Green River Biological Preserve

Botany of the Miller & Byler Tracts on Lawler Bend

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Botanical Survey of Western Kentucky University tracts in Hart County, with addition of the Miller and Byler Tracts at Lawler Bend*

A contribution for the Resource Management Plan, as required by the Kentucky Heritage Land Conservation Fund; updated and incorporating 'cross-walk' with vegetation notes on other tracts in the preserve

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SUMMARY

This report is based on ca. 30 days of field work between 2007 amd 2014, covering the following tracts acquired by Western Kentucky University at their "Green River Bioreserve": Core Tracts (including Williams); Bush / Goebel Tracts; Kinney Tract and the adjacent Durham Knob Tract (= Dorociak Tract); Miller and Byler Tracts on Lawler Bend. These notes are being moulded into a revised comprehensive report on the vegetation and flora of the whole Green River Bioreserve area. [See associated species lists for plants in Excel spreadsheet. See associated GIS shapefiles and dbf tables for rare species locations (in Arcview); shapefiles are unprojected, in decimal degrees with NAD 1927. In all files select data for field "Quadrangle" = "Mammoth Cave" or "Horse Cave" or "Munfordville".]

Core WKU Tracts (including Williams). See 2008 Plan submitted by WKU to HLCF for complete report on biology and ecology of the initial Bioreserve, which did not include details for the tracts covered below. The vegetation notes in that report are summarized below under subsections titled "Core WKU Tracts" in order to advance general consensus on vegetation types to be mapped across the whole area. That report also focussed on rare species at the site, especially in the aquatic system. The attached species lists include separate lists for the core tracts, Bush/Goebel tract, and Kinney/Durham Knob tracts.

Bush / Goebel Tract. Native vegetation can be generally described in terms of a gradient from riparian forest to mesic forest to submesic forest to more xeric types. Most of the area currently is covered by a complex of submesic types, with various disturbance histories, successional stages and initial compositions. There are virtually no poorly drained areas above the river level, but small areas with seeps, compacted soil in fields and other sites should be

explored further to document any independent variation in mesic versus hydric conditions. The flora is typical for calcareous regions in south-central Kentucky. At higher elevations, there appears to be more influence of sandy soils, with distinct local shifts in the flora and vegetation, but these areas have been heavily logged and largely cleared in the past.

No imperiled species (federal/state endangered or threatened) were discovered, but a few rarely reported species were determined on the Bush/Goebel Tract or nearby. These include *Solidago rupestris* (rocky river banks), *Bromus* cf. *nottowayanus* (in low woods; to be studied further), *Carya carolinae-septentrionalis* (in subxeric woods on N side of river), and *Tragia cordata* (xeric woods and edges). Compared to nearby areas closer to the former "barrens" of the karst plain, there are relatively few conservative species indicative of open, burned or browsed, conditions on the uplands before settlement. Some conservative species are typical of rocky glades (e.g. *Hypericum dolabriforme*, *Penstemon tenuiflorus*), but these may have been restricted to the most xeric woods, or might even have increased along eroded trails and roads after settlement. These floristic data are consistent with a general assessment of the Mammoth Cave area showing that more conservative indicators of presettlement grassland are absent or rare in rugged terrain within a few miles of the river, in contrast to the more gentle uplands closer to the karst plain (see report on fire manangment to NPS).

Kinney & Durham Knob Tracts. Native vegetation can be generally described in terms of a gradient from riparian forest to mesic forest to more xeric types, plus disturbed variants. Much of the area currently is covered by a complex of submesic types, with various disturbance histories, successional stages and initial compositions. There are virtually no poorly drained areas above the river level, but there are a few small areas (<0.1 ha) with seeps on uplands. The flora is typical for calcareous regions in south-central Kentucky. At

higher elevations, there is clearly some influence of sandy soils, with distinct local shifts in the flora and vegetation.

No imperiled species (federal/state endangered or threatened) were discovered, but a few rarely reported species were discovered. These include *Acalypha deamii* (in disturbed mesic woods on toe-slopes), *Carya carolinae-septentrionalis* (in subxeric woods on north side of river), and *Tragia cordata* (xeric woods and edges). Compared to areas closer to the former "barrens" of the karst plain (on the southeast side of the Green River corridor), there are relatively few conservative species indicative of open, burned or browsed, conditions on the uplands before settlement.

The most common invasive aliens in woodlands on the tracts noted above are Japanese honeysuckle (*Lonicera japonica*) and, locally, common chickweed (*Stellaria media*). Status of the Japanese grass, *Microstegium vimineum*, also needs to be monitored carefully, given its local abundance on adjacent land to the west. Unusual aliens that are now rare but might increase include *Celastrus orbiculatus*, *Cyrtomium fortunei* and *Lonicera maackii*.

Miller & Byler Tracts (Lawler Bend). There is major gradient from riparian woods (and riverbanks) to mesic woods to subxeric woods (and limestone cliffs). Also, mesic to subxeric woods on calcareous slopes differ significantly from mesic to subxeric woods on old high terraces with more sand and gravel. Moreover, there is much variation due to disturbance history, with steeper slopes generally exhibiting less sign of recent cutting, grazing or other human influences. There are no poorly drained areas above the river level, except for one shallow slough (with green ash) on the bottomland and two artificial ponds on the high terrace.

No federal/state endangered or threatened species were discovered except for the previously known *Aureolaria patula* and *Phlox bifida* at the northwestern side of Lawler Bend. Relatively rare species ("special concern" or "watch list" in Natural Heritage Program) include *Carya carolinae-septentrionalis* (common in subxeric woods above the cliffs), *Houstonia* cf. *rupestris* (clifftops with *Phlox bifida*), *Nabalus crepidineus* (thin low submesic woods), *Solidago rupestris* (rocky riverbank on NW side) and a few plants of *Panax quinquefolius* (mesic woods on Byler). Mesic woods are well developed in places, including a few locally uncommon species (e.g., *Jeffersonia, Stylophorum, Trillium flexipes*). In contrast to remnants of historic "barrens" on the karst plain (southeast of the Green River), there are few conservative species indicative of formerly burned or browsed conditions on the uplands before settlement. A few weak indicators occur along the clifftops and more rocky roadsides, but these may have been more dependent on xeric conditions more than distured conditions before settlement (e.g., *Houstonia canadensis, Hypericum dolabriforme, Lithospermum canescens, Nothoscordium bivale*).

The most common aliens in woodlands on these tracts are Japanese honeysuckle (*Lonicera japonica*), Japanese stiltgrass (*Microstegium vimineum*) and, locally, common chickweed (*Stellaria media*). In addition, winter-creeper (*Euonymus fortunei*) needs to be monitored and dealt with soon, since a few patches were found in mesic-submesic woods on slopes along the east side of the project area. Old fields have many other aliens, but these species will largely disappear after reforestation.

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Next page: on Lawler Bend in mesic-subxeric transition with rather large remnants of an older forest, beech & sassafras. Companion Robert Stauffer channels John Muir.

INTRODUCTION: Regional Context for Focus on Conserved Area

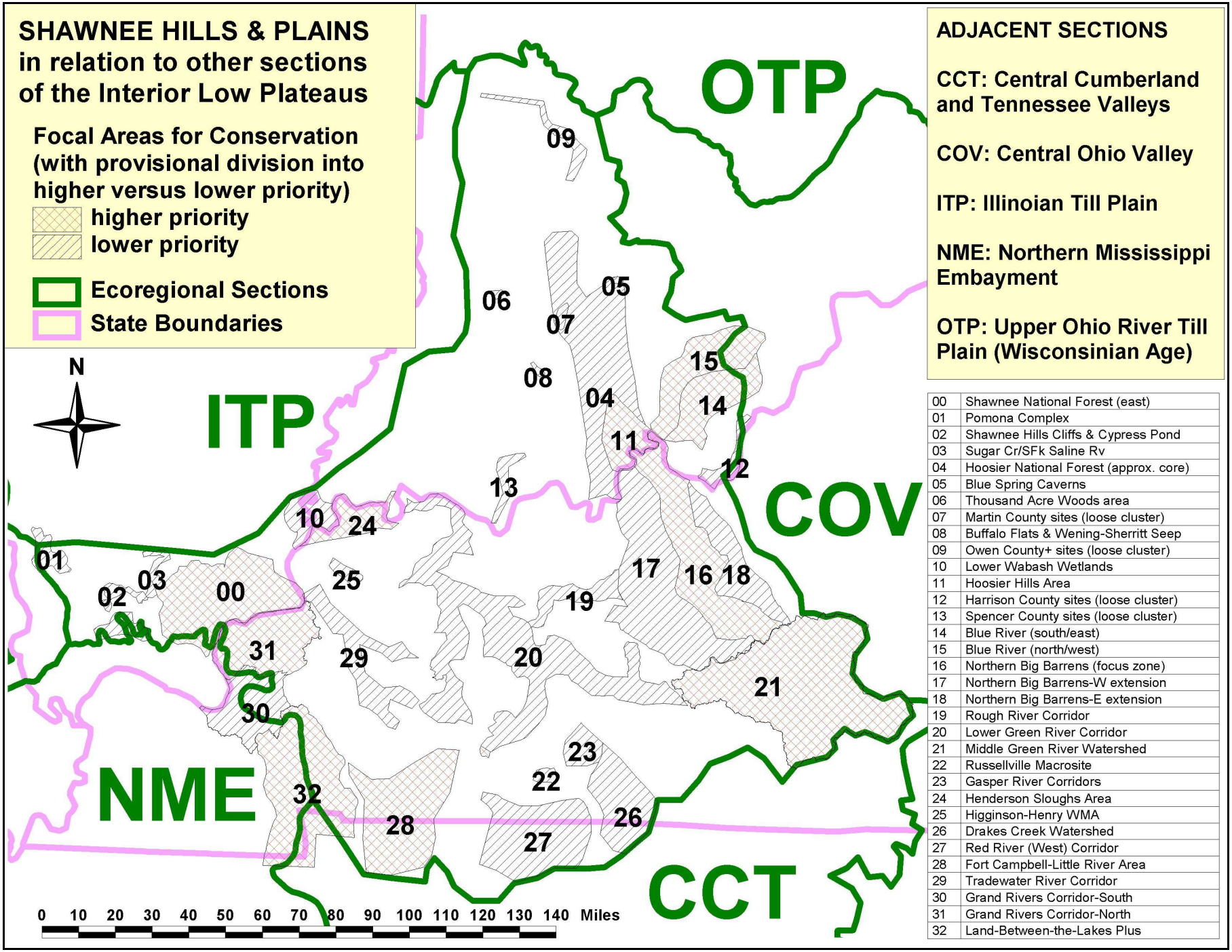
Landscape level: rationale for conservation of this site in the ecoregion

The Middle Green River watershed drains the southeastern borders of the Shawnee Hills (broadly defined) plus the adjacent karst plains and hills of the Mississippian Plateaus (Woods et al. 2002, Campbell & Medley 2012). The climate of nearby Mammoth Cave National Park is humid mid-temperate, with mean annual temperature of 14.9 °C or 58.9 °F and mean annual precipitation of 133 cm or 52.3 inches (US Climate Data 2014).

The 'Shawnee Hills and Plains' is a useful ecoregion for planning, implementing and assessing conservation of biological diversity (see site 21 at lower right of map on next page). Within this region, the Middle Green River watershed is generally considered to be the most important focal area for conservation at a large 'landscape-scale.' Other important large focal areas ('megasites') include the Hoosier National Forest, Wabash River and Blue River (IN); Shawnee National Forest (IL); and the loosely defined Grand Rivers or 'Big Rivers' Corridor (IL and KY).

The Middle Green River watershed contains a highly significant concentration of habitats and species that are globally imperiled. In addition to the watershed itself (with many rare mussls, fishes and other aquatic species), this area includes the Mammoth Cave system (with several endangered or endemic species), large blocks of forest, and many small remnants of the grasslands (or 'barrens') that once covered the karst plain plus adjacent low hills. The watershed does not include extensive wetlands, but there are several ponds and patches of swampy woods that are also priorities for conservation.

The growing ‘Green River Biological Preserve’ of Western Kentucky University covers over a thousand acres upstream of Mammoth Cave National Park. While not as significant as the park itself, the preserve does provide important protection for the river corridor and it will enhance the potential for continuous blocks of habitat in this region. Moreover, most of the land is less wooded, and will allow important research on restoration of both woodland and grassland that can be applied elsewhere in the region. [Below: epiphytic resurrection fern.]



00	Shawnee National Forest (east)
01	Pomona Complex
02	Shawnee Hills Cliffs & Cypress Pond
03	Sugar Cr/SFk Saline Rv
04	Hoosier National Forest (approx. core)
05	Blue Spring Caverns
06	Thousand Acre Woods area
07	Martin County sites (loose cluster)
08	Buffalo Flats & Wening-Sherritt Seep
09	Owen County+ sites (loose cluster)
10	Lower Wabash Wetlands
11	Hoosier Hills Area
12	Harrison County sites (loose cluster)
13	Spencer County sites (loose cluster)
14	Blue River (south/east)
15	Blue River (north/west)
16	Northern Big Barrens (focus zone)
17	Northern Big Barrens-W extension
18	Northern Big Barrens-E extension
19	Rough River Corridor
20	Lower Green River Corridor
21	Middle Green River Watershed
22	Russellville Macrosite
23	Gasper River Corridors
24	Henderson Sloughs Area
25	Higginson-Henry WMA
26	Drakes Creek Watershed
27	Red River (West) Corridor
28	Fort Campbell-Little River Area
29	Tradewater River Corridor
30	Grand Rivers Corridor-South
31	Grand Rivers Corridor-North
32	Land-Between-the-Lakes Plus

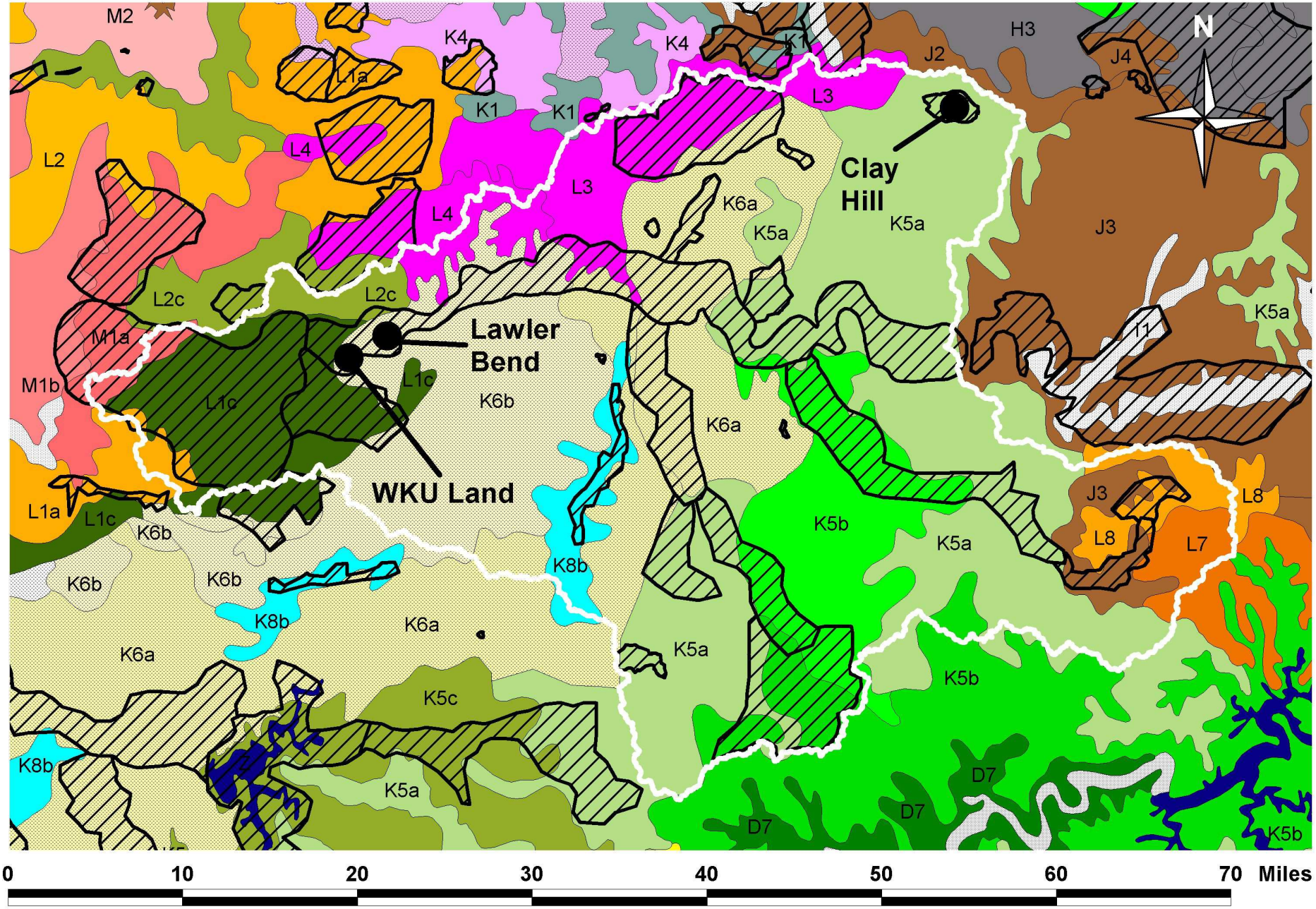
Geology. This preserve is at the eastern edge of the watershed's 'Mammoth Cave Section', in a transition from Mississippian limestone on karst plain to Pennsylvanian sandstone on the Dripping Hills Escarpment and Shawnee Hills beyond. Topography is rugged, with largely calcareous valleys among largely sandstone-capped hills. At 470-500 ft asl (140-150 m), land is mostly covered with alluvium of Quaternary age; on gentler bends to the north and west, remnants of ancient terraces, as old as late Tertiary, also exist as high as 580 ft (175 m). Up to ca. 620 ft (190 m), the Saint Genevieve Limestone (white, oolitic) is exposed; at 620-780 ft (190-240 m), the Girkin Formation (limestone, shale & siltstone); at 780-830 ft (238-253 m), the Big Clifty Sandstone (with some shale); at 830-850 ft (253-259 m), the Haney Limestone (gray-brown fossiliferous). Haney is limited to a few hilltops on the south side of the preserve, where there are also some slumped remnants of the overlying Hardinsburg Sandstone.

Soils. Predominant series are well-developed ultisols and (especially on limestone) alfisols. Relatively 'immature' inceptisols occur in more rugged rocky terrain (especially dystrochrepts on sandstone) and on younger alluvium (both dystrochrepts and eutrochrepts). Still less developed entisols (except for A horizon) are largely restricted to wetter alluvium, and rare from this study area. Within largely non-calcareous areas, alfisols may be locally associated with thicker deposits of loess in residual uplands, or with local seepage or calcareous springs (sometimes between ultisols on upper and lower slopes). Within largely calcareous areas, ultisols may be locally associated with slumped sandstone remnants on some uplands, or with old high sandy terraces and impure cherty limestone. More deeply weathered soils—paleudalfs or paleudults with deep silica- or iron-rich B horizons—occur in less rugged terrain on more ancient exposures of limestone to the southeast, or on ancient terraces of the river. On flatter ground in some of these areas, fragipans have developed and drainage is slow.

Miller & Byler Tracts (Lawler Bend). These tracts range in elevation from about 470 to 750 feet [140 to 210 m] above sea level. Bedrock is mostly Ste. Genevieve Limestone. The underlying St. Louis Limestone is exposed on steeper slopes along the river (below 550 feet), and the overlying Girkin Formation (limestone, shale, siltstone) is exposed on the higher ridges above 700 feet). Soils at higher elevation are mostly calcareous hapludalfs (Bledsoe, Caneyville, Hagerstown). Nearby, there are transitions to the karst plain with paleudalfs (Vertrees, Baxter, Crider), but these soils have negligible coverage within the project area. Soils at intermediate elevation include hapludalfs on steeper slopes, but they are mostly hapludults (Allegheny) and paleudults (Nolichucky, Canmer) that are derived in part from old high terrace deposits. Soils at lower elevation include some hapludalfs (Elk) or fragiudalfs (Otwell) on less ancient terraces, but are mostly eutrochrepts (Nolin, Lindside) or locally fluvaquents (Newark) on more recent alluvium.

Botanical survey of the Miller and Byler tracts was conducted mostly on six days during May to September of 2014 (5/1, 5/9, 6/9, 9/8, 9/9, 9/10), traversing all patches of woodland in the project area. There was also a thorough review of floristic data from the region in order to indicate rare species that might be expected. And local ecological classification was developed in association with the author's continuing research plus attempts to 'crosswalk' with types outlined by the Kentucky. State Nature Preserves Commission (B. Yahn, pers. comm.) and by the National Vegetation Classification (NatureServe 2014). Collections were made of a few species, especially sedges and others difficult to identify in the field. These collections should be accessed at WKU's herbarium if it can be re-established as a secure facility.

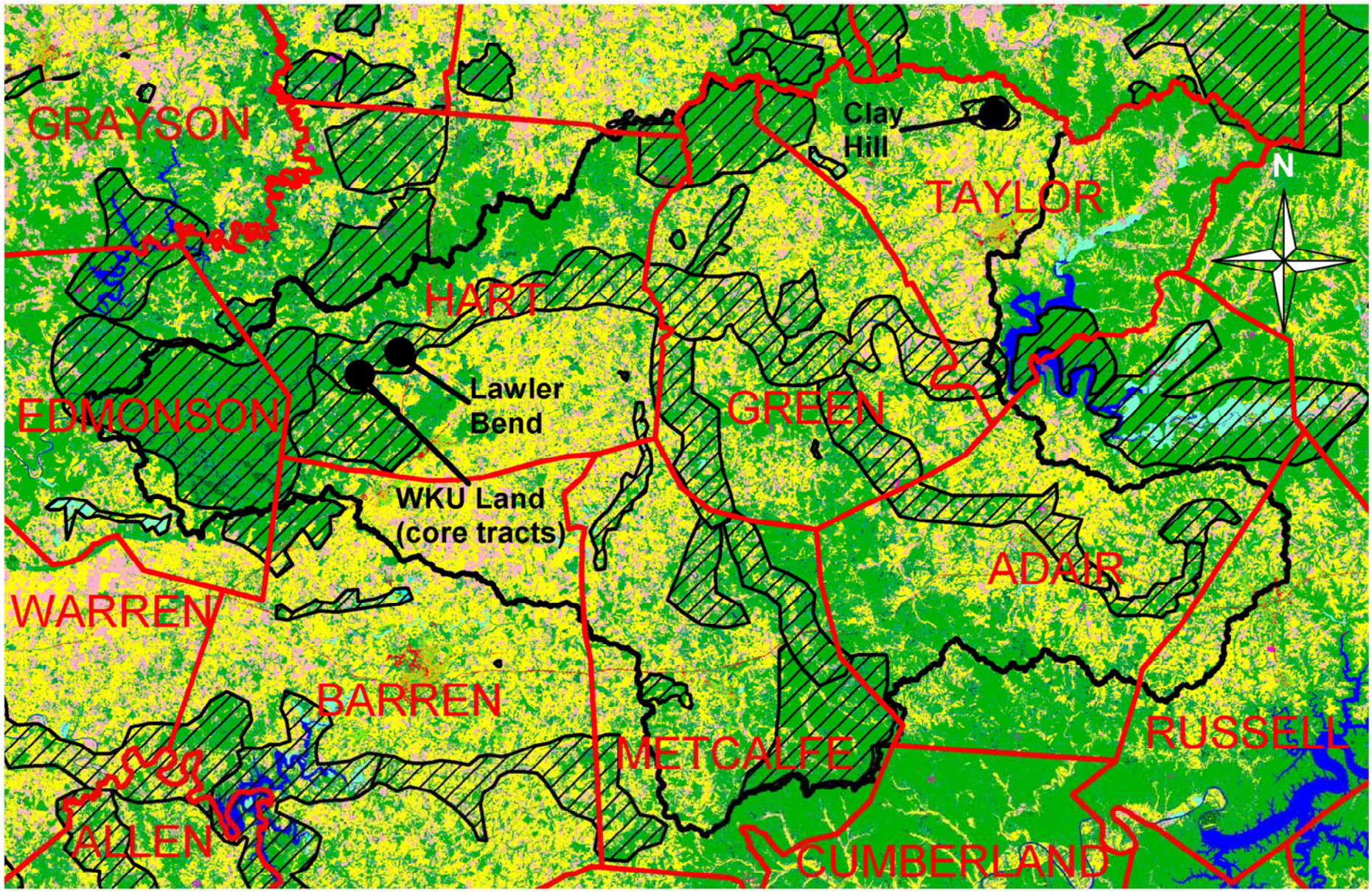
Middle Green River Watershed (white) in relation to Land Type Associations (color-coded; see legend on next page). River corridors and other focal areas for conservation are hatched.



Middle Green River Land Type Associations: legend for codes

- D7. Burkesville Valley Slopes
- H1. Black shale-siltstone Knobs
- H2. Black shale-dolomite Knobs
- H3. Black shale-siltstone Knobs
- H4. Knobs-escarpment transition
- H5. Black shale-siltstone Knobs
- H6. Black shale-siltstone Knobs
- H7. Siltstone Hills
- I1. Bottomland in the Knobs
- I2. Lower Salt Rv Bottoms & Terraces
- J1. Limestone-siltstone Escarpment
- J2. Limestone-siltstone Escarpment
- J3. Limestone-siltstone Escarpment
- J4. Limestone-siltstone Escarpment
- K1. N. Shaley Karst Plain Transition
- K11. Eastern Karst Plain
- K12. Eastern Karst Plain (wet)
- K2. Northern Karst Plain
- K3. Nolin Karst Plain
- K4. Slumped-sand Karst Plain
- K5a. Dissected Calcareous Plain
- K5b. Calcareous Hills
- K5b. Calcareous Hills (gentler)
- K5c. Dissected Calcareous Plain (cherty)
- K5d. High Terrace/Calcareous Plain
- K5e. W Pennyrile Cherty Hills
- K6a. Pennyrile Karst Plain (leached cherty)
- K6b. Pennyrile Karst Plain (cherty)
- K6c. Pennyrile Karst Plain (loessic)
- K7a. Pennyrile Karst Plain (pure)
- K7b. Pennyrile Karst Plain (some chert)
- K7c. Pennyrile Karst Plain (cherty)
- K7d. Pennyrile Karst Plain (shaley)
- K8a. Pennyrile Karst Plain (damp)
- K8b. Pennyrile Karst Plain Wetlands
- L1. Dripping Springs Hills (dissected)
- L1b. Dripping Springs Ravines
- L1c. Dripping Springs Hills (dissected calcareous)
- L2. Dripping Springs Hills (loessic)
- L2c. Dripping Springs Hills (calcareous)
- L3. Slumped-sand Ridge
- L4. Slumped-sand Ridge
- L5. Dissected Sandy Calcareous Plain
- L6. Damp Sandy Calcareous Plain
- L7. Dissected Sandy Plain
- L8. Damp Sandy Plain
- M1a. Loessic Sandstone Ravines
- M1b. Loessic Sandstone Hills
- M2. Loess-covered Sandstone Uplands
- M3. Loess-covered Sandstone Uplands
- M4. Loess-covered Sandstone Uplands
- M5a. Tradewater River Bottomlands (ponded)
- M5b. Tradewater River Wetlands
- M5c. Outer Shawnee Hills Bottomlands
- M6a. Inner Shawnee Hills Bottomlands (ponded)
- M6b. Inner Shawnee Hills Wetlands
- M6d. Outer Shawnee Hills Wetlands
- M6e. Central Green River Valley
- M7a. Deep Loessic Sandstone Uplands
- M7b. Deep Loessic Sandstone Hills
- M8a. Deep Loess Rolling Uplands
- M8b. Deep Loess Hills
- M8c. Deep Loess Terraces
- M9. Mined Shawnee Hills
- Y1. Bottomland in Shawnee Hills
- Y3. Lower Cumberland River Bottomland
- Y5. Central Cumberland River Bottomland
- Z. Water

Middle Green River Watershed (black line) in relation to Land Use (see legend on next page). River corridors and other focal areas for conservation are hatched. Counties are shown in red.



Land Use [NLCD 1992]

- water
- wetland
- woods: mostly deciduous
- woods: mixed
- woods: mostly evergreen
- fields: mostly grass
- fields: mostly row-crops
- suburban/developed
- urban/industrial
- quarries/similar
- stripped coal mines

Above: legend for map on previous page; adapted from the 1992 National Land Cover Data Set (Vogelmann et al. 2001)

Right: typical aerial view of Green River [http://www.city-data.com/forum/kentucky/233322-rural-ky-photo-sticky-24.html].

Next page: Lawler Bend, cliffs with columbines.

HABITATS: Ecological Gradients, Land Use History and Targets for Conservation

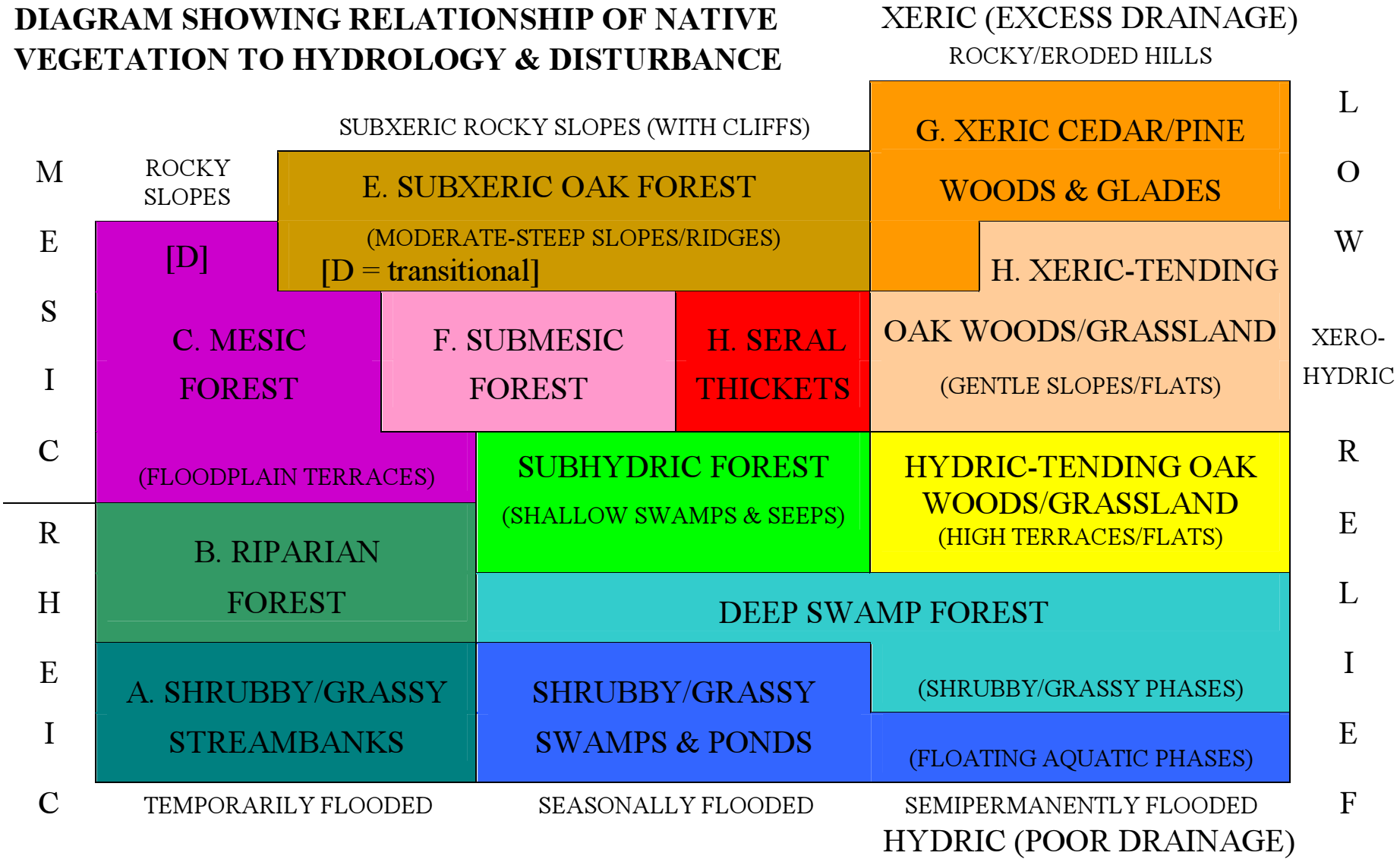
Terrestrial habitats at the Preserve can be conceptually organized along three major gradients in physical conditons: related to (1) dryness, (2) flooding or wetness, and (3) soil pH or associated physico-chemical factors. However, the varied history of timbering and farming over this landscape has added further complexity, making it difficult to infer what the original vegetation was like in some areas.

The diagram below (next page) illustrates the full potential range of vegetation within this region, from wetter to drier conditions (vertical dimension), and from deep mesic (or riparian) woods to open grassland maintained by frequent disturbance (horizontal dimension). But more swampy habitats (in lower right) are rare to absent in the Mammoth Cave area.

Succession from old fields to woods can be projected onto this diagram, but need not have a close relationship to the original gradient from grassland to woodland. That gradient was probably controlled, in large part, by patterns of disturbance in time and space. It is likely that widespread burning by Native Americans, plus locally intense browsing by larger herbivores, was more frequent in karst valleys and plains to the south and east. The more rugged topography near the Green River may have reduced these disturbances due to rock outcrops and watercourses.

Submesic forest is defined here in a loose sense to include gradual transitions in space (or successions in time) from more open brushy woods and thickets to deeper subxeric or mesic woods. It often occurs in locations between more gentle slopes and steeper slopes, but there are various other contexts depending on local history.

DIAGRAM SHOWING RELATIONSHIP OF NATIVE VEGETATION TO HYDROLOGY & DISTURBANCE



This is a simplified summary for 12 broadly defined classes of native vegetation in Kentucky. In the Mammoth Cave area, the best preserved remnants are mostly in classes A-E (see text).

Most of the deeper woods in more rugged terrain of the Mammoth Cave area do not need special management for conservation, although constant vigilance may be needed to reduce some alien plants. In contrast, 'macro-management' is needed for habitats that have been more modified, degraded or cleared in the past.

The most obvious need for management is to bring back a regular fire-regime in drier woods and old fields where it is appropriate to restore native grassland or open oak woodland. Such work can be centered in the class named "xeric-tending oak woods/grassland" of the summary diagram (previous page; labelled "H" here and in text below). To some extent, this fire-regime should be extended into the vegetation of other intergrading classes (E, F and G).

Another general activity for management that can often be justified is to plant trees where forest has been largely cleared for farming in the past. The need is most pronounced on lowlands, where intensive grazing, mowing and cropping have eliminated virtually all original vegetation. This loss applies mostly to "submesic" and "subhydric" forest plus transitions to "riparian forest" along streambanks, and to "mesic forest" on toeslopes.

In a few locations, more hydric conditions may be enhanced by removing old artificial drains or by small degrees of impoundment. There may be few opportunities on the WKU lands. But elsewhere in the Mammoth Cave area the few remnants of swampy woods and ponded areas do deserve more attention for protection and enhancement.

Notes on Land Use

Core WKU Tracts. See initial Resource Management Plan. The old Williams Tract (on south side of the river) offers a great range of disturbance histories. Most of the limestone valley leading down to the river bottom, plus the bottomland itsefl, has been intensively farmed for 150-200 years. At the northeast side of this tract, there was probably a regular ancient ford across the river for larger animals and humans. The Gardner House, now being restored by WKU, is one of the oldest brick houses in the county. Woods on slopes west of this old farm have a mix of older woods (mostly with oaks and hickories), younger woods (mostly with much red cedar or scrub pine), and old brushy pastures. Mature mesic woods are largely confined to steeper north-facing slopes along the river.

Bush / Goebel Tract. A small tenant farmhouse used to be located at top of the hill on the southeast side of this tract, next to the barn. It was abandoned before the WKU acquisition, and the new large cabin was built at the top of the lowland field by the Goebels. These gentle lower slopes and bottomland here has been cleared for 100-200 years. Much of the woods on the southwest side of the tract has also been cleared partially in the past, or intensively grazed by livestock, especially on less rocky or sloping ground While there are few remnants of native grassland in these disturbed woods, the local abundance of *Rudbeckia tenax* may be significant (see notes below under vegetation types; it is somewhat conservative species that survives mostly along rocky roadsides. Other woods have been logged (perhaps 50-100 years ago) but never cleared, at least on steeper slopes along the river.

Kinney Tract. This has had several sections largely devoted to farming during the last 100-200 years: (a) intensively farmed fields on the Green River bottomland, (b) fields around the old Kinney house, mostly mowed or pastured in recent decades (including their inholding); and (c) smaller upland fields, including on top of the central knob, but largely abandoned at least 10 years ago. In marked contrast to the Williams Tract (on west side), most old farmland on the Kinney Tract was already abandoned to various degrees when WKU acquired it. As elsewhere in the region, most of the younger woods on gentler slopes have been cleared in the past 100-200 years or used to various degrees by livestock. Other woods have been logged (perhaps 50-100 years ago) but never cleared, at least on steeper slopes along the river.

With remarkable memory, Vilma Jean Kinney recalls the following (pers. comm. to A. Meier). The large island in the river was last cultivated in 1947, when pumpkins were grown among the corn stalks. During a previous year, a flood washed away the pumpkins, which could be seen floating merrily down the river into the park. On top of the high knob near the center of the tract, there is a small field on the Haney Limestone, which was last cultivated in 1947 with corn. Lowlands remained cultivated until the early 1980s. Cattle were fenced into some low fields until 1988; some also roamed on uplands until 2007 in another fenced area.

Durham Knob Tract. This is almost all wooded, but gentler slopes have been cleared in the past, presumably for rough grazing of livestock at least, and perhaps for temporary cropping in a few places. There is an old tenant house and barn on top of the hill at the south side (just outside the tract transferred to WKU). From this base, there appear to have been one or two dirt roads down leads onto the bottomland that is adjacent to this tract on the northeast side. Steeper slopes along the river have been logged 50-100 years ago, but never cleared.

Miller Tracts (Lawler Bend). Forest covers higher elevations except for a small hayfield along the road. Land here is generally too rocky for farming but there has been repeated cutting of timber for many decades, and probably been much use by livestock. The local abundance of red cedar and hickories (including much southern shagbark) might be partly caused by logging of oaks and by the aversion of mammalian herbivores to browsing on cedar or hickory. At intermediate elevation, the land is mostly cleared—including privately owned land not included in this project. Woods are fragments into patches and strips, and red cedar is locally abundant. Current farming is mostly for pasture and hay, and there a few ponds. At lower elevation, much land is also cleared for farming, probably with some cropping along the bottoms in the past. Extensive woods remain on slopes and along the riverbanks, but these woods have been much influenced by cutting and browsing. Some areas are severely eroded, cutting into the ancient terrace deposit in places. Red cedar is locally dominant on some recovering sites. Hunting cabins or other peripheral uses have developed in recent decades.

Byler Tract (Lawler Bend). This is all forested except for a small hayfield at higher elevation along the road. There has been selective local logging during recent decades, especially on gentler slopes, resulting in some dense thickets. Also, an ancient pathway on gentler slopes leads down to the river (and large islands) from the gap in low hills on the southwest side.

At Lawler Bend, there is a notable paucity of palatable forbs that are typical of more fertile or mesic lowland soils: e.g., *Helianthus tuberosus, Heliopsis occidentalis, Lactuca canadensis, Silphium perfoliatum, Symphyotrichum novae-angliae*. (Notable woody absences in much of the area may include *Sambucus* and *Tilia*.) It is likely that two centuries of pervasive continual use by livestock (including hogs in the past) has reduced these species.

The old Kinney place, on gentle calcareous slopes and benches above the Green River.
Some of the farmland is worn out with erosion, leaching of nutrients and grown up with scrub.

Typical farmland in limestone valley adjacent to WKU land, looking east from the main entrance. Some of this valley was probably thin woodland or grassland before settlement.

Lawler Bend: during recent decades, prosperous Amish farmers have settled in this area.

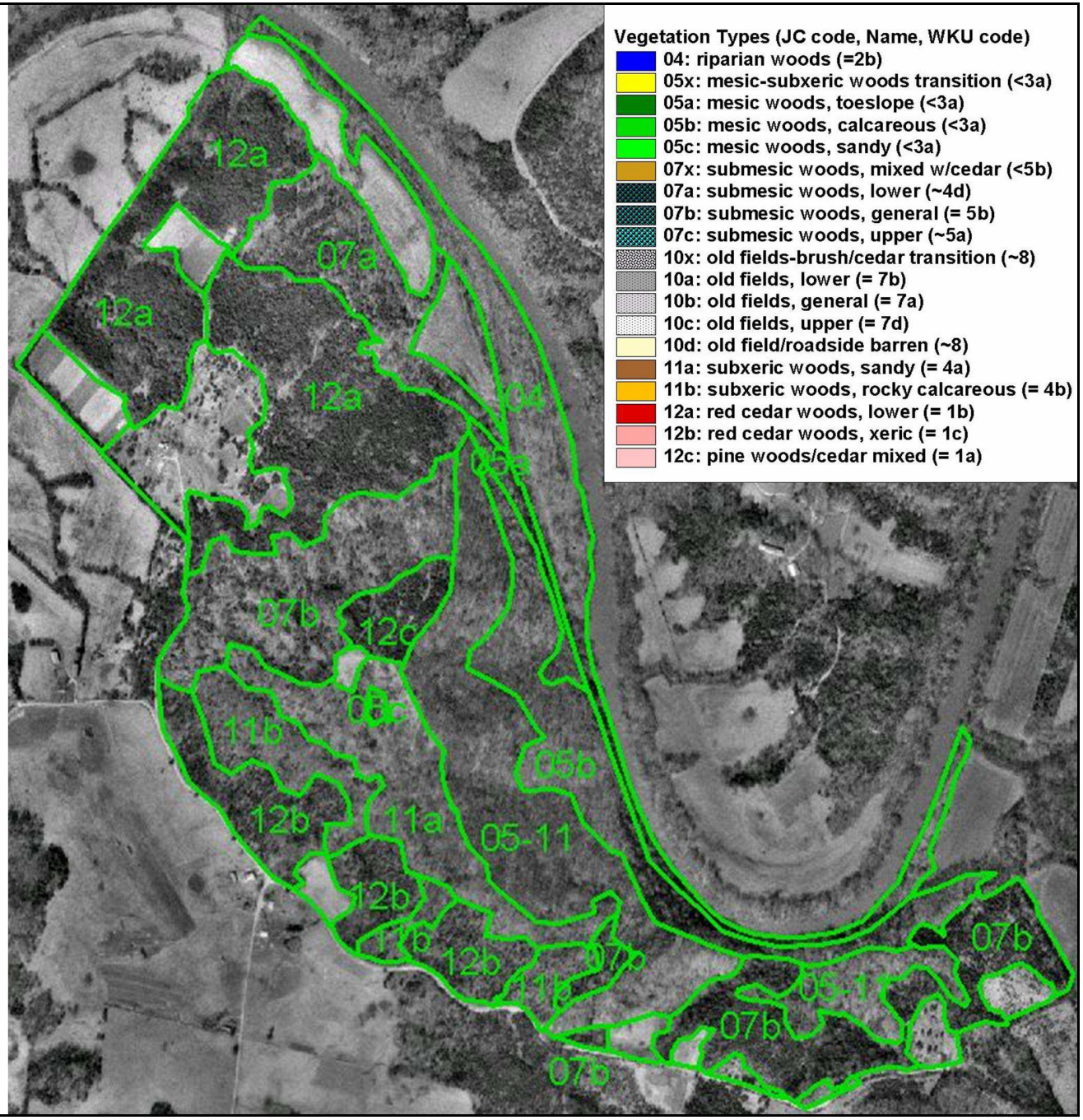
Provisional vegetation maps for the Green River Biological Preserve

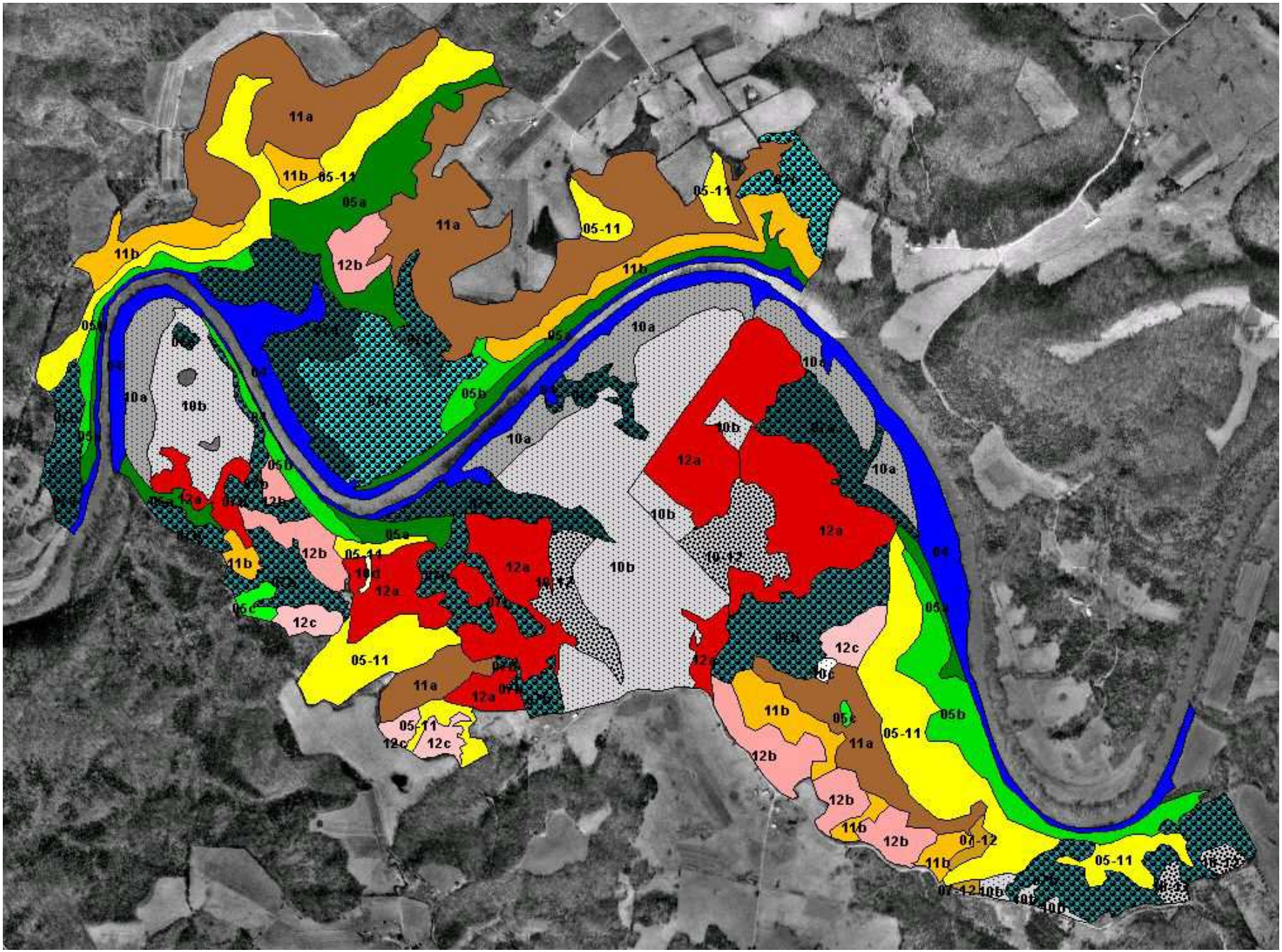
1 [this page]: general legend (upper right); and local map for Kinney and Durham Knob Tract.

2 [second page]: colorized map for whole preserve (2.5 miles wide).

3 [third page]: outlined map for whole preserve (2.5 miles wide).

All maps are based on aerial photos from 1999 [digital ortho quarter quads].

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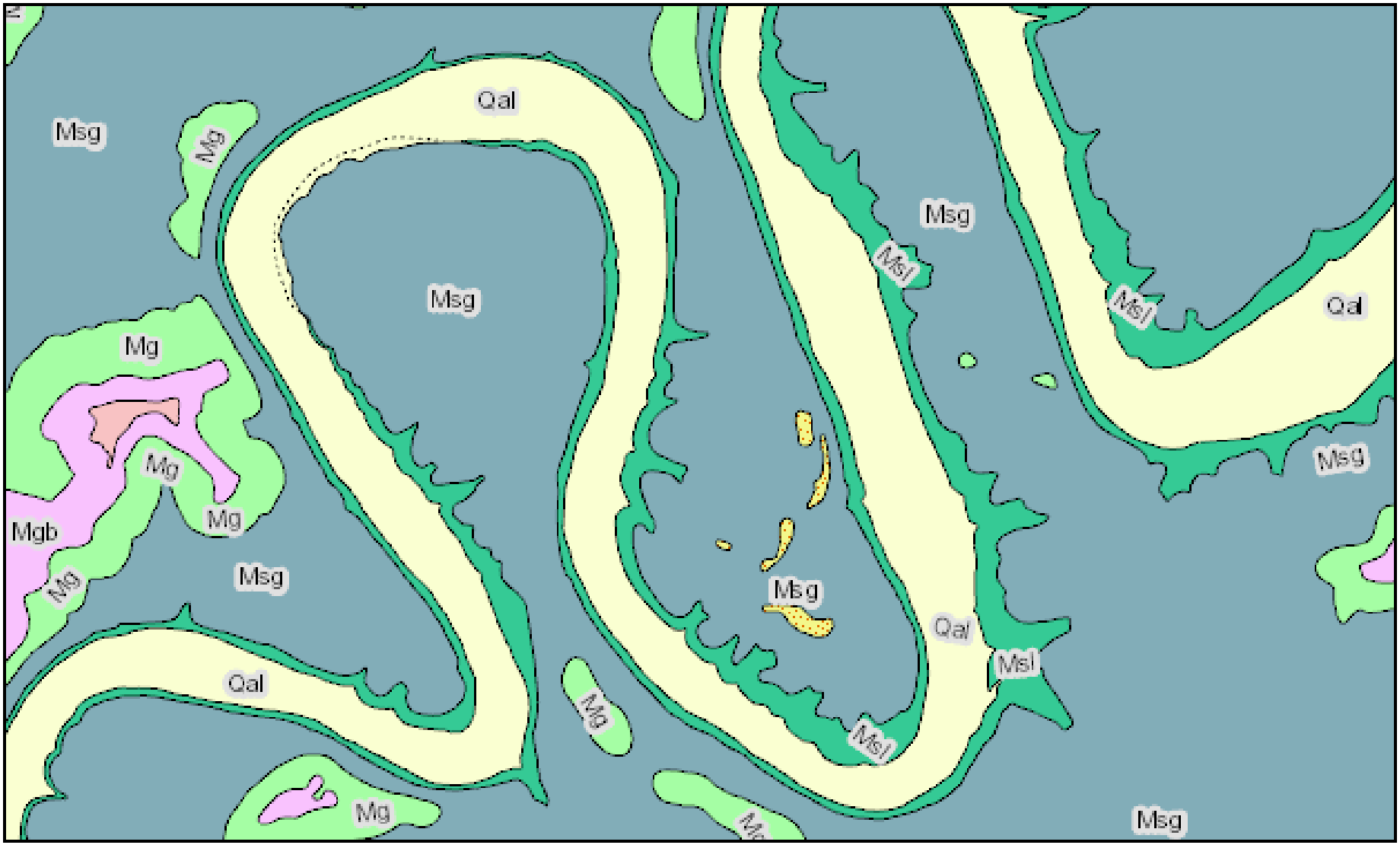
11b
12b
11b
10a
05b
07a
07a
07b
05a
10a
04
04
10a
10b
07c
05b
04
07a
07b
05a
04
10a
07a
10b
12a
05b
10a
07b
07a
05a
12a
07b
12b
07a
10b
07b
12a
11b
12b
05-11
05a
10-12
04
07b
10d
07b
12a
10-12
10b
12a
07b
05c
12c
05a
07b
12c
12a
10c
05-11
07b
11a
12a
07b
07b
11b
05c
05b
05-11
11a
05-11
12c
12c
12b
12b
11b
12b
07-12
11b
05-11
10-12
07b
10-12
07-12
10b
10b
10b

Maps of Lawler Bend area: subsequent eight pages.

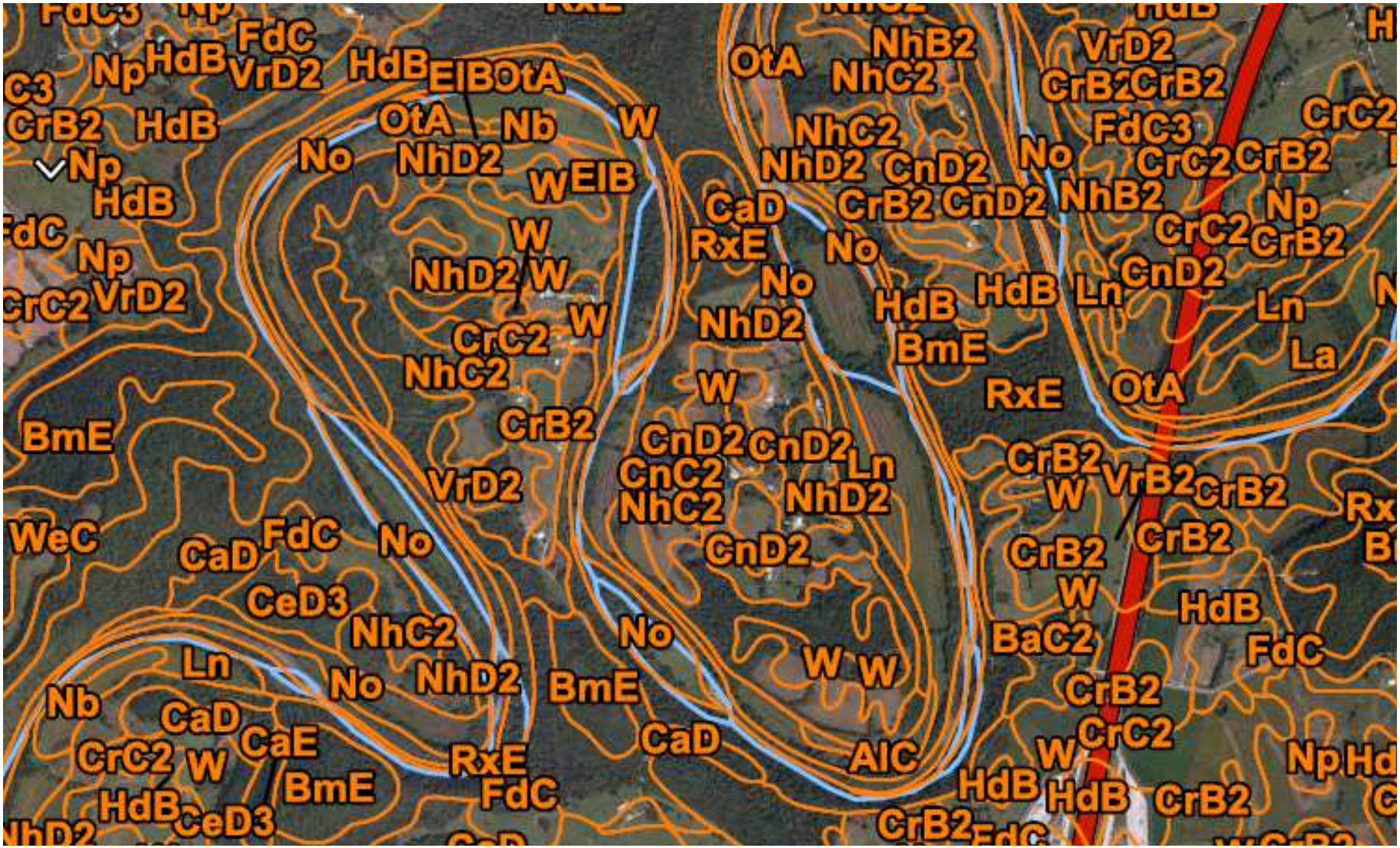
These maps have been developed for the current project (Miller and Byler tracts), using new standards for submission to the Heritage Land Conservation Fund. It is anticipated that a broader mapping of the whole conservation area will eventually adopt such standards.

(a) Geological map extracted from website of Kentucky Geological Survey (KGS 2014).
(b) Soil map extracted from website of Natural Resource Conservation Service (USDA 2014).
(c) Interpreted soil map developed from (b), plus legend.
(d) Topographic map from the 1950s US Geological Survey 7.5 minute quadrangles.
(e) Aerial view in 2006 from the National Agriculture Imagery Program (USDA 2013).
(f) Vegetation map developed for this project plus legend, including crosswalk to earlier coding of the initial Resource Management Plan: = is good match; ~ is approximate match; < is segregation; > would be combination.

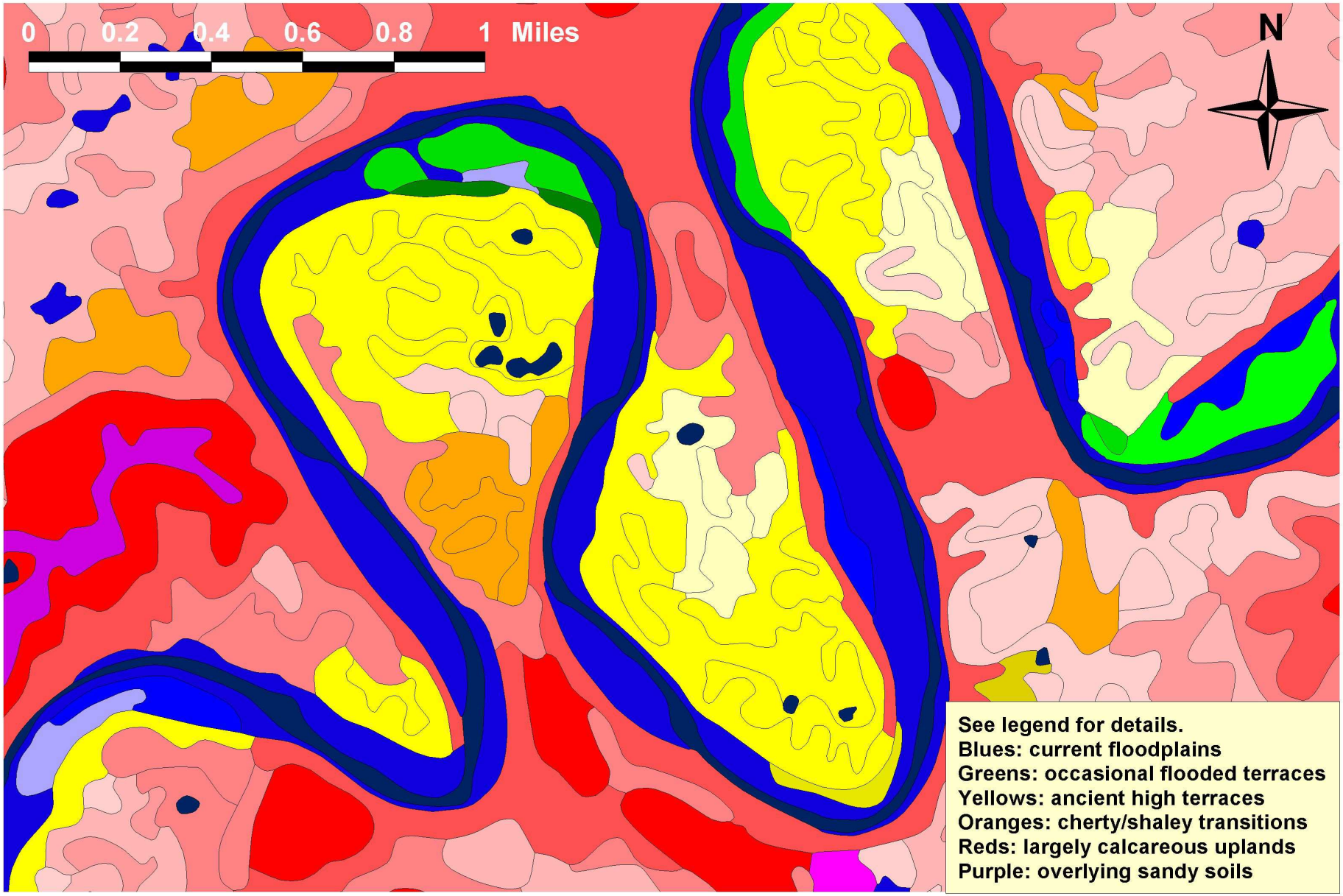
In subsequent sections of this report, after notes on the vegetation below, there are also maps of rare species locations and selected invasive alien species.



Geological map from website of KGS: Qal = Quaternary Alluvium; Qt = Quaternary / Tertiary Terrace [stippled orange]; Msl = St. Louis Limestone; Msg = Ste. Genevieve Limestone; Mg = Girkin Formation (limestone, shale, siltstone); Mgb = Big Clifty Sandstone member; Mgh = Haney Limestone member [darker pink]; Mh = Hardinsburg Sandstone [purple to northwest].



Map of soil series produced from website of NRCS: Al = Allegheny; Ba = Baxter; Bm = Bledsoe; Ca/e = Caneyville; Cn = Canmer; Cr = Crider; El = Elk; Fd = Fredonia-Hagerstown-Vertrees; Hd = Hagerstown; La = Lawrence; Ln = Lindside; Nb = Newark; Nh = Nolichucky; No/p = Nolin; Ot = Otwell; Rx = Rock-Caneyville; Vr = Vertrees; We = Wellston.



Map of interpreted soil series for Lawler Bend area

Legend for map of soil series in Lawler Bend area

- water (rivers, creeks, ponds)
- well-drained floodplain (Nolin)
- less well-drained floodplain (Lindside)
- somewhat poorly drained floodplain (Newark)

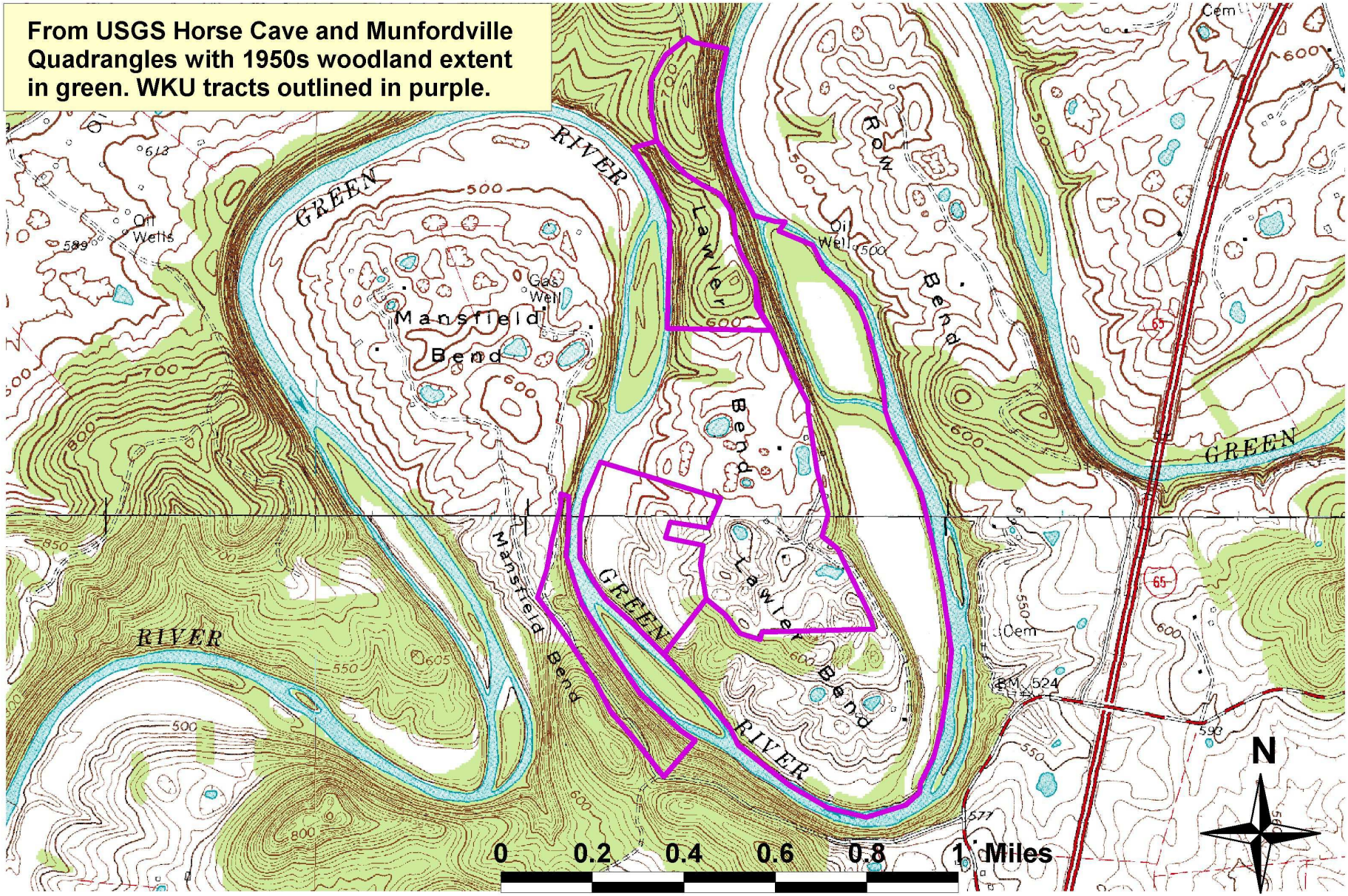
- well-drained sandy terrace (Grigsby)
- well-drained silty terrace (Elk)
- somewhat poorly drained terrace (Otwell)
- poorly drained terrace (Lawrence)

- loamy high terrace (Allegheny)
- deeply weathered dissected terrace (Nolichucky)
- deeply weathered level terrace (Canmer)

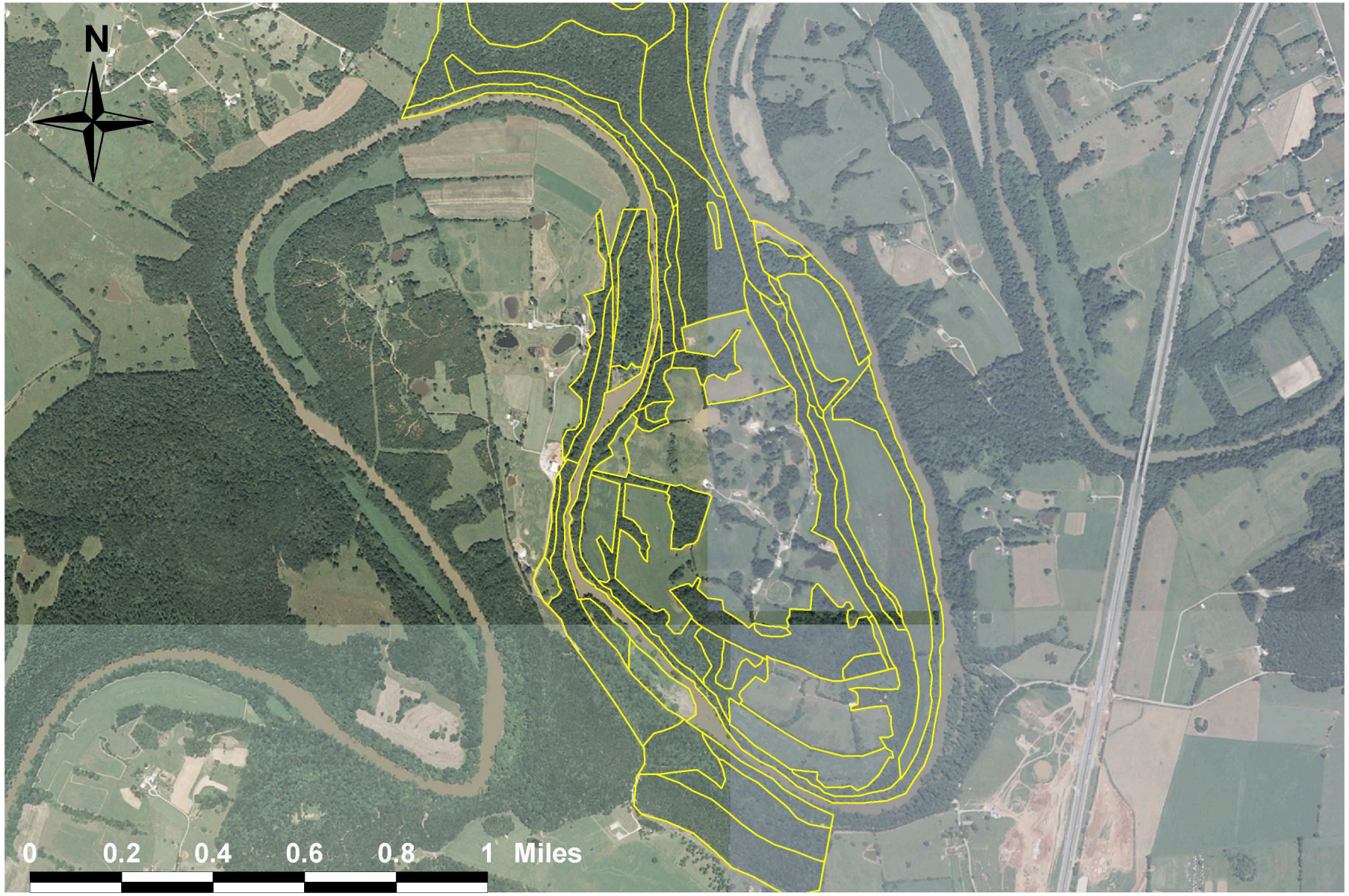
- deeply weathered shaley uplands (Vertrees)
- deeply weathered cherty uplands (Baxter)

- steep rocky colluvial calcareous slopes (Bledsoe, some Wallen)
- steep rocky residual calcareous slopes (mostly Caneyville and rock)
- steep to moderate residual calcareous slopes (Caneyville)
- moderate residual calcareous slopes (Hagerstown)
- moderate to gentle residual calcareous slopes (Fredonia)
- gentle, deeply weathered residual calcareous uplands (Crider)

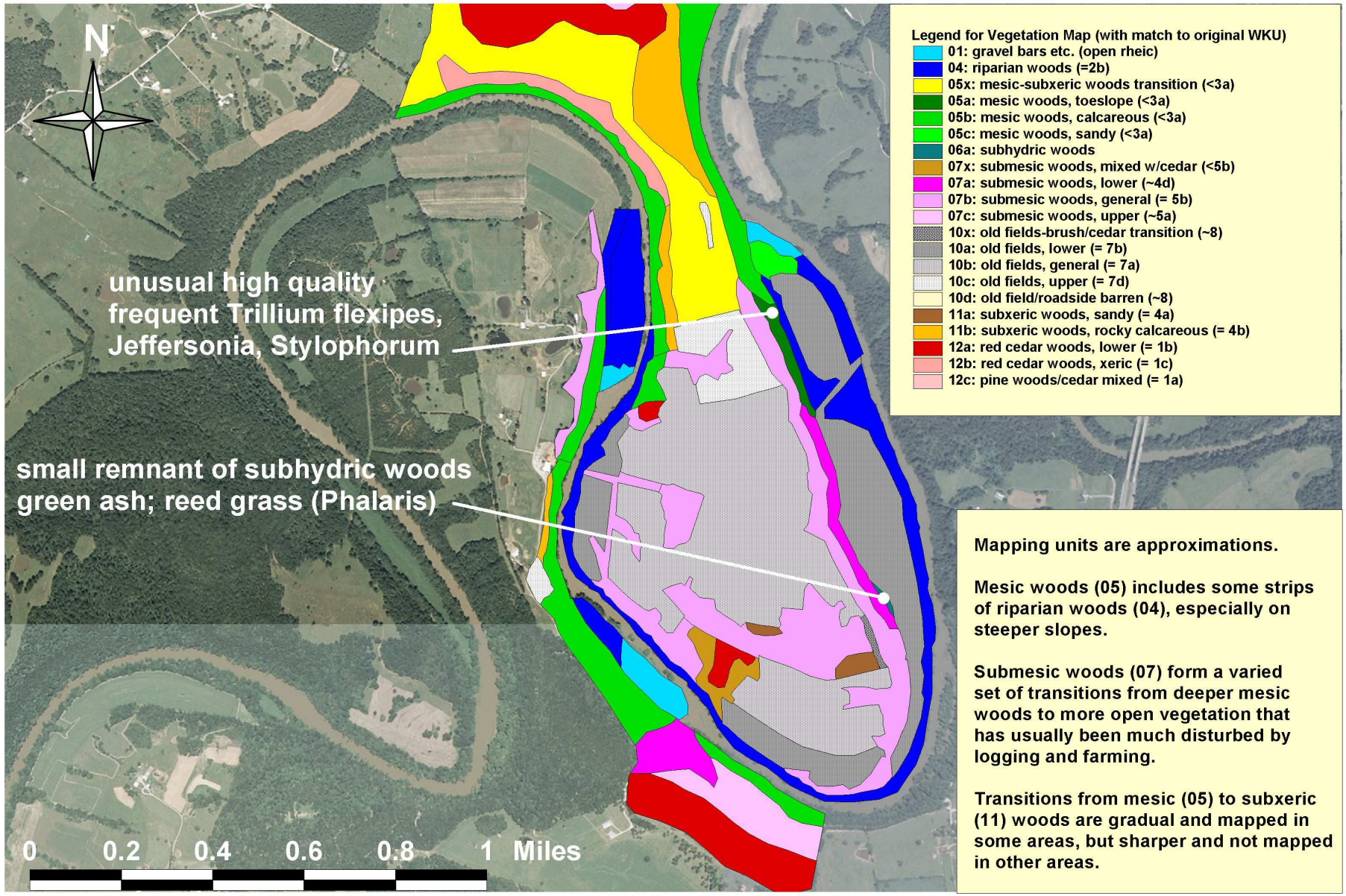
- varied sandy uplands (Jefferson, Wallen, Wellston, Lily, Tilsit)



Topographic Map for Lawler Bend Tracts



Aerial view of Lawler Bend area showing mapped vegetation type boundaries



Map of vegetation types in Lawler Bend area

Legend for Vegetation Map (with match to original WKU)

- 01: scoured (rheic) thin woods and gravel bars
- 04: riparian woods (=2b)
- 05x: mesic-subxeric woods transition (<3a)
- 05a: mesic woods, toeslope (<3a)
- 05b: mesic woods, calcareous (<3a)
- 05c: mesic woods, sandy (<3a)
- 06a: subhydric woods
- 07x: submesic woods, mixed w/cedar (<5b)
- 07a: submesic woods, lower (~4d)
- 07b: submesic woods, general (= 5b)
- 07c: submesic woods, upper (~5a)
- 10x: old fields-brush/cedar transition (~8)
- 10a: old fields, lower (= 7b)
- 10b: old fields, general (= 7a)
- 10c: old fields, upper (= 7d)
- 10d: old field/roadside barren (~8)
- 11a: subxeric woods, sandy (= 4a)
- 11b: subxeric woods, rocky calcareous (= 4b)
- 12a: red cedar woods, lower (= 1b)
- 12b: red cedar woods, xeric (= 1c)
- 12c: pine woods/cedar mixed (= 1a)

Next page: view of long bottomland field on east side of Lawler Bend, looking north. Trees have been planted in rows for eventual

Lawler Bend: washed-out gravel on terrace at about 540 ft (165 m) in elevation, 70 ft (20 m) above the current summer pool level of the Green River; see soil map for detailed mapping.