Green River by Mammoth Cave. Also, *Vallisneria americana* was mapped in the Green River watershed by Kartesz (BONAP). Elsewhere in the Green River corridor, another rare species, just above the *Justicia* zone, is *Physostegia virginiana* (the typical var. *virginiana*, not var. *praemorsa* of the uplands). Also, big bluestem *Andropogon gerardii*) is locally dominant in open zones just below the transition to forest edges with wild oats; switch grass (*Panicum virgatum*) occurs at a few sites along the river.

Core WKU Tracts [2008 plan]. Not mapped in plan; noted as: "10a. Rheic Zone."

Bush/Goebel. In the following notes: * indicates lower levels, at water level or often flooded in growing season; # indicates upper levels, in transition to shrubs and trees on lower slopes; also some species are added in parentheses from sites near the Goebel Tract, and may not occur directly on that tract. Typical species include: *Aster lanceolatus* (common), *A. ontarionis*#, *A. prenanthoides, Campsis radicans, Chasmanthium latifolium*#, *Cynanchum laeve*, (*Diodia virginiana** rare/upstream?), *Eleocharis erythropoda**, *Elymus* spp. (especially *virginicus*, *riparius*), *Equisetum arvense*#, *Justicia americana**, *Leersia virginica* (+ locally *L. oryzoides*), (*Lycopus americanus* upstream), *Lysimachia ciliata*, (*Phyla lanceolata* rare/upstream), *Polygonum* spp.# (*longisetum, punctatum*, ?others), (*Potamogeton nodosus* in river), *Toxicodendron radicans*, *Rorippa sylvestis**, *Ruellia strepens*#, (*Saururus cernuus** downstream), *Silphium perfoliatum*#, *Solidago gigantea*# (common), *S. rupestris* (rare), (*Teucrium canadense*# upstream), (*Xanthium canadense** upstream), etc. The woods in or adjacent to these zones are open, usually with scattered *Platanus* (especially), *Acer* spp., *Fraxinus pensylvanica*, etc. An uncommon shrub on open rocky shores is *Amorpha fruticosa*.

Kinney & Durham Knob Tracts. There are some extensive gravel bars with fresh deposits, but more stable upper rocky zones (e..g. with big bluestem) are not well developed. At the southeast end of the tract, there are relatively narrow rocky transitions from slope forest to riparian zones, with poison ivy (*Toxicodendron radicans*), wild oats (*Chasmanthium latifiolium*) and water-willow (*Justicia americana*). Other scattered species of interest in adjacent thin woods include *Ranunculus caricetorum*.

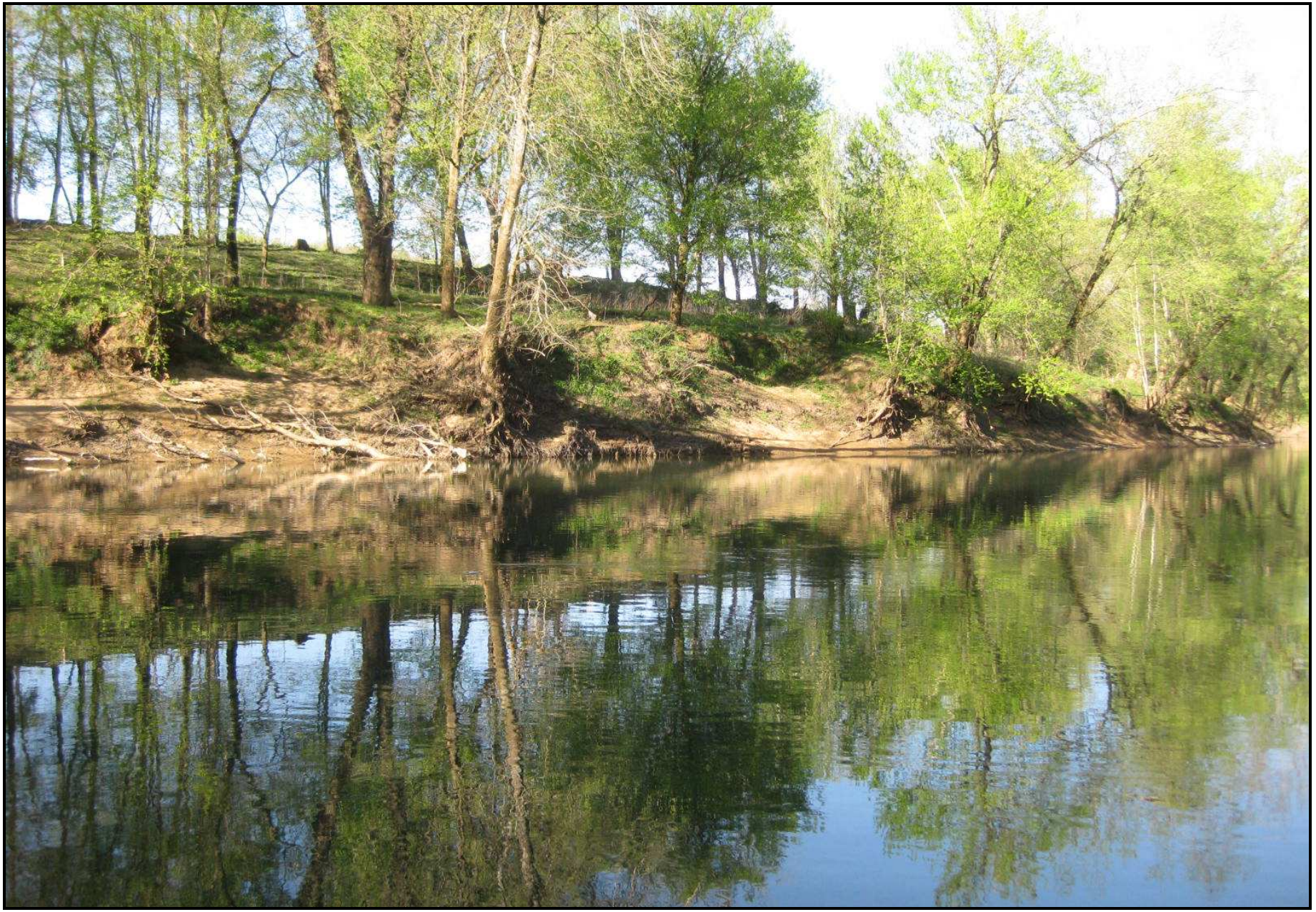
Miller & Byler Tracts (Lawler Bend). There are several open gravel bars or similar scoured sections alonmg the river. Shorelines at these sites mostly have ephemeral vegetation that is usually dominated by annuals (such as *Persicaria* spp.). More stable sites with exposed bedrock occur at the base of steeper slopes, with distinctive species such as *Andropogon gerardii* and *Solidago rupestris*. Narrower strips of this vegetation are included with general riparian woods in the vegetation map.

Lawler Bend: much river frontage has been highly disturbed by cattle during past decades.

More open gravel bars along Green River have several zones. Right: fresh deposits where annual plants often grow in summer. Left: back with ponded areas and more shrubby growth.

Banks of Green River in April at boundary of Kinney and Durham Knob Tracts. The scoured zone with rock exposed at left is dominated locally by poison ivy; water-willow is lower.

Close-up of rocky banks with poison-ivy. General high-water mark is at edge of woods, where there is a fringe of sycamore, boxelder, white elm and hornbeam.



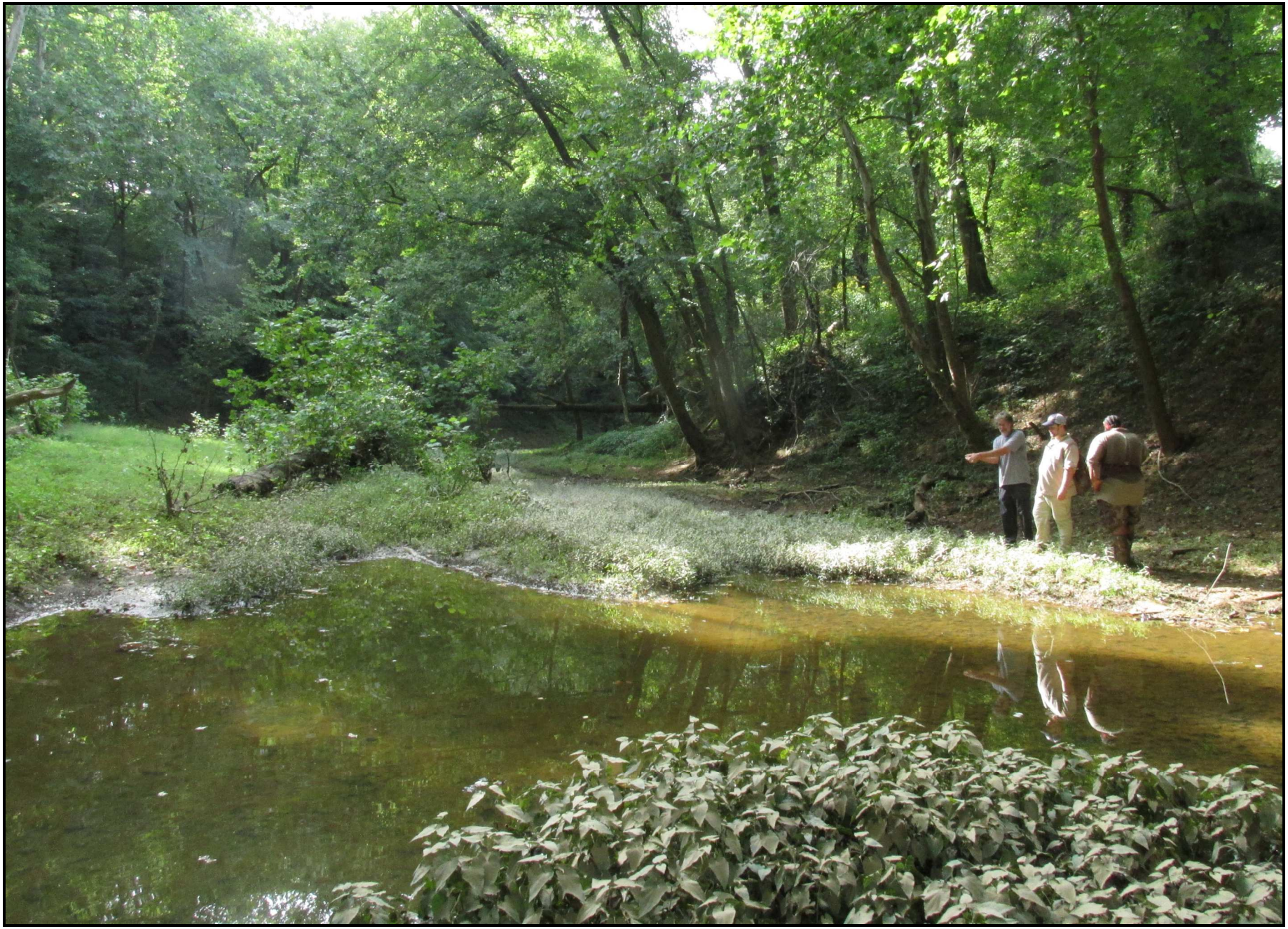
Opposite banks (compared to previous view), with gentle slopes where cattle have easy access to the water and much slumping occurs. Silver maple is locally abundant on deep muddy soil.

Lawler Bend: *Persicaria* spp. are abundant annuals along shores: above, *P. lapathifolia*.

Lawler Bend: with dodder (*Cuscuta* cf. *campestris*) an abundant parasite on herbaceous plants

Lawler Bend: back channel with beds of water willow (*Justicia*) and riparian graminoids.

Lawler Bend: riparian grasses at two ecological extremes within 10 m of each other: left, *Pasplaum repens* along back channel; right, *Chasmanthium latifolium* on well-drained bank



Lawler Bend: more stagnant section of back channel; patches of lizard-tail (*Saururus*) in front.

B. Riparian Woods: mapped as code 04 [JC Class 04; KHP "riparian forest" in part; NVC 2586, 5033, 7184, 7334]. This often grades into submesic or mesic forest on the well drained levee crests or on higher terraces [JC 06/05]. Most canopy trees are ca. 3-4 dm dbh, but a few are up to 6-7 dm. It is generally difficult to make a clean separation in mapping the strict "front" zone, with some scouring, versus more mesic terraces, without regular scouring. In addition to field notes, elevation could be used to guide further refinement of the map.

Core WKU Tracts [2008 plan].
"2b. Bottomland hardwood forest—riverfront" (dominated by silver maple and sycamore)
"2a. Bottomland hardwood forest" (more variable mix on terraces): similar to Bush/Goebel; *Phacelia purshii* is locally abundant, especially on south side of river just upstream from Goebel (also small patches in submesic lower slopes).

Bush/Goebel. *Platanus occidentalis* (generally common), *Acer negundo* (especially on terraces), *Acer saccharinum* (especially on broader bottoms), *Fraxinus pensylvanica, Ulmus americana, Carpinus caroliniana*, etc. Mesic transitions include *Aesculus flava* (up to 8 dm dbh), *Carya cordiformis* (locally frequent), *Celtis occidentalis, Gleditsia triacanthos, Juglans nigra, Liriodendron tulipifera* (locally frequent), etc. Locally common in the shrub layer are *Arundinaria gigantea* (transitions to mesic forest), *Lindera benzoin* (increasing up slopes into mesic forest) and *Sambucus canadensis* (disturbed open areas). Vines are frequent, including *Campsis radicans, Rhus radicans, Smilax hispida, Vitis* spp. (?*riparia* & *vulpina*). Common in the dense ground vegetation are *Amphicarpaea bracteata*, *Aster* spp. (*lanceolatus, ontarionis*), *Carex* spp. (*blanda, grayi, grisea*, etc.), ?*Cinna arundinacea* (locally), *Cryptotaenia canadensis*, *Elymus* spp. (esp. *macgregorii, virginicus*), *Festuca subverticillata,*

Laportea canadensis, ?*Microstegium vimineum* (locally), *Leersia virginica, Pilea pumila, Poa sylvestris, Polygonum* spp. (*virginianum*, others), ?*Rudbeckia laciniata* (locally), *Ruellia strepens*, *Silphium perfoliatum, Solidago gigantea, Verbesina alternifolia*. A remarkable addition in 2010 (AM) was *Collinsia verna*, dense within a 2-3 m^2 patch on the levee front.

Kinney & Durham Knob Tracts. Box elder (*Acer negundo*) is locally dominant; other typical trees include silver maple (directly on riverbanks), sycamore, white elm, green ash and(locally on washed-over gravelly or sandy alluvium) river birch. Higher terraces and transitions to toe slopes have locally common black maple, with scattered stinking buckeye, tulip tree, hackberry and chinquapin oak. Lower woody strata are thin except at higher levels, with locally abundant *Arundinaria*; other species include *Carpinus* and *Lindera*. The ground is dense, much being dominated by *Laportea*; other frequent herbs include *Cardamine bulbosa, Corydalis, Phlox paniculata, Solidago flexicaulis, Stellaria media, Thasphium trifoliatum* and *Viola papilionacea*. Graminoids include locally common *Elymus macgregorii*.

Miller & Byler Tracts (Lawler Bend). Box elder and silver maple (on deeper muddy banks) are abundant; other trees are sycamore, white elm, tulip poplar plus species of mesic woods in transitions on toe-slopes. Shrub layers include locally common *Arundinaria* (esp. toe-slopes); vines include *Toxidodendron radicans* (with unusually large leaves) and locally *Isotrema tomentosa*. Ground vegetation includes abundant *Laportea*; other species are *Hydrophyllum appendiculatum* (toeslopes, some browsed), *Leersia virginica, Pilea* (upper), *Poa sylvestris, Rudbeckia laciniata, Solidago gigantea, Verbesina alternifolia, Viola papilionacea*.

Edge of riparian woods on island in Green River: pile-ups of drift-wood create varied micro-habitats; the smooth running white aster (*Symphyrotrichum lanceolatum*) is dominant in front.

Riparian woods with sycamore and boexlder, interrupted by back-channel of river around island: *Viola papilionacea* is typical of upper levels (distinct from *V. sororia* of drier woods).

Riparian woods, upper level: *Viola papilionacea* with shoots of *Symphyotrichum lanceolatum*.

Riparian woods with much fresh sandy alluvium at the base of steep slopes. Boxelder is largely restricted to regularly flooded banks (right). Cane is concentrated on toeslopes (left).

Lawler Bend: stoloniferous *Ranunculus caricetorum*, at upper riparian zone in partial shade.


Left: upper riparian woods: *Viola papilionacea*, *Monarda* sp. nov., *Elymus macregorii*.
Right: toe-slope (100 ft from left): *Hydrophyllum canadense*, *Enemion biternatum* [type 05a].

Lawler Bend: intense browsing by deer on box-elder in the large bottomland field at east side.

Lawler Bend: *Silphium perfoliatum* much browsed by deer, as is *Helianthus tuberosus* in sun.

Lawler Bend: disturbed bank with *Helianthus tuberosus*; red cedar in dry old field above.

Lawler Bend: vines often cover upper edges of riparian woods; here much *Fallopia scandens*.

C. Mesic Woods: mapped as codes 05a/b/c [JC Class 05 (see segregates below); KHP "calcareous" and "acidic mesophytic forest", with narrow inclusion of "mesic/wet limestone cliff/outcrop" and some local "bottomland ridge/terrace forest"; NVC, varied potential matches as noted below]. Mostly on N/NE-facing slopes, and grading into subxeric slopes on other kinds of site. It also grades into riparian forest on toe-slopes and high terraces. The canopy is usually dominated by sugar maples but with several other characteristic species locally abundant: beech, tulip, buckeyes and basswood. The forest is generally mature, with canopy trees mostly ca. 3-4 (5) dm dbh plus a few up to 7-8 dm.

Core WKU Tracts (2008 Plan)
"3a. Mesic forest" [~05a of JC]
"3a. Mesic forest" (and part of "Mixed Hardwood forest"?) [~05b of JC]
"3a. Mesic forest" (and part of :Mixed Hardwood forest"?) [~05c of JC]; this shifts locally into "3a1. Early seral mesic forest" with more *Liriodendron* (see 05c of JC on Kinney Tract).

Bush/Goebel Tract [mostly JC 05b].
The long NE-facing bluff has relatively well developed forest of this type, with canopy trees mostly ca. 2-5 dm dbh, with several up to 7 dm. Abundant *Acer saccharum* (plus occasional *A. nigrum*); also frequent are *Aesculus flava, Fagus grandifolia, Fraxinus americana, F. quadrangulata, Liriodendron tulipifera, Q. rubra, Q. muhlenbergii, Tilia americana*. This mesic type grades locally into *Quercus* spp. (especially *alba*), *Carya* spp. (especially *ovata*), *Juniperus virginiana*, etc., in various disturbed phases or drier sites (see notes on subxeric woods under E below). At mid-slope below cliffs, the most extreme mesic type may be

recognized, with *Acer, Aesculus, Fagus* and *Tilia*. On benches below this, probably with more acid/leached soil development [~JC 05c], there are concentrations of *Fagus* and *Liriodendron*.

Common in the shrub layer are *Asimina triloba* (especially lower), *Hydrangea arborescens* (especially steep gullies), *Lindera benzoin* (especially lower), *Ostrya virginiana* (upper/drier areas) and *Staphylea trifoliata* (steep talus). Vines include frequent *Aristolochia tomentosa*. Common species on the ground (at least locally) include *Asarum canadense* (abundant), *Carex* spp. (*albursina, cumberlandensis, laxiflora, jamesii, oligocarpa, rosea*, etc.), *Mitella diphylla, Monarda clinopodia, Polymnia canadensis* (abundant on loose talus), *Solidago flexicaulis*. Cliffs have distinctive *Asplenium rhizophyllum, Cystopteris bulbifera, Heuchera macrorhiza*, ?*Woodsia obtusa* (locally), etc. Better developed toe slopes grading into riparian forest [JC 05a; see also Class 04], with deeper/damper soil, have distinctive *Amphicarpa bracteata, Eupatorium rugosum* (also in submesic transitions on uplands), *Festuca subverticillata, Hydrophyllum canadense* (locally abundant), *Impatiens pallida, Laportea canadensis* (locally abundant but much browsed), *Pilea pumila, Stylophorum diphyllum*, etc.

Kinney & Durham Knob Tracts.
This type is largely restricted to lower slopes and gullies on the N/NE-facing side of the land, plus a few local extensions or disjunctions up gullies and around springs and seeps at higher elevation. Three variants are outlined here.

Variant 1 [JC 05a; NVC aff. 4411-5035, 8412]. Toe-slopes below the limestone cliffline and associated talus; this is best exemplified on the Kinney tracts by a few acres at the NW end of the cliffline. In addition to abundant sugar maple, black maple is also frequent. Other

trees include sweet buckeye, hickories (bitternut hickory and shagbark), hackberry, red elm, white ash and oaks (chinquapin, northern red and shumard). In lower woody strata, *Asimina* is common; other species include *Hydrangea, Lindera* and, locally, the alien *Rosa multiflora*. The ground layer is relatively dense and varied, with locally common *Carex* spp. (*careyana, kraliana*, etc.), *Chaerophyllum procumbens, Dicentra* spp. (especially *canadensis*), *Enemion, Erigenia, Glechoma* (alien), *Hydrophyllum canadense* (lower areas), *Phacelia bipinnatifida* (talus slopes), *Stellaria* spp. (*corei* and the alien *media*), and *Stylophorum*.

Variant 2 [JC 05b; NVC aff. 6201, 7698]. Well-developed gullies that interrupt the limestone cliffs, and some slopes directly below the regular cliffline. In addition to abundant sugar maple, other characteristic trees are sweet buckeye and basswood. Other trees include beech, red elm, hickories (bitternut and shagbark) and oaks (chinquapin, northern red, white and chestnut). Lower woody strata are varied, with typical species including *Asimina*, *Hamamelis, Hydrangea* (on lower banks), *Lindera, Ostrya* and *Staphylea*. Ground vegetation is highly varied, with frequent to (*) locally abundant *Adiantum, Asarum, Chaerophyllum procumbens, Claytonia virginiana, *Dentaria* spp. (*laciniata, multifida*), **Erythronium americanum*, **Polymnia canadensis*, *Sanguinaria*, **Solidago flexicaulis* and *Stylophorum*. The only frequent graminoids noted are *Carex* spp. (especially *laxiflora*) and *Diarrhena*. A. Hulsey and A. Meier have recently discovered the alien fern, *Cyrtomium fortunei*, in this habitat (see Alien Species).

Variant 3 [JC 05c; NVC aff. 5222, 2411]. Sinkhole-depression below sandstone cliff. An unusual site occurs on the south side of the main ridge, covering up to 1-2 acres around a slight depression that must overly an incipient sinkhole. Tulip tree is locally dominant,

together with frequent sugar maple (especially along the gully downstream), scattered white ash and white elm. There are few shrubs, but *Corylus* is locally frequent at edges, suggesting past exposure to disturbance. Frequent herbs—and fern—include *Dentaria laciniata*, *Oxalis violacea*, *Podophyllum* and *Polystichum*; also, a large patch of *Hydrastis* was noted. Graminoids include *Carex* spp. (*blanda, kraliana*, etc.) and *Diarrhena.*

Miller & Byler Tracts (Lawler Bend): note absence of sweet buckeye (*Aesculus flava*).

Variant 1 [JC05a; NVC aff. 6201, 7695, 8412]. This is restricted to exceptionally fertile sites on lower E-facing slopes just south of the cliffs at the narrowest section of Lawler Bend, probably more disturbed than Variant 2. It grades into submesic woods on gentler slope to the south. Sugar maple is strongly dominant (with some black maple also present); other trees include hackberry, black walnut, northern red oak, shumard oak and chinquapin oak (drier). Beech and tulip poplar are infrequent to absent. *Asimina* and *Lindera* are most common in the shrub layers; also frequent are *Carpinus* (lower), *Hydrangea* (steeper talus) and *Staphylea* (upper). Ground vegetation includes locally abundant *Laportea, Hydrophyllum canadense* and *Stellaria corei*; also frequent are *Asarum, Cystopteris protrusa, Enemion* and *Trillium flexipes* (100s of plants). Other species include *Adiantum, Carex* spp. (*albursina, kraliana*), *Dentaria laciniata, Dicentra cucullaria, Diplazium, Impatiens pallida, Poa sylvestris, Solidago flexicaulis, Stylophorum, Uvularia grandiflora, Viola papilionacea*, etc.

Variant 2 [JC05b; NVC aff. 7698, 2411]. This is best developed on N- or E-facing slopes close to the river. Most canopy trees are only (1)2-5(6-8) dm dbh (beech generally the largest), reflecting relatively frequent tree-falls on steeper slopes plus local logging. Common species include sugar maple (gen. dominant), black maple (loc. frequent), tulip poplar (esp. toe slopes and low terraces), beech (local), Ohio buckeye and basswood (both infreq.), oaks (esp. northern red and chinquapin), hickories (shagbark and shellbark) and white ashes (often common as seedlings in addition to scattered trees). Other species are typical of transitions to drier or more disturbed areas: hackberry, black walnut, bitternut hickory, pignut hickory (*glabra* & *ovalis*), black oak, white oak, cherry, sassafras, mulberry (including thin woods along cliffs), elms, box elder, etc.

The shrub layer has generally abundant *Lindera*, with more local *Carpinus* (esp. lower edges), *Hydrangea* (steeper rocky slopes) and *Symphoricarpus* (esp. disturbed transitions). Ground vegetation includes locally common *Asarum, Cystopteris protrusa, Erythronium americanum, Parthenocissus, Podophyllum* and *Polystichum*; *Adiantum pedatum* and *Smilacina* are locally common on lower talus; *Cystopteris bulbifera, Heuchera macrorhiza* and *Sedum ternatum* are common along cliffs. Other typical species are *Actaea pachypoda, Ageratina altissima, Caulophyllum, Dentaria laciniata, Diplazium* (close to *Caulophyllum*), *Enemion, Impatiens pallida* (from cliffs to toeslope), *Lonicera japonica, Phlox divaricata, Sanicula canadensis, Smilax hispida, Solidago flexicaulis, Stellaria corei, Symphyotrichum cordifoluim, Viola sororia*, etc. Species typical of drier transitions include *Galium circaezans, Nabalus altissimus, Oxalis violacea* and rare *Panax quinquefolius*.

Variant 3 [JC 05c; NVC aff. 2411, 8429, 7200]. This is mostly on gentle lower slopes with less calcareous soils, especially benches and terraces where old alluvium covers the limestone. Composition is generally similar to Variant 1 but with beech or tulip locally dominant. Terraces with dominant tulip poplar (5-7 dm dbh) are well developed in a few places, somewhat transitional to submesic woods especially where adjacent to cleared areas; associated trees (* indicates understory-concentrated) include sugar maple*, beech*, white ash*, blackgum (25 cm dbh), sassafras (15 cm), black walnut, Ohio buckeye, shumard oak, northern red oak (drier sites), shellbark hickory, bitternut (locally frequent). *Lindera* is abundant in the shrub layer in these woods; other common species include *Arundinaria, Asimina* and *Carpinus*. Ground vegetation on less disturbed terraces include abundant *Hydrophyllum canadense*, also frequent are *Allium canadense, Carex* spp. (esp. *jamesii*), *Laportea* and *Viola affinis / papilionacea*. Other species include *Ageratina altissima*, *Collinsonia, Galium aparine, Leersia virginica, Microstegium, Packera aurea, Poa sylvestris, Viola pennsylvanica*, etc.

Mesic woods on toe-slope of Kinney Tract [type 05a], with diverse native flora on deep rich soils: yellow poppy (*Stylophorum*), rue-anemone (*Enemion*), chickweed (*Stellaria corei*).

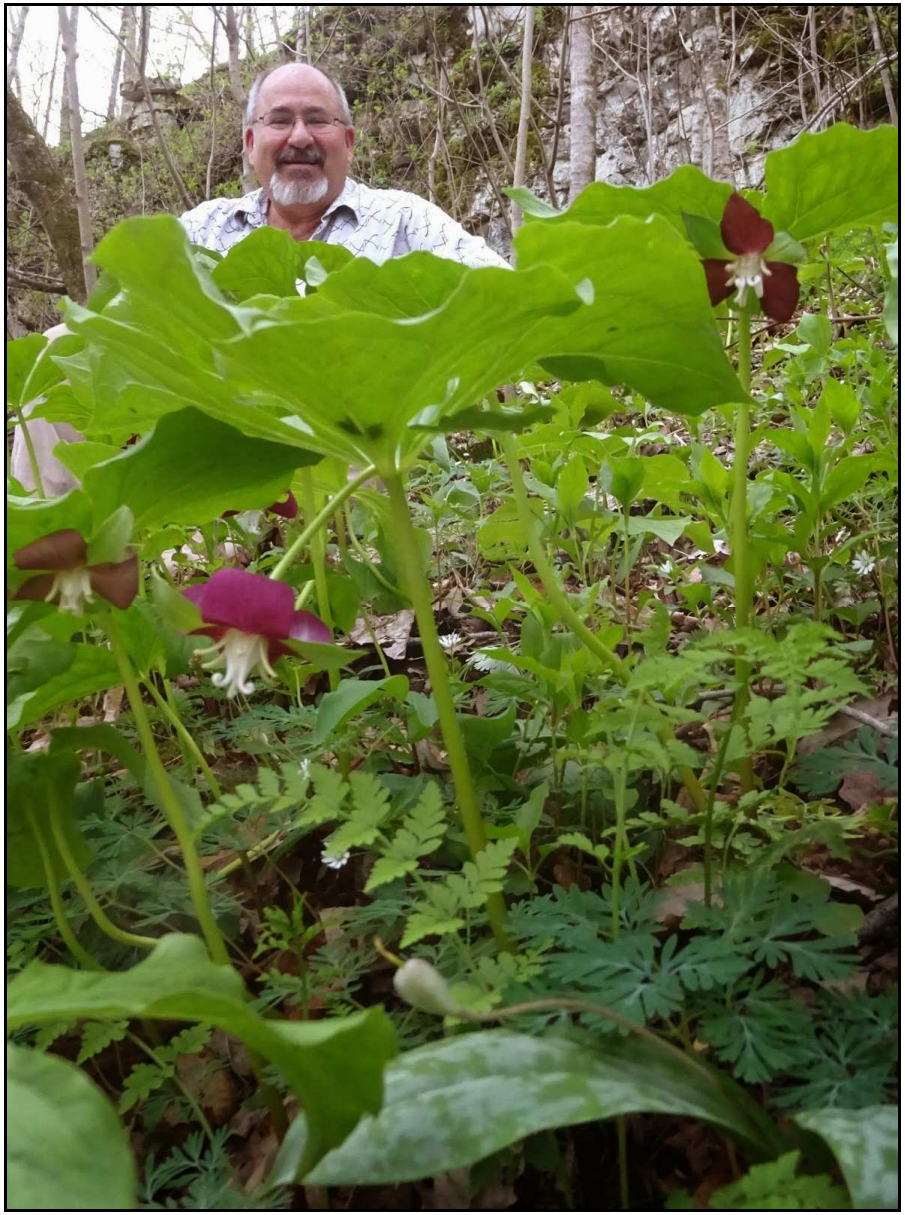
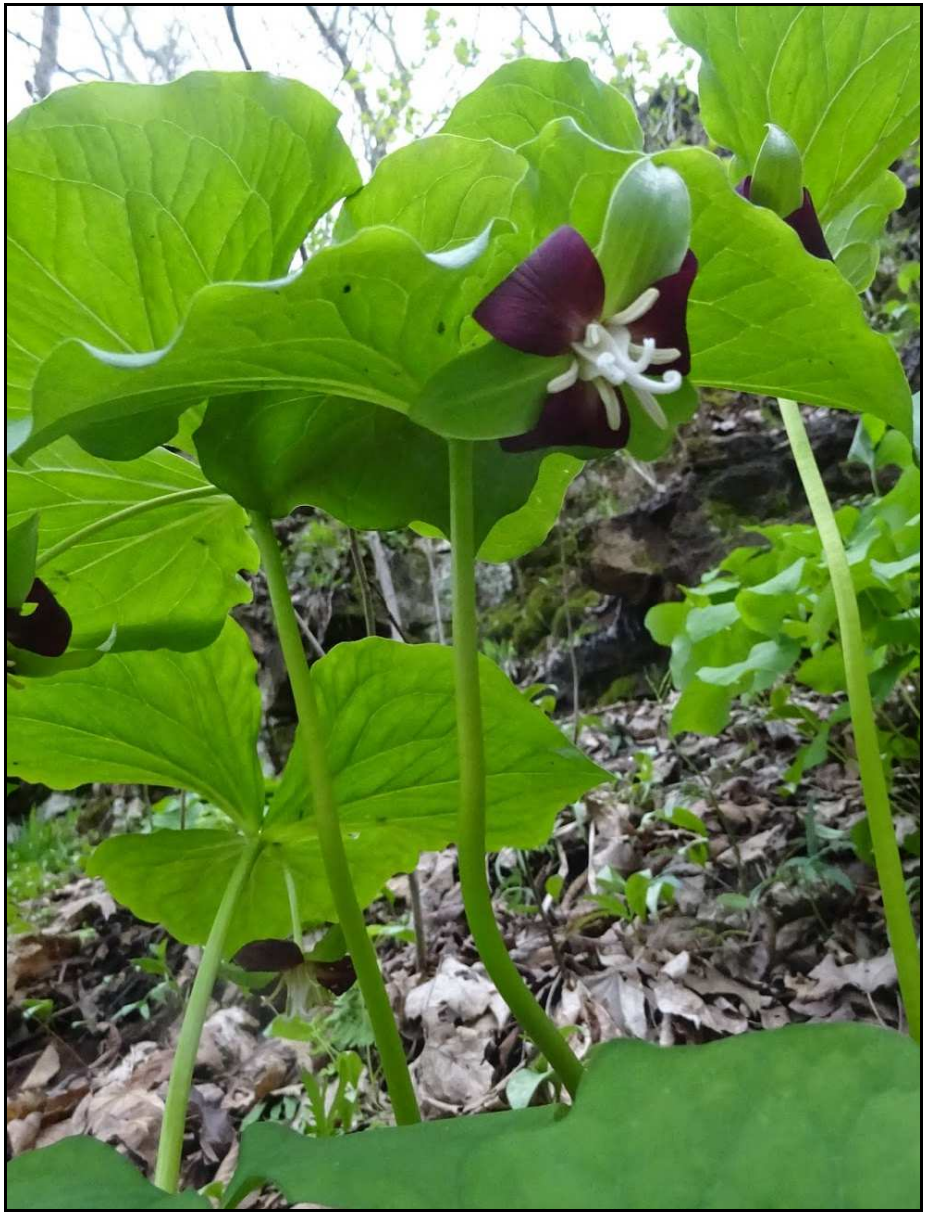
Close-up on toe-slopes (same area as previous page).

Mesic woods (type 05b) on gentle mid-slope gully between cliffs; soil may be slightly acid. Common vernal wildflowers include *Dentaria multifida* and *Phlox divaricata*.

Additional views (same area as previous page).

Limestone cliffs on north-facing slope of Kinney Tract near Green River. Alum-root (*Heuchera macrorhiza*) is common in crevices. Mesic woods below; subxeric above.

Students about to conduct a burning experiment in mesic woods on the toe-slope of the Kinney Tract. Research of AM has shown that several typical plants are sensitive to fire.

Lawler Bend: a large population of bent trillium (*T. flexipes*) occurs on mesic toe-slopes. For more photos from Panayoti Kelaides (left) see his blog posted at following site: http://prairiebreak.blogspot.com/2015/04/revisiting-kentucky-3-years-later-in.html

Lawler Bend: mesic woods on low bench with beech, pawpaw and yellow jewelwood.

Lawler Bend: deer-browsed wood-nettle (*Laportea*) in thin mesic woods on toe slopes.

Lawler Bend: mesic woods; yellow jewelweed (*Impatiens pallida*) much browsed by deer.

Lawler Bend: running “fragile” fern (*Cystopteris protrusa*), common in mesic-submesic woods; this unusual fern may be avoided by deer; its rhizomes enable it to resist disturbance.

Lawler Bend: mesic woods on drier calcareous slope; frequent ash and oak; *Dirca palustris*.

D. Mesic-subxeric Woods Transitions: mapped as code 05x or 05-11 [JC Classes 05-11, varied transitions; KHP see notes for mesic and subxeric types; NVC, varied potential matches as noted below]

This is relatively mature forest that is transitional from mesic to subxeric conditions. Canopy trees mostly have dbh ca. 2-4 dm, with scattered older relics up to 7-8 dm. Some areas have grown up from old fields, and there has been some local logging ca. 10-20 years ago. The following types have not yet been distinguished clearly on the Core WKU tracts and the Bush/Goebel tracts, but do appear reasonable on the Kinney & Dorozniak tracts.

Kinney & Durham Knob Tracts.

This forest is most extensively developed on upper N/NE-facing slopes, often with sandy parent material slumped onto calcareous. Sugar maple is generally the most common tree, at least in lower strata. Oaks are also common, especially white and northern red; others include post, southern red and chinquapin. Hickories (especially pignut and shagbark) and white ash are also frequent and, in some cases, locally dominant. Four variants are outlined here.

Variant 1 [JC 05d; NVC aff. 6017, 7268, 7881]. Slopes along the upper side of limestone cliffs, from high bluffs to slopes above low gullies. Sugar maples are relatively well-developed, with canopy trees often up to 3-5 dm, and black maple present as well as typical sugar. Oaks are mostly northern red, plus some chinquapin and local chestnut on ledges. Other trees include the hickories, ashes (blue and white), red elm, buckeyes (both species) and beech. In lower woody strata, *Staphylea* is locally common; other frequent species include *Carpinus*, *Cornus florida*, *Dirca* (especially grading into gullies near the Kinney-Dorociak boundary), *Euonymus* spp. (especially *americanus*), *Lindera* and *Ostrya*. Frequent herbs

include *Dasystoma*, *Heuchera* spp. (*hirsuticaulis, macrorhiza*), *Monarda clinopodia, Prenanthes altissima* and *Solidago* spp. (*caesia, flexicaulis, sphacelata, ulmifolia*). Ferns include *Asplenium* spp. (*platyneuron, resiliens, rhizophyllum*) and *Cystopteris bulbifera*. Frequent graminoids include *Elymus hystrix* and *Muhlenbergia sobolifera*.

Variant 2 [JC 05e; NVC aff. 7233]. More or less convex mid-upper slopes with more exposure to effects of droughts and disturbances. In addition to frequent sugar maple, other common trees include oaks, hickories, white ash and tulip tree, plus scattered cedar or pine in more open or disturbed areas. In lower woody strata, typical species include *Asimina* (locally frequent), *Cornus florida, Euonymus americana, Ostrya* and, vining on the ground, *Lonicera japonica*. Frequent herbs include *Agrimonia pubescens, Circaea canadensis, Eupatorium rugosum* (lower areas) and *Viola sororia*. Frequent graminoids include *Carex* spp. (*albicans, cumberlandensis, digitalis,* etc.), *Diarrhena* (lower areas), *Dichanthelium boscii*.

Variant 3 [JC 05f; NVC aff. 5173, 7881]. Mostly on more or less concave slopes, especially along gullies with deeper soils. Trees are generally similar to the preceding type but additional trees, locally, include red maple and beech. In lower woody strata, locally frequent species are *Asimina, Staphylea, Ostrya* and *Toxicodendron radicans*; others include *Cercis, Symphoricarpos* and *Viburnum rufidulum*. Frequent herbs—and fern—include *Circaea canadensis, Dentaria laciniata, Podophyllum*, (*Polymnia canadensis* at edges of its populations,) *Symphyotrichum shortii* and *Polystichum*. Graminoids are not abundant; no species are notably frequent.

Variant 4 [JC 05g; NVC aff. 4741]. Relatively thin woods, probably with more history of disturbance, especially on more gentle slopes and leads between gullies, where paths have often lead from uplands to lowlands. In addition to abundant sugar maple, hickories are locally common (especially *glabra* and locally *ovata*). Other trees include white oak, white ash and winged elm. In lower woody strata, *Ostrya* is the most frequent species. Herbs include *Prenanthes altissima, Polymnia canadensis* and *Viola sororia*, but the most common species in ground vegetation are sedges, especially *Carex* cf. *pennsylvanica*.

Miller & Byler Tracts (Lawler Bend)*.
This is mapped as a distinct unit in some sections, but it needs further description. Much of the woodland along the road into the southern part of the Byler Tract may be classified here, but less disturbed below the road and more disturbed above. Sugar maple is generally dominant (mostly 3-6 dm but up to 9 dm) in less disturbed sections (along Byler), together with frequent northern red oak (to 7 dm), white oak (to 6 dm) and chestnut oak (to 7 dm); other trees include white ash, red elm, hickories (shagbark, pignut, bitternut), black walnut, beech. Cutover sections above the road have more tulip tree and sassafras; *Ailanthus altissima* is also present. On the ground, several species (on Miler) appear to be strongly concentrated in this transition: including *Dirca palustris* (especially W-facing slope near narrows in bend). Others are *Brachyelytrum erectum, Carex communis, C. kraliana, Dentaria laciniata*, *Elymus hystrix, Endodeca serpentaria*, *Geum virginianum*, *Hybanthus concolor*, *Oxalis violacea*, *Polymnia canadensis*, *Silene virginica*, *Solidago caesia*, etc.

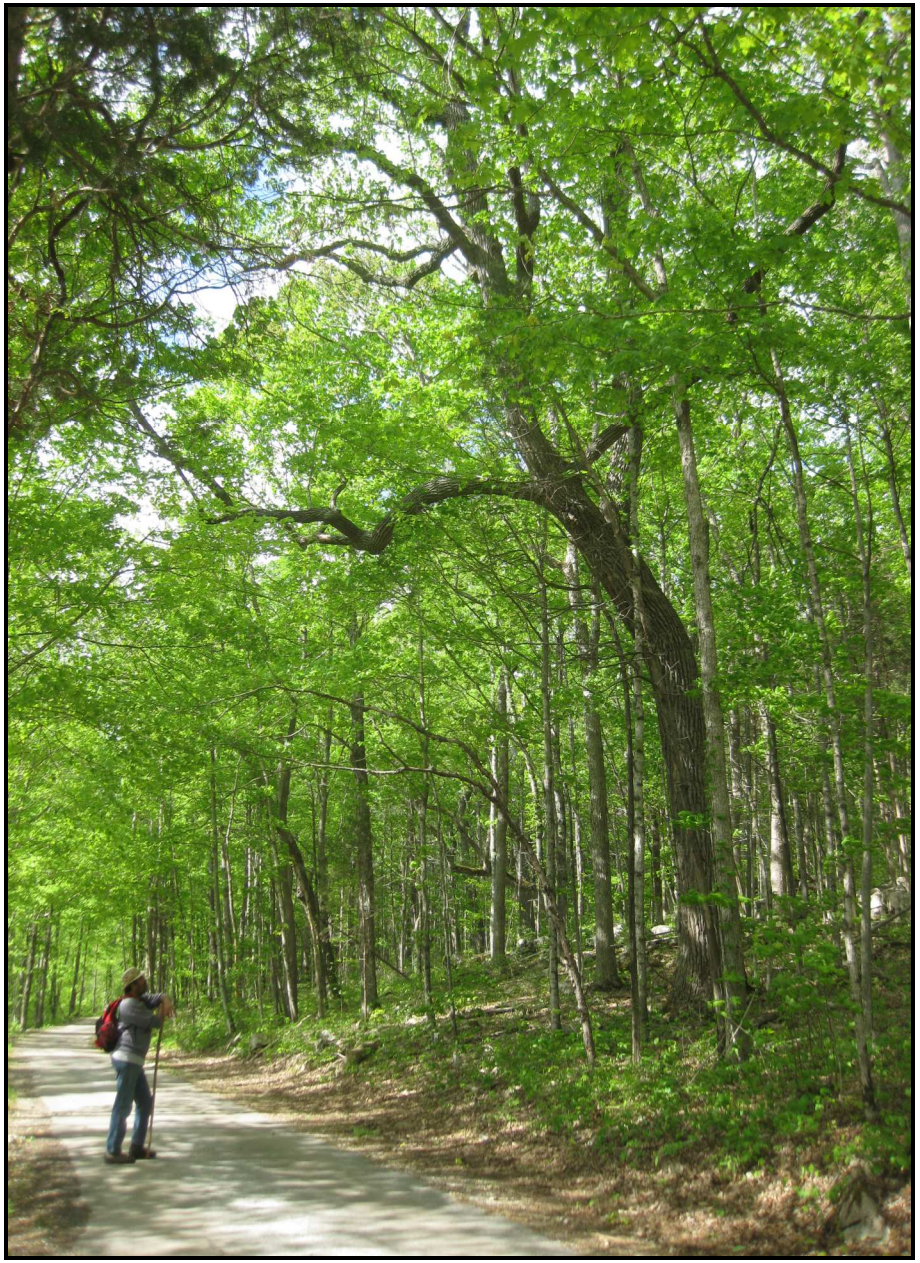
HL and AM in mesic-subxeric transition on north-facing slope at east side of Kinney Tract. The understory has much sassafras, ash and sugar maple. The discussion is philosophical.

Typical scenes in broad mesic-subxeric transition on N-face of Kinney Tract. Left: looking up into more oaks and hickories. Right: looking down into more beech and sugar maple.

Species typical of mesic-subxeric transition on slightly acid soil: mayapple & woodland phlox.

Lawler Bend: extensive patch of mayapple (*Podophyllum*) in mesic-subxeric transition.

Lawler Bend: drier mesic-subxeric transition on limestone, with shooting-star (*Dodecatheon*).



Lawler Bend. Left: pondering a large tulip tree, remnant from old mesic-subxeric woods. Right: typical herbs, *Silene virginica* (fire-pink), *Viola sororia* (woolly blue violet).

E. Subxeric Woods: mapped as codes 11a/b/c [JC Class 11, locally grading into Class 10; KHP "acidic" and "calcareous subxeric forest" with some local inclusion of cliffs/outcrops; NVC, varied potential matches as noted below]

Mostly on drier ridges, S/W-facing slopes, and locally clifftops, often grading into mesic forest. Forest is generally mature, with canopy trees mostly 2-4 dm dbh, locally 4-6(7) dm. A few small areas were cleared in the past, e.g. around the small old field on the high knob.

Core WKU Tracts [2008 plan]

"4a. Oak-hickory forest—white oak and hickory" [~ JC 11a]
"4b. Oak-hickory forest—chinquapin oak" [~ JC 11b]
"4c. Oak-hickory forest—chestnut oak" [~ JC 11c]; "dominated by *Quercus montana*, *Q. rubra* and *Q. velutina*... tend to develop on sandstone and *Smilax* is often abundant".

Bush/Goebel Tract [mostly JC 11b]

The more distinctive drier areas have frequent *Quercus* spp. (especially *muhlenbergii*, locally *alba*), *Fraxinus* spp. (much *quadrangulata*, some *americana*), *Carya* spp. (especially *ovata*, locally *carolinae-septentrionalis*), often grading into relatively stable *Juniperus* woods of Class 12 (as opposed to successional submesic cedar woods of Class 07). These areas are most pronounced near outcrops, and are much more extensive on drier slopes nearby along the Green River outside the Goebel Tract. Typical in the shrub layer are *Cercis canadensis* (especially rocky open woods), *Cornus florida* (especially acid soils), *Ostrya virginiana*, etc. Locally common on the ground are *Aster shortii, Elymus hystrix, Hybanthus concolor, Muhlenbergia sobolifera, Polymnia canadensis* (abundant on limestone talus), *Senecio obovatus, Solidago ulmifolia, S. sphacelata, Tradescantia subaspera*.

Kinney & Durham Knob Tracts. Oaks are generally dominant; also frequent are hickories, ashes, red cedar and (esp. on more sandy soils) pine. Two variants are recognizable, as follows.

Variant 1 [JC 11a; NVC aff. 7240, 7795]. Some sites are relatively mesic and less open, especially on concave slopes and gullies with some sandy slumpage. The main oaks are white and black; other scattered oaks are post (especially above), northern red (especially below) and a few chestnut oak (mostly on drier side slopes and blufftops). Other common trees include hickories: *tomentosa, glabra/ovalis* and *ovata*. Sugar maple is locally common in the understory (or perhaps red cedar in more disturbed areas). Distinctive acidophilous trees are also present: sassafras (locally frequent in younger woods), persimmon, blackgum, red maple and sourwood. In lower woody strata, frequent species include *Cercis,Cornus florida* and *Vaccinium* spp. (especially *pallidum*). Frequent herbs include *Agrimonia rostellata*, *Houstonia caerulea* (more open ledges/bare soil), *Circaea canadensis* (damper spots), *Uvularia perfoliata*, *Polygonatum biflorum* and *Viola* spp. (?*affinis, hirsutula, sororia*). Graminoids are locally abundant, including *Carex* spp. (*albicans, digitalis*, ?*pensylvanica*, etc.) and *Danthonia spicata*; locally on damper spots there are patches of *Brachyelytrum* and *Diarrhena*. The alien *Microstegium* is locally frequent, especially along old roadbeds.

Variant 2 [JC 11b; NVC aff. 5018, 2076]. Other sites are generally drier, more disturbed and locally more open, especially on rocky limestone slopes and ridges. Oaks are white oak and post oak, mostly, plus a local scattering of blackjack, chinquapin, etc. Red cedar is locally frequent, especially along clifftops, potentially separated as narrow enclaves of Class 12 (see G below). Other common trees include white ash and hickories: *glabra*, *ovata* and locally (among outcrops) *carolinae-septentrionalis*. In lower woody strata, frequent species include

Cercis, Ostrya, Symphoricapos and *Toxicodendron radicans*. Frequent herbs include *Polygonatum biflorum* and *Viola* spp. (*sororia* and *triloba*, sensu stricto). Graminoids are locally abundant, including Carex spp. (*albicans, digitalis*, etc.), *Danthonia spicata* and *Muhlenbergia sobolifera*. Additional species occur in more open woods and adjacent roadsides (see Class 12 below).

Variant 3 [JC 11c; NVC aff. 8521/4987]. There are small groups of chestnut oaks, perhaps forming a local basis for recognizing an additional variant of subxeric forest on slumped sandy material above limestone. *Vaccinium arboreum* might also be characteristic. However, no patches of these species were observed covering more than 0.1 ha.

Miller & Byler Tracts (Lawler Bend).

Variant 1 [JC 11a; NVC ~ 2076, 2070]. This occurs on gentler upper slopes with less calcareous soils, especially sites with S or W-facing aspect. The best example appears to occur on the ancient high terrace of Green River towards the south end of Lawler Bend, which has probably been much influenced by livestock and deer. Dominant trees include white oak and shagbark hickory (perhaps more in browsing-influenced areas). Other trees include sugar maple, beech (local), tulip poplar, black oak, chinquapin oak, ?post oak (expected), blackjack oak, pignut hickory, mockernut hickory, southern white ash ("*smallii*"), winged elm, red cedar, Virginia pine. The shrub layer is sparse, with scattered *Cornus florida* and locally abundant *Symphoricarpos*. Ground vegetation is locally dominated by sedges (*Carex*), especially *oligocarpa* and *umbellata*; others include *albicans, blanda, digitalis, kraliana, retroflexa*. Other common species include *Dentaria multifida* (abundant), *Galium circaezans* (frequent) and *Cynoglossum virginianum*.

Variant 2 [JC 11b; NVC = 8442]. This is associated with rocky calcareous sites on ridges and S- or W-facing slopes, especially the main "gooseneck" ridge into Lawler Bend with relatively mature woods and canopy trees mostly 3-6 (8) dm dbh and ca. 70 years old (from a cut stump). A narrow strip also occurs along the slight ridge between the road and the river bluff along the northern half of the Byler Tract. These areas are dominated by chinquapin oak (mostly 4-6 dm), southern shagbark (3-5 dm) and red cedar (1-4 dm), with frequent southern white ash (*biltmoreana* / *smallii* 3-5 dm) and blue ash (1-3 dm plus abundant seedlings). Other trees include sugar maple (1-2 dm), shumard oak (scattered large), shingle oak (locally frequent in grassy transitions on Byler), other hickories (especially shagbark, pignut and possible hybrids) and red elm (largely restricted to suckers in the shrub layer). *Cercis* is locally frequent at edges. Ground vegetation has frequent *Parthenocissus*; other typical species include *Asclepias quadrifolia, Carex umbellata, C. oligocarpa, Danthonia spicata, Dodecatheon meadia* (esp. on cliff ledges)*, Lithospermum tuberosum*, *Solidago ulmifolia*, etc.

In several area, these types of woods (variants 1 and 2) intergrade with submesic woods, making separate mapping difficult or impossible. Transitions to submesic woods tend to have more sugar maple (locally abundant up to 3 dm dbh) and white ash (including much *biltmoreana* / *smallii*), with occasional knarly black walnuts.

Lawler Bend: upland edge of subxeric woods; white oak (left), shagbark hickory (right)

Subxeric woods of Kinney and Durham Knob Tracts in April: oaks were dominant before settlement, but logging and livestock may have increased the local proportion of hickories.

Subxeric woods can be invaded by more mesic species unless regular droughts, fires or other disturbances keep them back. Mayapple patches suggest the ‘vanguard’ of such invasion.

Subxeric woods on medium acid soils. Left: shagbark hickory is typical of slightly better soils, especially where browsing or logging has reduced oaks. Right: white oak used to be dominant.

Scenes within subxeric woods. Left: old stump of logged-out oak or perhaps chestnut (which was formerly frequent). Right: poverty-grass, sedges (*Carex* cf. *albicans*) and mayapple.

Sassafras is persistent in the understory of subxeric woods, occasionally forming clonal groups at old edges. Larger stems then often have bizarre cankers caused by *Neonectria* fungus.

Chestnut oaks are locally common in subxeric woods [type 11c] along the crests of limestone cliffs, presumably growing partly on more sandy colluvium washed down from above.

Lawler Bend: calcareous subxeric-xeric woods with oaks, ashes, hickories and red cedar.

Lawler Bend: more mature subxeric woods with oaks, southern shagbark hickory, red cedar.

Lawler Bend: calcareous subxeric woods grading into submesic with sugar maple at back.

Lawler Bend: southern shagbark hickory seedlings are locally numerous, not browsed by deer.