Conservation in the Central Ohio Valley

Land-of-Cane-and-Clover or Dark-and-Bloody-Hunting-Ground?

Notes by Julian Campbell: bluegrasswoodland.com

CONSERVATION IN THE CENTRAL OHIO VALLEY:
Land of Cane and Clover, or Dark and Bloody Hunting Ground?
Julian Campbell; bluegrasswoodland.com; August 2015.

INTRODUCTION. The western frontier of colonial America was unsettled during the late 18th Century, with disrupted human society and natural ecology. The colonists' views of Native American interests varied greatly. Dreams of a former utopia were reportedly used by the English agent, Simon Girty, to instill resistance among the region's tribes in 1782: "Brothers: the fertile region of Kentucky is the land of cane and clover—spontaneously growing to feed the buffaloes, the elk and the deer; there the bear and beaver are always fat—the Indians from all the tribes have had a right from time immemorial, to hunt and kill unmolested these wild animals, and bring off their skins, to purchase themselves clothing—to buy blankets for their backs and rum to send down their throats, to drive away the cold and rejoice their hearts, after the fatigue of hunting and the toil of war [great applause from the crowd]. But Brothers, the long knives have overrun your country, and usurped your hunting grounds,—They have destroyed the cane—trodden down the clover—killed the deer and buffaloes, the bear and raccoon—They are building cabins and making roads on the ground of the Indian camp and warpath: The beaver has been chased from his dam and forced to leave the country [palpable emotion among the hearers]."

In contrast, Humphrey Marshall (1812) described the early settlement of Kentucky as follows: "Their arrival on the plains of Elkhorn, was in the dawn of summer; when the forest composed of oaks of various kinds, of ash, of walnut, cherry, buckeye, hackberry, sugar trees, towering aloft to the clouds, overspread the luxuriant undergrowth, with their daily shade; while beneath, the class of trees—the shrubs, the cane, the herbage, and the different kinds of grass, and clover, interspersed with flowers, filled the eye, and overlaid the soil with the forest's richest carpet..." Of the Indian conflicts over the land, he stated: "In consequence of which, and because these combats were frequent—the country being thickly wooded, and deeply shaded—was called in their expressive language, THE DARK AND BLOODY HUNTING GROUND."

Cover photo: Griffith Woods (Harrison Co. KY), our best opportunity to restore something like the original Bluegrass Woodland. Although the land may now be protected, it has been transfered from The Nature Conservancy to Kentucky Department of Fish & Wildlife Resources, and it has been difficult to generate a management plan that addresses the fundamental issues. In this photo, young shellbark hickories (browsing-resistant but fire-sensitive) have come to dominate the old pasture in young recovering woods, among much larger trees of blue ash and chinquapin oak. This regrowth occurred after mowing ceased in the 1980s—despite continual grazing by cattle—and then more so after 2003 when all farming ceased. The ash and oak have virtually no regeneration within openings, but seedlings do appear locally in deeper woods. Running buffalo clover was observed here along cow paths in thin woods during the 1990s, but it disappeared after cattle were removed. Currently, there are active plans to manage with prescribed fire but not with livestock—which helped maintain the woodland and clover for over 200 years.

From "Death of Tecumseh" (at US Capitol): last Indian leader of the Ohio Valley, killed in 1812 by R.M. Johnson, later 9th USA Vice-President, who lived near Griffith Woods in 1784 (see Filson's map).


This Map of KENTUCKE, Drawn from actual Observations, is inscribed with the most perfect respect to the Honorable the Congress of the United States of America; and to his Excell.y George Washington late Commander in Chief of their Army. By their Humble Servant, John Filson.
Scale of 10 Miles to an Inch.
EXPLANATION.
Stations or Forts.
Salt Springs & Licks.
Towns.
Dwelling-houses & Mills.
Wigwams.
The dotted lines represent Roads; some Cleard, others not.
While this Work shall live, let this Inscription remain a Monument of the Gratitude of the Author, to Col. Dan. Boon, Levi Todd, & Ja. Harrod, Capt. Christ. Greenup, Jn. Cowan, & W.m Kennedy Esq.rs of Kentucke: for the distinguish'd Assistance, with which they have honor'd him, in its Composition: & a testimony, that it has recieved the Aprobation of those, whom he justly Esteems, the best qualified to Judge of its Merit.
The stream of the Ohio is in every part Moderate, except the Rapids.
Gen. Clark's Grant 150,000 Acres
12
11
10
9
39
38
37
Peeaway town
Old Chelicothe
Mingo Nation live here
INDIAN TERRITORY
Natural Meadow
Great Miami
Little Miami
Old Shawanee Town
Sciotha R.
321 Miles below Fort Pitt
Big Bone C.r
Salt Springs
Bones are found here
War Road
Banklick
LICKING RIVER
Bird's War Road
N.th Fork
Main Licking
Fine Cane Land
the Blue licks a fine salt spring
Upper Blue licks
FAYETTE
Indian Kentucke
10 Mile C.r
Eagle C.r
Little Kentucke
the Twins
Seven
Shoemaker's C.r
Cedar C.r
Elkhorn
Fine Cane
Riddle's St.n
Hingston Fork
Abundance of Cane
Stoner's Fork
Capt. Johnston
COUNTY
Patton's C.r
18 Mile C.r
Clark's C.r
The Rapids
Clarkville
Louisville
Low Dutch
Sturgis's
Linn's
Sullivan's
Kirkindol's Mill
Fish Ponds
Hites
JEFFERSON
Greenville
Lee's-town
Col. Marshal's Office
Lexington
Bryan's
Col. Todd's
Boon's
Stroud's
Morgan's Mill
Boonsburg
RED RIVER
N. Fork
Middle F.
S. Fork
Station Camp C.r
Big Benson
Bullet's lick
Floyd's Fork
Town Fork
SALT RIVER
Otter C.r
Deer Run
Buck Run
Col. Cox's
Fine Cane
Bard's Town
Chaplain's Fork
Parker
Beech Fork
Harrod's Town
Grant's Mill
Danville
Dick's R.
Paint lick C.r
Blue lick
Gilbert's C.r
Craig's
LINCOLN
KENTUCKE RIVER
OHIO RIVER
NELSON

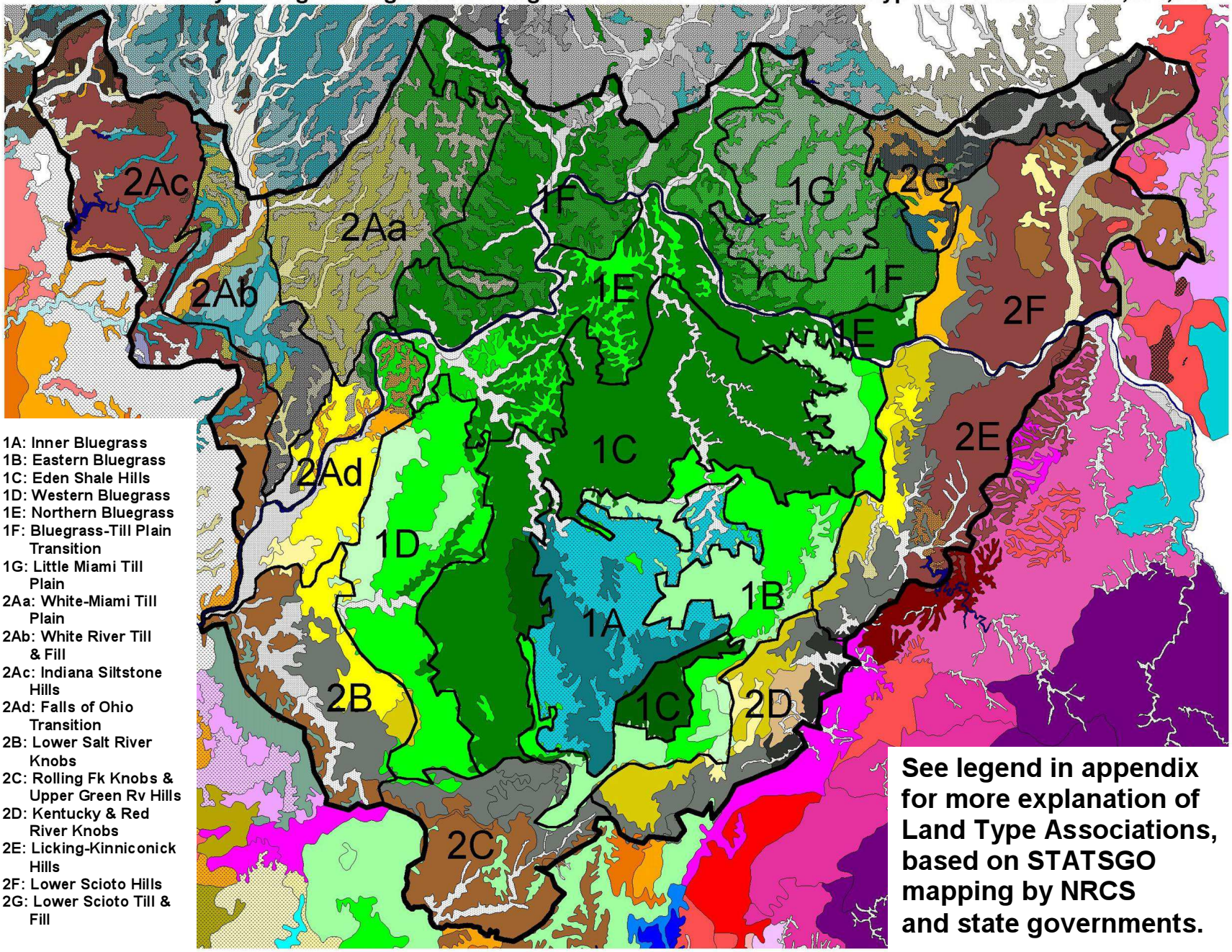
Organized conservation in this region, as in most of North America, did not advance much until the early 20th Century. Initial leadership emerged in the Cincinnati area, especially due to C.G. Lloyd and later E.L. Braun, as well as in the Louisville area, especially the city parks designed by F.L. Olmstead and the protected forest established by Isaac Bernheim. State governments then began to establish parks (primarily for recreation) and wildlife areas (primarily for hunting and fishing) across the region. The federal government has remained a minor landowner except in parts of the Appalachian transition, with Daniel Boone National Forest. During the 1970s, a more concerted effort began to focus on the scientific details of our imperiled biological diversity, with establishment of local chapters by The Nature Conservancy (TNC) and of Natural Heritage Programs in all state governments. There has been a substantial growth in relevant information during recent decades, but, as outlined below, there have been difficulties extracting and synthesizing those data most pertinent to priorities for conservation, their implementation and assessment.

In addition to problems with scientific data, there are substantial differences in ideological approaches to conservation. There has been some tension between proponents of a more utopian attempt to restore the 'natural heritage' that existed before colonial settlement, and those people with more practical goals to extract timber, game and fish—albeit in a sustainable manner. The latter interests have tended to predominate in terms of governmental funding, while a large segment of the general public probably yearns somewhat unrealistically for a more 'natural' or 'native' or 'wilderness-like' condition in protected areas. Efforts to advance more political consensus among conservationists have been limited. During the 1990s, TNC did establish 'ecoregional planning' networks among some professional groups, but this has not been continued effectively for those groups, and there has been little public outreach. The educational system, especially at grade-school level, remains poorly connected to the urgent need for better understanding of our natural heritage and for discussion of varied methods for conservation. In this author's view, all of this could be signficantly changed through more regular field trips and meetings among conservation-minded people.

Preceding page: upper part of John Filson's 1784 "This Map of Kentucke", including several early references to natural features across the Central Ohio Valley. On uplands in more fertile parts of the Kentucky Bluegrass, he notes "cane". In Ohio, he notes "Natural Meadow" on both sides of the Scioto River, corresponding somewhat with evidence of native grassland that was once locally widespread on uplands and lowlands there. In Kentucky, he notes several "licks" that were frequented by bison and other animals. In Ohio, he notes several Indian towns.

Right: Emma Lucy Braun (1889-1971), from Cincinnati, was an influentiual botanist, ecologist and conservationist in this region. She wrote the only existing book that synthesizes knowledge about forests across all of eastern North America. She was the first person to thoroughly describe vegetation types in the Ohio Valley. She helped establish the Cincinnati Nature Center, was involved in associated conservation projects, and became president of the Ecological Society of America. This organization fostered development of The Nature Conservancy, and then Natural Heritage Programs as an integrated science-based community.

Central Ohio Valley Ecological Region: showing Subsections overlaid on Landtype Associations 1:2,500,000



1A: Inner Bluegrass
1B: Eastern Bluegrass
1C: Eden Shale Hills
1D: Western Bluegrass
1E: Northern Bluegrass
1F: Bluegrass-Till Plain Transition
1G: Little Miami Till Plain
2Aa: White-Miami Till Plain
2Ab: White River Till & Fill
2Ac: Indiana Siltstone Hills
2Ad: Falls of Ohio Transition
2B: Lower Salt River Knobs
2C: Rolling Fk Knobs & Upper Green Rv Hills
2D: Kentucky & Red River Knobs
2E: Licking-Kinniconick Hills
2F: Lower Scioto Hills
2G: Lower Scioto Till & Fill

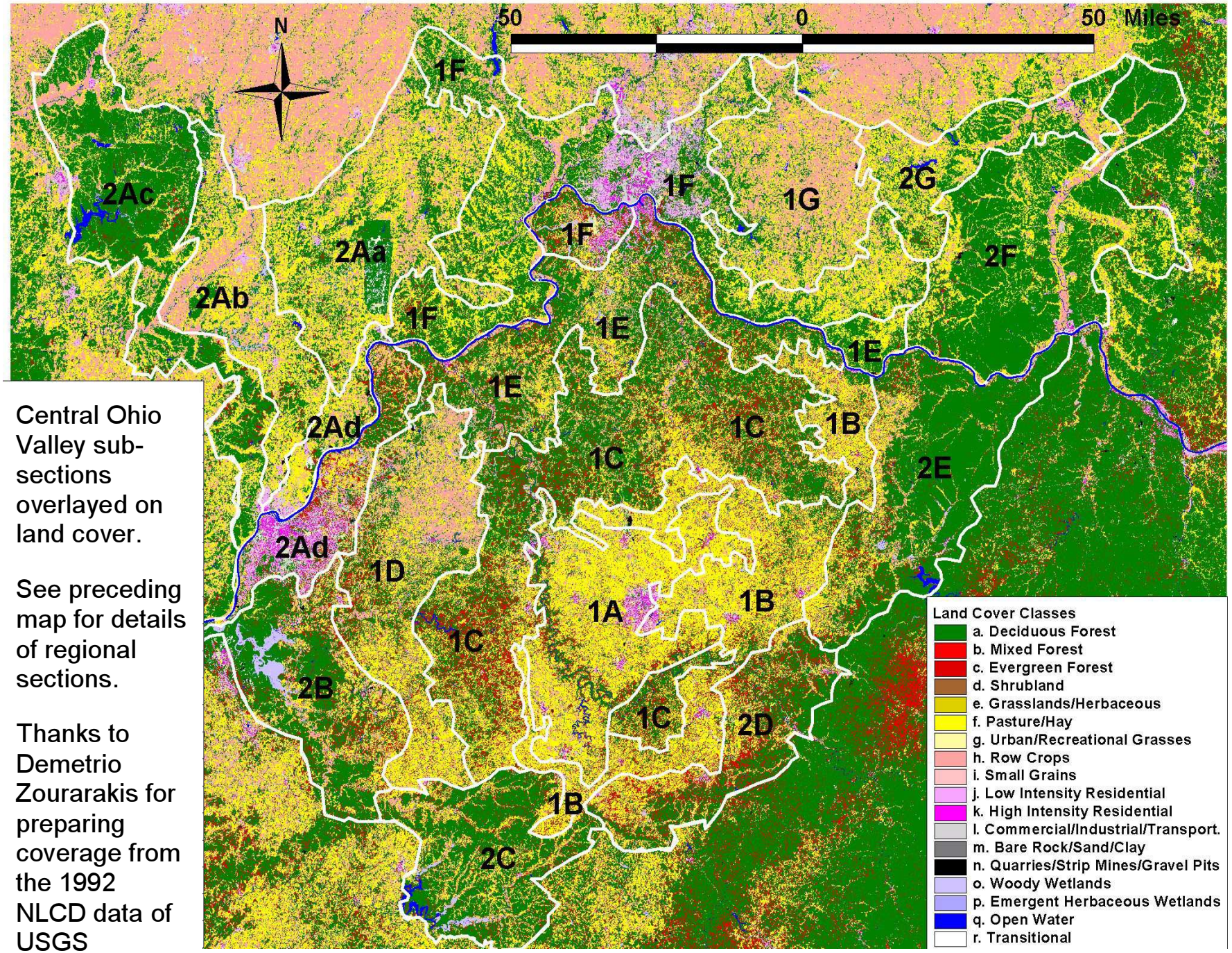
See legend in appendix for more explanation of Land Type Associations, based on STATSGO mapping by NRCS and state governments.

TEAMWORK. Modern conservation, broadly defined, seeks to be 'science-based' and 'community-based'. There is some scientific basis for most current programs in conservation across the 'Central Ohio Valley' (see maps). But we conservationists have generally failed to build communities of interested people who regularly interact within regional sections of reasonably moderate size—large enough to exert good cooperative influence, and small enough to focus on common understanding of each region's features. Even within organizations focused on conservation, there is often a wide range of views and experiences concerning actual goals and methods. And there is often insufficient interaction between organizations with different approaches to conservation. We still do not have consensus on some technical aspects in prioritization of landscapes and watersheds to 'target'; in restoration of degraded habitats (especially old fields and grassland remnants); in selection of imperiled species for recovery; and in methods for reduction of invasive aliens.

Having been involved in conservation across Kentucky for over 40 years, I know the value of regular interaction among people with common interests. While there have been past efforts to coordinate across the state or within regions, such efforts have dwindled during the past decade or so. The Central Ohio Valley would be a reasonably sized region for regular review and planning, ideally with an annual meeting and objective reporting on progress. Within this region, there are some 4-8 sections (with flexible boundaries) that could become more intense 'ecological neighborhoods'—essentially groups of counties that share features and natural relationships, including watersheds or river-frontage (see map below, p. 18). I am currently experimenting with the 'central' section (number 1 on map), as a focus for regular monthly fields trips to interesting sites. Such trips should enable us to become knowledgeable about the range of conditions, and to build relationships. I am seeking a few partners to organize an annual meeting for this section, and then connect with people based in other sections, perhaps leading to a rotated annual event. At the county level, as well, we could bring together local knowledge and connect more with interests of local government. A few of us held an initial public meeting for Jessamine Co. in 2014.

Brown County Hills of Indiana: largely protected, with extensive forested hills providing much contrast to adjacent glacial plains.

Edge of Appalachia, Ohio, with grassland remnants in dolomitic foothills. Over 16,000 acres are protected here by TNC and partners, plus 4000+ acres by Arc of Appalachia, a local non-profit that works independantly from TNC, with little mutual references in websites.



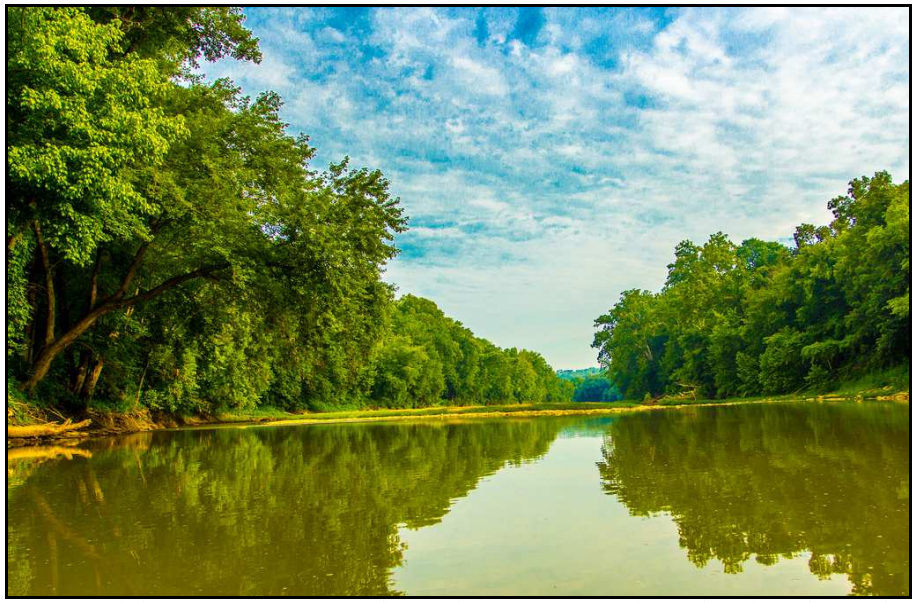
Central Ohio Valley sub-sections overlayed on land cover.

See preceding map for details of regional sections.

Thanks to Demetrio Zourarakis for preparing coverage from the 1992 NLCD data of USGS

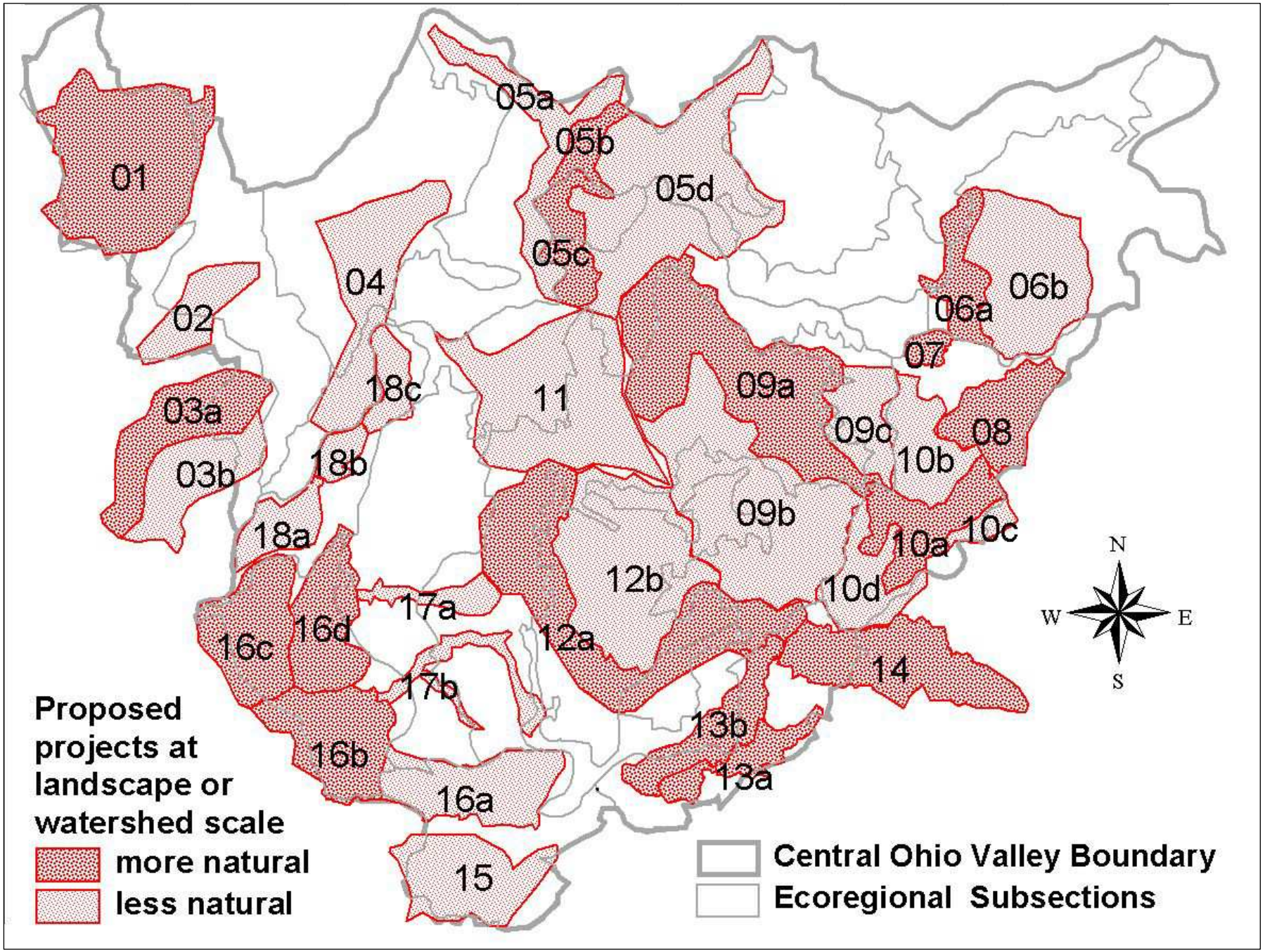
Some priorities for protection of more natural lands are obvious across the region, given the contrasts with farmed or urban lands. There are limited areas that have relatively wild conditions, such as along Palisades of the Kentucky River, but more degraded habitats also deserve restoration, including some headwater streams and remnants of native vegetation on largely farmed uplands. Much effort has gone into purchasing land or securing easements, with the state's Heritage Land Conservation Fund playing a significant role during recent decades, together with varied non-profit organizations and county governments. However, the Fund is now severely cut and there are problems with issues of management at the protected sites. Griffith Woods and Jessamine Creek Gorge are among the most significant sites on uplands of the central Bluegrass and along the Palisades, respectively. Yet it has been difficult even here to build consensus, especially for management of old fields and open woods that are prone to invasion by alien bush honeysuckle and then winter-creeper (*Euonymus fortunei*) in deeper shade. While reforestation may be a reasonable goal in some areas, how will we reduce the invasion of aliens? And if we are to maintain some open areas with naturalistic browsing or burning—rather than just mowing—how can we best do that? These central questions for the ecology and economy of designed natural areas are not being addressed by regular gatherings of interested people across the region.

The situation would be improved if 'targets' for conservation were defined and assessed more clearly through professional meetings and public outreach. Within protected tracts, we need clearer priorities for restoration of defined habitats. And within habitats that are at least partly restored, we need clearer priorities for recovering selected natives and for reducing selected aliens. Obvious but challenging examples of plants for recovery are the native clovers, which used to depend on browsing and trampling of the vegetation. We need long-term research into how disturbances of various types can influence the balance of such natives versus the aliens. This work deserves much more focus by HLCF, the Kentucky Organization of Field Stations and others. It should be possible to integrate plans for landscape protection, habitat restoration and species recovery.



Lower Licking River near Falmouth in summer, free-flowing through the Eden Shale Hills, still with rare mussels, especially in riffles.

Kentucky River Palisades in winter: most extensive wild area of the Inner Bluegrass, but mostly impounded and farmed up to the cliffs.



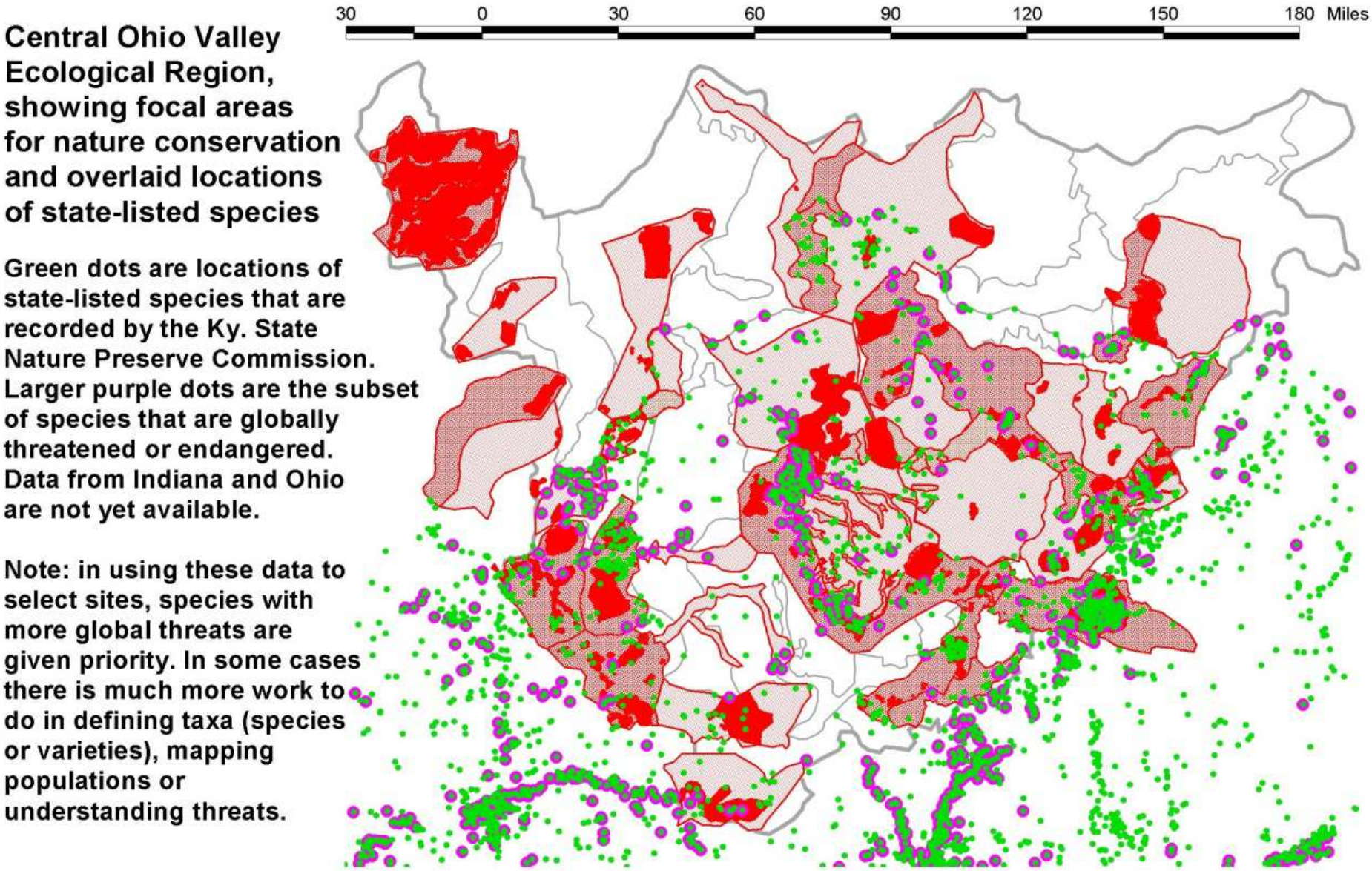
See Appendix 2 for listing of numbered project areas and their provisional names (developed or modified by the author in some cases).

TARGETS. At the broad landscape level, there are clear priorities in some of the hills or 'knobs' around the Bluegrass, especially the 'Brown County Hills' and upper Blue River* watershed of Indiana; in Ohio, the 'Edge of Appalachia, Brush Creek and Shawnee State Forest area'; in Kentucky, the Kinniconick Creek* watershed, the knobs and hills along the Licking River* and lower Red River*, Berea Knobs (and 'Central Kentucky Grasslands'), upper Green River* corridor, and Rolling Fork*-Fort Knox-Bernheim Forest area. Within the Bluegrass proper, extensive natural areas (with 1000s of acres) are less feasible but remain possible along the Great Miami River corridor in Ohio; near the Ohio River, in Kentucky along the Oldham & Trimble County bluffs and on the 'Big Bone Hills' of Boone County; also along the Kentucky River Palisades and the lower Licking River* corridors. Only a few of these areas contain relatively intact watersheds where concentrations of imperiled aquatic species still survive, as marked by asterisks (*). Currently, active projects that have at least one full-time staff person are focussed on the Brown County Hills, Blue River, Edge of Appalachia, lower Licking River River, Berea Knobs (with Army Depot) and Rolling Fork-Fort Knox-Bernheim areas. It has been more difficult to maintain such large projects within the central Bluegrass, including the Kentucky River Palisades. TNC has been working there for over 30 years, and recently indicated that its "Master Plan" would be completed by 2013, but there is still little collaborative outreach.

In several sections of the Central Ohio Valley, especially on more level land with more human development, there is virtually no potential for large intact naturally functioning landscapes or watersheds. However, careful attention to remnants of natural habitats can suggest a series of 100-1000 acre sites where varied components of the original landscape could be restored. This process of selection, protection and restoration of degraded components has been particularly challenging to conservationists within the region, because public funding for our profession tends to be diverted away to less degraded landscapes in other regions, where success tends to be more readily claimed in terms of "protected acres" per dollar spent on land purchase, and where management issues tend to be less intense.

Kentucky River below High Bridge: larger streams used to have distinctive grassy banks, but impoundments have reduced them.

Duncannon Road Swamp (Madison Co.): small wetland remnants tend to be overlooked, but this one has been partially protected.



Outline of prioritized areas for conservation (red), together with overlay of species that are state-listed (green) and globally imperied (purple). This is a provisional work-in-progress. We need to synthesize data from Natural Harutage Programs in Kentucky, Indiana and Ohio to compare state-rankings, to improve global rankings and to apply data for selection of areas.

At the habitat level, restoration is often needed to supplement programs of direct land protection at larger scales. For example, it is important to focus on general enhancement of riparian vegetation at selected sites for watershed projects. But priorities for protection and restoration of smaller sites with special habitats are often disjunct from larger project areas. In less rugged landscapes, such degraded riparian zones or wetlands can form locally significant remnants. Distinct conditions used to occur in diverse types of streamheads, seeps, seasonal ponds, flatwoods, swamps and oxbows before settlement reduced or damaged them. Better examples are often neglected in conservation yet could be restored to some ecological function. Disjunct habitats also include some individual cave systems, and remnants of more open or disturbed native woodland and grassland, especially on more fertile and intensively farmed soils.

On drier ground, especially hills, prevalent forest types may not need much site-specific focus. However, the overall balance of older growth versus younger trees for timber (and maples versus oaks) is often a controversial matter, at least on public land. It is also important to seek more consensus on the appropriate use of burning versus browsing—or both—for restoring more open grassy vegetation, where many rare plants and animals did prosper in disturbed habitats. The few remnants of such vegetation are often overlooked in broader planning. Remnants include scattered rights-of-way where rare plants can be rescued for transplantation to safe sites, and for wider propagation. There used to be a zone of grassland along foothills around the Bluegrass, especially on or near Silurian dolomite, but good remnants are restricted to only a few 10-100 acre sites, and most are not yet protected or restored, except at the 'Edge of Appalachia' in Ohio, 'Pine Creek Barrens' and 'Bouteloua Barrens' in Kentucky. On more fertile uplands, especially phosphatic limestones, there was unusual woodland with much disturbance from large herbivores, but apparently little or no fire. Griffith Woods is our best opportunity for restoration of something like the original woodland, perhaps using livestock eventually to simulate effects of elk, bison and mastodon, but it has been difficult to develop a collaborative vision for this challenging site.

Cane replanted in old pastures at Griffith Woods (Harrison Co.); this woody grass used to dominate openings within Bluegrass Woodland

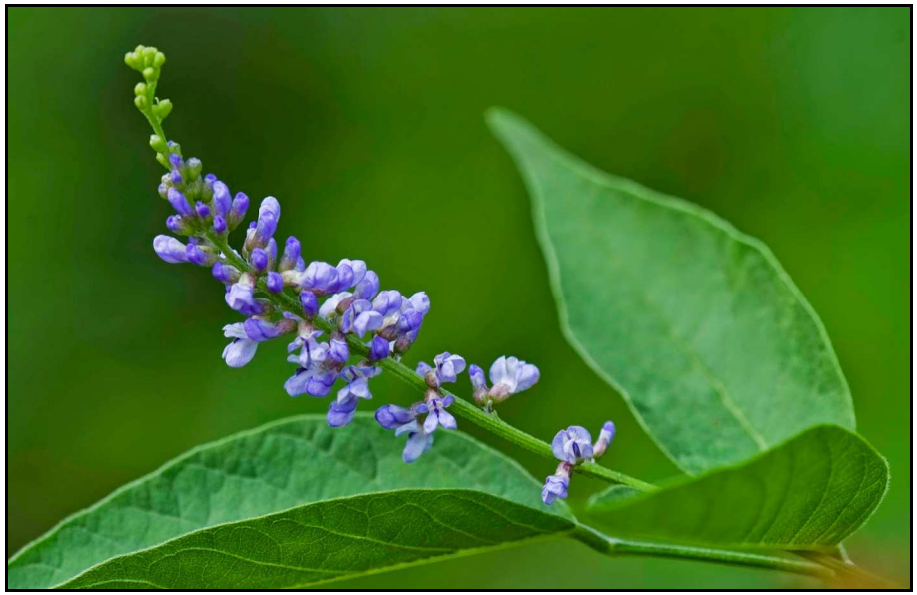
Dolomitic grassland remnants on Harmon's Lick Road (Garrard Co.); much mowed grass and hayfield here still has abundant native plants.

Imperiled Species for Recovery. At the species level, there are several priorities for recovery of imperiled species—or for reduction of invasive aliens. The appendices provides lists for various groups of globally rare plants and animals, together with some indication of which species deserve most attention for 'micro-management' (i.e. focussed recovery in the wild or even artificial propagation), as opposed to just land protection and habitat restoration. These lists are relatively complete for vascular plants, vertebrates and gastropods, but remain poorly known for most lower plants and invertebrates.

Among vascular plants, the most obvious examples for focused recovery include globally rare species that are typical of browsed or burned woodland and grassland. These species have somewhat distinct ecological groupings in central Bluegrass, Eden Shale hills, western and eastern Knobs (see Appendix 3). In riparian zones, in wetlands and especially in diverse habitats along wooded ravines, there are several other species with global rarity, but few of these are high priorities for micro-management since their habitats are generally somewhat secure. If species with more local rarity are considered as well, then wetlands do also provide a significant cluster that deserves attention (as detailed at bluegrasswoodland.com). Moreover, the demise of chestnut on drier sites is now being followed by hemlocks, ashes and walnuts, so we must now collect seed from these trees and breed for resistance to pests and pathogens. And genetic diversity within these tree deserves deeper analysis.

It would be good to organize nurseries, arboreta and botanical gardens around such efforts. Local universities could lead some of this work, based partly at their herbaria, but systematic botany has dwindled across most of the region. With interests often diverted to other regions, botanists in Kentucky have tended to overlook natural history of the Bluegrass region. But there is a wealth of ecological information that can be extracted from early land surveys, and a few early botanists did make detailed observations. The notes and collections of C.W. Short and his colleagues during 1820-1850 provide much insight to the original vegetation. When reviewing which rare plant species now deserve most attention for recovery, we need to include all of this evidence from the region.

Trifolium kentuckiense (from Franklin Co.) in garden of the author; we need a recovery program for this highly endangered species.



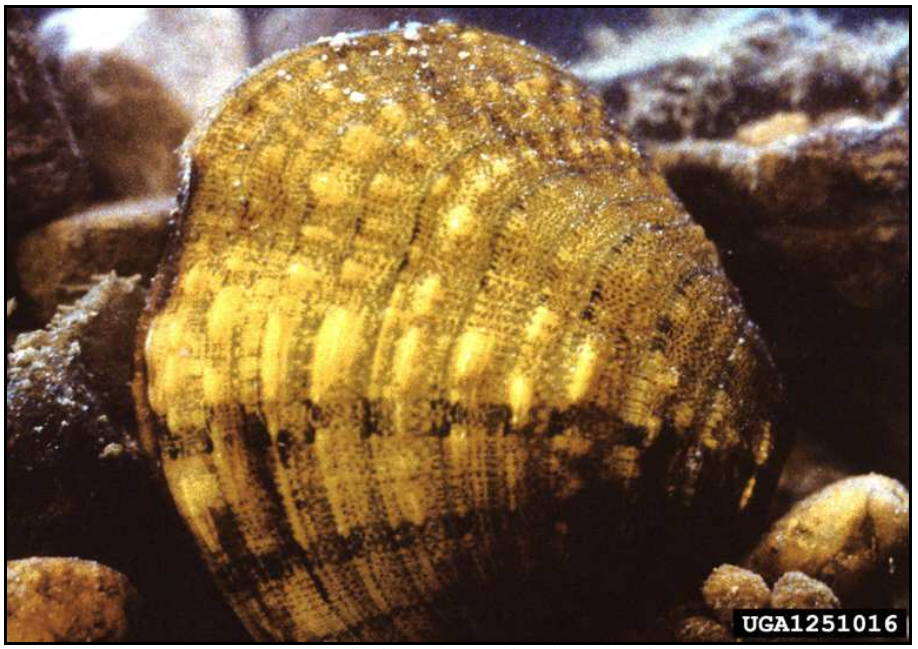
Orbexilum onobrychis, rare grassland plant; the related *O. stipulatum* grew at Falls of the Ohio River, but is now perhaps globally extinct.

Among vertebrate animals, the most obvious examples for focussed recovery are the globally rare fish species that have disappeared from large sections of most river systems (see Appendix 4). Small rare fishes are generally hard to raise, but some progress is being made at the Wolf Creek National Fish Hatchery in Kentucky. Several herptiles are also globally or locally rare, and artificial enhancement of their habitats, or even raising them from eggs, could be considered.

There are several rare, imperiled or locally extinct birds and mammals, but plans for direct recovery are generally not feasible. A few moderately large species with some public interest have already been reintroduced with considerable success across Kentucky—or allowed to recover alone: turkey, grouse, quail, beaver, and the more controversial coyote replacing the eliminated wolf. For smaller species (especially sparrows, warblers and bats), protection or restoration of habitat has higher priority than direct recovery. The impending catastrophe for most bats due to fungal disease (white-nose syndrome) appears largely unavoidable, but much relevant research is being conducted—there is interest in potential biological control using other fungi (US Fish & Wildlife Servie 2012). For larger vertebrate species (especially bison and elk), artificial simulation of their effects using livestock is a much more reasonable avenue for experiment than reintroductions.

Among invertebrates, obvious priorities for focussed recovery are the imperiled species of mussel (see Appendix 4). Several of these species are now being artificially grown with support from appropriate government agencies. But in many other taxonomic groups, there is still a basic need for more intensive inventory. For example, some globally rare—or little known—species of lepidoptera are known to live on infrequent to rare plants typical of grassland remnants or thin woodland, such as *Orbexilum onobrychis* (*Hystricophora loricana* and *Schinia* sp. nov.), *Baptisia* or related Fabaceae (*Callophrys irus*), *Cirsium* spp. (*Calephelis muticum*), *Eryngium yuccifolium* (*Papaipima eryngii*), *Liatris spicata* (*Papaipema beeriana*), *Packera obovata* or related Asteraceae (*Calephelis borealis*), *Silphium terebinthinaceum* (*Papaipema silphii*) and *Viola pedata* (*Speyeria idalia*).

Ammocrypta pellucida (Eastern Sand Darter): up to about 5 cm long. This was formerly widespread in the upper Mississippi River and Ohio River watersheds, plus parts of the Great Lakes. However, it is becoming globally threatened. Small populations may remain within the lower Licking River and Rolling Fork of Salt River.



Cyprogenia stegaria (Fanshell): up to about 5 cm long. This is a globally endangered species of mussel that used to be widespread in larger streams of the Ohio River watershed. The only viable population remaining within the Central Ohio Valley appears to occur within the lower Licking River.

Alien Species for Reduction. In addition to pests and pathogens, aliens in this region include several invasive plants. Strategies to reduce them—let alone control them—are not clearly established in some cases. The most severe problems range from *Myriophyllum spicatum*, *Naias minor* and other aquatic plants, to honeysuckles, privets, sericea lespedeza, sweet clovers, spotted knapweed and Johnson grass on uplands. There are fewer species in deeper shade, but they include the garlic mustard (common on N-rich soils), purple winter-creeper (spreading on base-rich soils), Japanese stilt-grass (widespread especially on medium acid soils), and Japanese chaff-seed (spreading in riparian woods near the Ohio River). While herbicides or other methods do exist to reduce such plants, we need sustainable programs to provide adequate long-term control, and there are fundamental questions of economy and ecology that must then be addressed.

It would be good to use appropriate 'macro-management' of whole habitats for reduction of aliens, rather than more expensive 'micro-management', if we can demonstrate real advantanges. However, much basic research is still needed. For example, problematic aliens include several evergreen vines, and there is circumstantial evidence that these species, in general, can be reduced by intensive browsing during the winter. Simple experiments with livestock—or perhaps deer-exclosures—should be used to explore potential effects. There is also some evidence that intense browsing can reduce bush-honeysuckles, especially in shade, but, again, there has been no definitive research yet on this potentially important effect. .

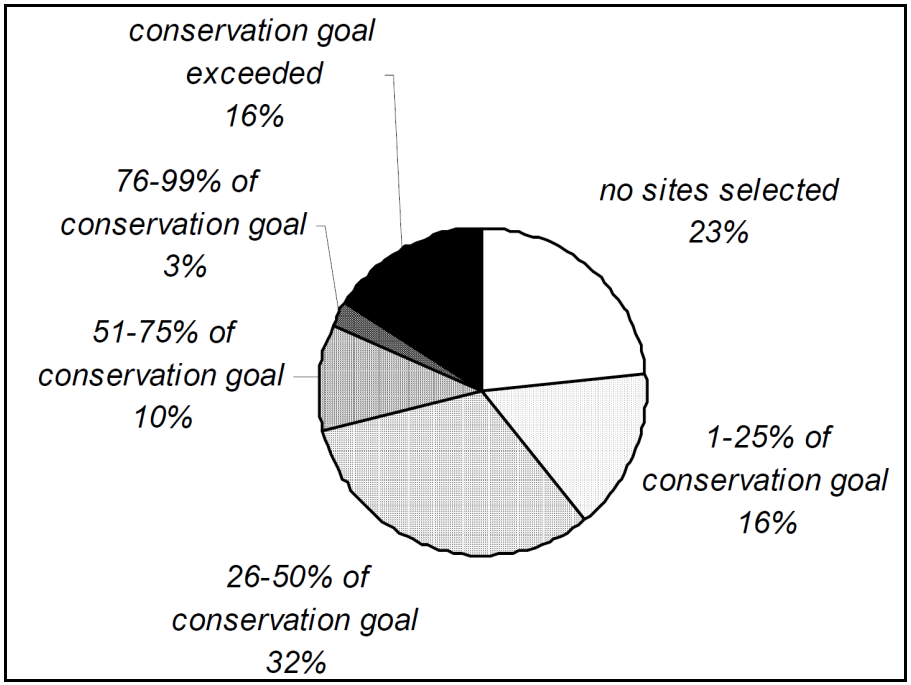
Direct micro-management of problematic alien species other than plants may be futile in most cases. Among vertebrates, the common alien mammals (cats, dogs, hogs), birds (starlings, sparrows), herptiles (Cincinnati lizard) and fish (carp, trout) may not provide devastating biological or ecological effects, except perhaps in the case of hogs—which have been successufully reduced at Bernheim Forest during recent years. It is claimed that reduction of feral cats by coyotes can aid recovery of bluebirds in suburban areas. The diverse serious problems caused by some alien invertebrates, pests and pathogens are outside the scope of this introductory discussion.

Euonymus fortunei (wintercreeper) has even invaded secluded parts of the Kentucky River Palisades, here at Boone Creek (Fayette Co.).

European Wild Boar (*Sus scrofa*): being trapped at Bernheim Forest.

TRADEOFFS. While there is uncertainty about whether human beings can solve some problems of conservation, we can frame the most important questions that divide us, seek more consensus—or at least balance—and develop mutual support. Regular meeting, effective communication and friendly debate would all help these causes within the Central Ohio Valley. More information should be combined from Kentucky, Indiana and Ohio, despite the 'ownership issues' for data that sometimes hinder such work. In some areas, taxonomic inventory and ecological analysis are still urgent matters, for guiding more balanced conservation across the region. In defining targets, we often ascribe significance to large continuous blocks of wilder land, but this rationale is generally based on ecological supposition rather than clearly demonstrated facts, and on economic arguments given lower costs per acre for acquiring and managing larger tracts. The recent protection of large tracts along river corridors is commendable, but smaller sites with special significance can be overlooked on less rugged land with more fragmentation. Small remnants of natural wetlands with varied conditions, and of more open grassy woodland (with bur oak or post oak), are easily ignored in state-based or federal programs. Moreover, it can be difficult to promote habitats that need regular burning or browsing for restoration, since prescribed fire is often expensive and management of wild or domestic ungulates in natural areas is generally difficult. Yet small remnants of native woodland or grassland can still habor globally imperiled browsing-enhanced plants, such as *Trifolium kentuckiense, Solidago shortii* and *Leavenworthia exigua* var. *laciniata* (all endemic to this region), plus many rare invertebrates.

In estimating effects of human actions and associated environmental factors on targets, beyond just habitat destruction, there are several obvious scientific problems that remain controversial topics and deserve more coordinated research. Through TNC's ecoregional planning and ongoing discussion, the most important areas of uncertainty have begun to emerge. For the community, it is particularly important to assess human effects that influence—or are influenced by—public funding. Some of the critical questions can be articulated as follows [see next page].



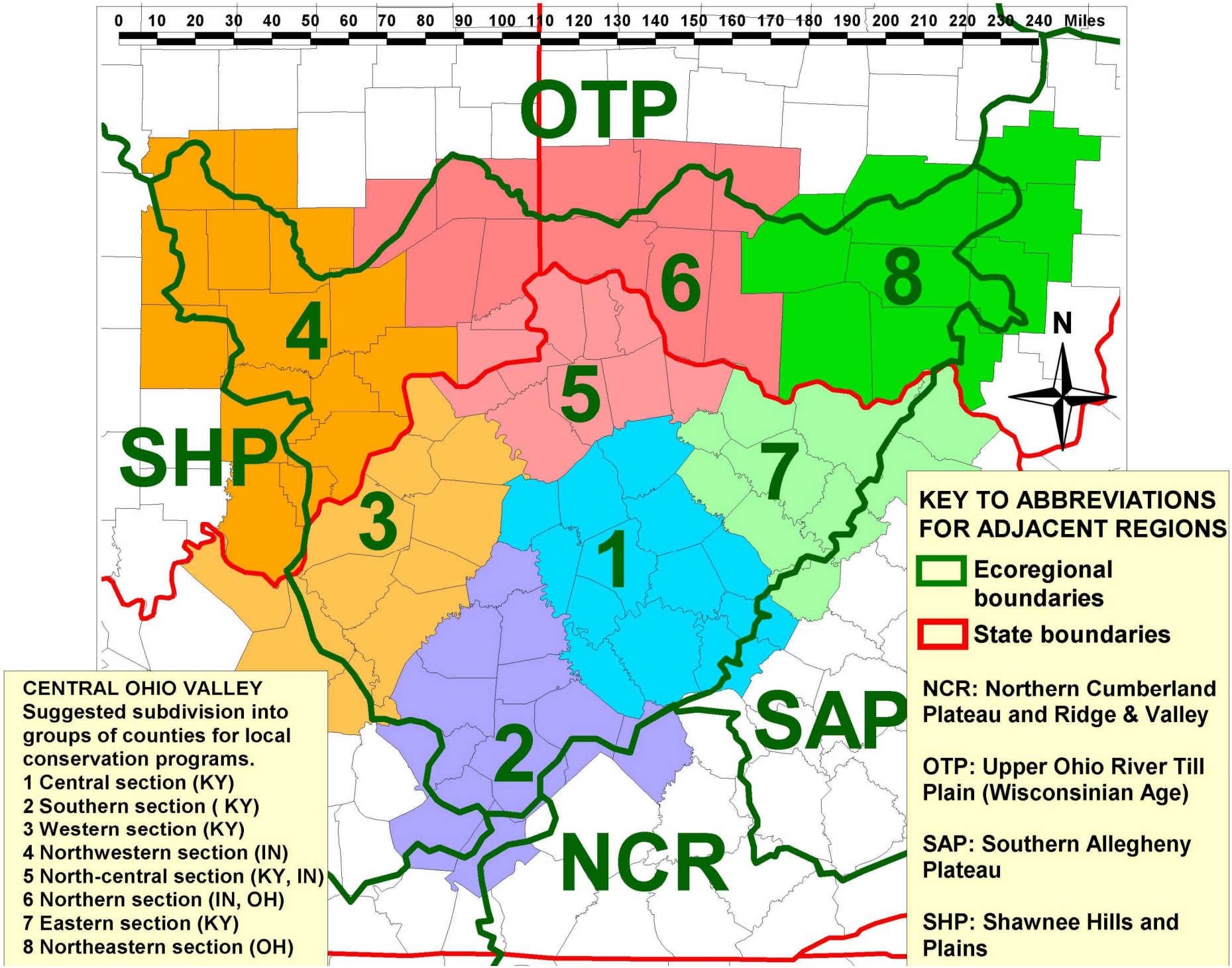
Above: diagram from TNC's 2001 Conservation Plan for the Interior Low Plateaus. It summarizes the percentages of all defined "targets" (landscapes/watersheds, habitats, species) that would be "protected" if this initial plan was implemented, within some unspecified period of time. But given inadequate information about many targets, the text of this plan retained a high degree of uncertainty. It concluded: "The Core Team will have the responsibility for ensuring that future iterations of the plan are completed on a periodic basis. It is reasonable to expect that, given the gaps in data identified above, the next iteration of the portfolio should be done in 5-6 years. This proposed schedule would allow for the state offfices to incorporate newly acquired data and revised priorities into their strategic planning as soon as possible. Following the next revision, future revisions may not need to be as frequent." There is no evidence that TNC has done any systematic assessment or update, now 15 years later. This author contends that regular reporting among partners across ecoregional sections is essential for good science and for building our community.

These five items are derived from an ecological viewpoint.
1. Can we design cost-efficient control of invasion by horticultural escapes in fragmented natural vegetation of farmland and suburban land (*Lonicera maackii, Euonymus fortunei, E. alatus, Ligustrum sinense, Ailanthus altissima*)? *
2. How can ungulates be managed to simulate natural interactions in woodlands and grasslands, especially on eutrophic soils that have potential for locally concentrated effects (with reduction of aliens)? *
3. How can fire be applied at appropriate intervals to restore native grasslands and open woodlands across their full presettlement range of sites, from hydric to xeric (ideally with reduction of aliens)? *
4. How can the entrenched impacts of dams and land-uses (clearance, farming, urban development) on large watersheds and aquatic biota (especially mussels) be mitigated?
5. How are changes in climate influencing ecosystems, and what are the implications for conservation plans?

From a more economic viewpoint, how can timber, other forest products and native plants be effectively marketed across the region? In more open habitats, how can management for game animals be combined optimally with use of fire to restore vegetation. And can we find some economic uses for material from invasive plants—perhaps involving use of livestock to browse out brushy alien thickets? If we are to develop sustainable economies, several critical themes will need continual attention. It has been difficult to demonstrate truly sustainable timber production that retains some old growth and other significant natural features. Indiana's Brown County Hills and Blue River programs, Ohio's Shawnee State Forest and Kentucky's Berea Forest are making some progress with such programs. Similar efforts by TNC in Kentucky were suspended due to lack of interest or due to disagrements among staff and partners. A broadly transparent, community-based evaluation of such programs will be needed for decades to come. Biological monitoring of conserved lands will be critical, especially if novel legal or financial mechanisms are used to establish protection and to guide stewardship. For example, it will important to determine how declining species of birds fair on these lands, and if alien plants are controlled.

Running buffalo clover, grown experimentally in the nursery at Griffith Woods in 2007, then not continued due to lack of support.

Warm-season grasses native to more western regions are often grown by TNC and other in old fields in the Bluegrass region, but this is best viewed as a reasonably transitional land use, not true restoration.


0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 Miles
OTP
SHP
SAP
NCR
1
2
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4
5
6
7
8
N
CENTRAL OHIO VALLEY
Suggested subdivision into groups of counties for local conservation programs.
1 Central section (KY)
2 Southern section (KY)
3 Western section (KY)
4 Northwestern section (IN)
5 North-central section (KY, IN)
6 Northern section (IN, OH)
7 Eastern section (KY)
8 Northeastern section (OH)
KEY TO ABBREVIATIONS FOR ADJACENT REGIONS
Ecoregional boundaries
State boundaries
NCR: Northern Cumberland Plateau and Ridge & Valley
OTP: Upper Ohio River Till Plain (Wisconsinian Age)
SAP: Southern Allegheny Plateau
SHP: Shawnee Hills and Plains

This table and map (on preceding page) outline regional subsections for general coordination among conservation-minded people. With ca. 10-12 counties each, this scale is reasonable for local leadership..

Practical Subdivisions of Shawnee Hills and Plains for Locally Coordinated Conservation	
Suggested Name (provisional)	**Larger Focal Areas and Other Notable Sites**
1: Central Bluegrass & SE Knobs (KY)	Kentucky River Palisades (most), South Fork of Licking River, Bluegrass Army Depot, Berea Forest, Pilot Knob, etc.
2: Southern Bluegrass & Knobs (KY)	Kentucky River Palisades (west side), upper Rolling Fork of Salt River, 'Bouteloua Barrens', other dolomitic grassland remnants
3: Western Bluegrass & Knobs (KY)	Rolling Fork-Fort Knox-Bernheim Forest area (with Jim Scudder Glade etc.), other natural areas & parks in greater Louisville area
4. Northwestern Knobs & Plains (IN)	Brown County Hills of Indiana, upper Blue River watershed, several smaller natural areas and parks in southern part
5. North-central Bluegrass (KY,IN)	Big Bone Hills, Lower Licking River watershed (lowest section)
6. Northern Bluegrass & Glacial Transitions (IN,OH)	Great Miami River Corridor, many other natural areas and parks in greater Cincinnati area
7. Eastern Bluegrass & Knobs (IN)	Lower Licking River watershed (main section), Crooked Creek area, Kinniconick Creek watershed
8. Northeastern Bluegrass & 'Edge of Appalachia'(OH)	Edge-of-Appalachia (and associated sites), Brush Creek watershed, Shawnee State Forest

SUMMARY. These notes outline challenges for nature conservation across the 'Central Ohio Valley'—defined here as the Bluegrass region and surrounding Knobs, plus transitions to adajcent regions (on lower Mississippian strata and on glacial till). This region is highly diverse in its geology, soils and natural vegetation, and it deserves more networking of conservationists with more coordinated field trips, more regular meetings and more objective assessment of progress. Without such interaction, important biological or ecological details are often being overlooked, and there is often a lack of consensus about how conservation projects should proceed.

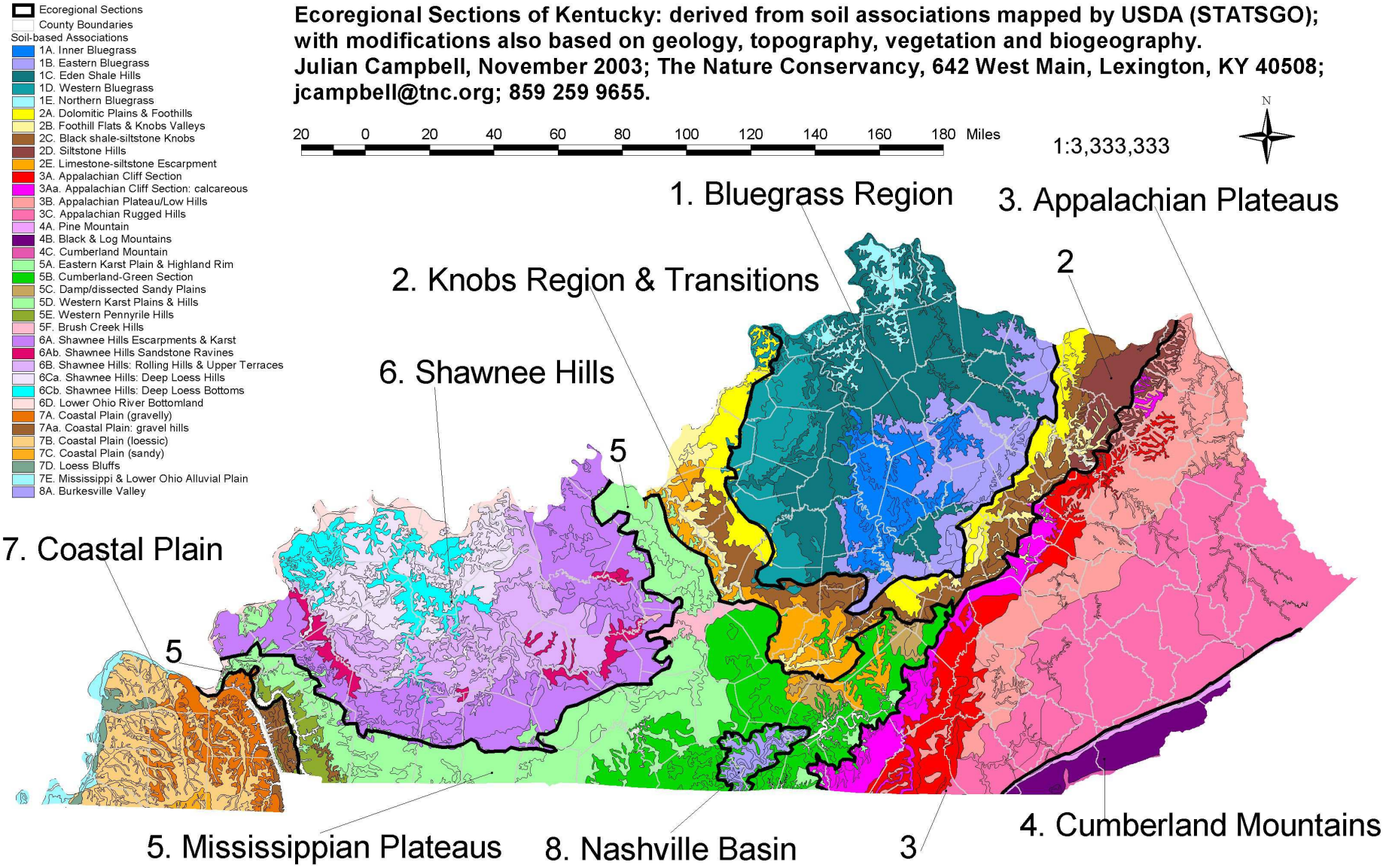
At the core of all conservation planning, we must strive to define relatively simple but meaningful 'targets'—in terms of larger landscape blocks or watersheds, of habitat types that most need restoration (even after land protection), and of species-groups that most deserve 'micro-management' (even after habitat restoration). Some updating is attempted here, based initially on TNC's 2001 ecoregional plan for the Interior Low Plateaus. However, without more regular pooling of data among Natural Heritage Programs and other local conservation biologists, it is impossible to provide a definitive report. There are several staffed conservation projects that cover large blocks of land (notably Brown Co. IN; Bernheim Forest etc., Berea Knobs etc., and Lower Licking River in KY; Edge of Appalachia and Shawnee State Forest in OH). But many scattered smaller sites of high significance have little or no protection.

Fundamental problems that have not yet been generally resolved among conservationists include: search for cost-efficient control of invasive plants; use of ungulates to simulate natural interactions in native vegetation; use of fire at appropriate intervals for restoration mitigation of entrenched impacts on watershed from dams and land-uses; understanding how changes in climate will influence ecosystems. More economic problems include: potential for sustainable timber (especially on state forests), other forest products and native plants to be effectively marketed across the region; optimal management of game animals, especially in more open areas with prescribed fire; and potential uses for invasive plant material (e.g. perhaps browsed by livestock or burned for local biofuel).

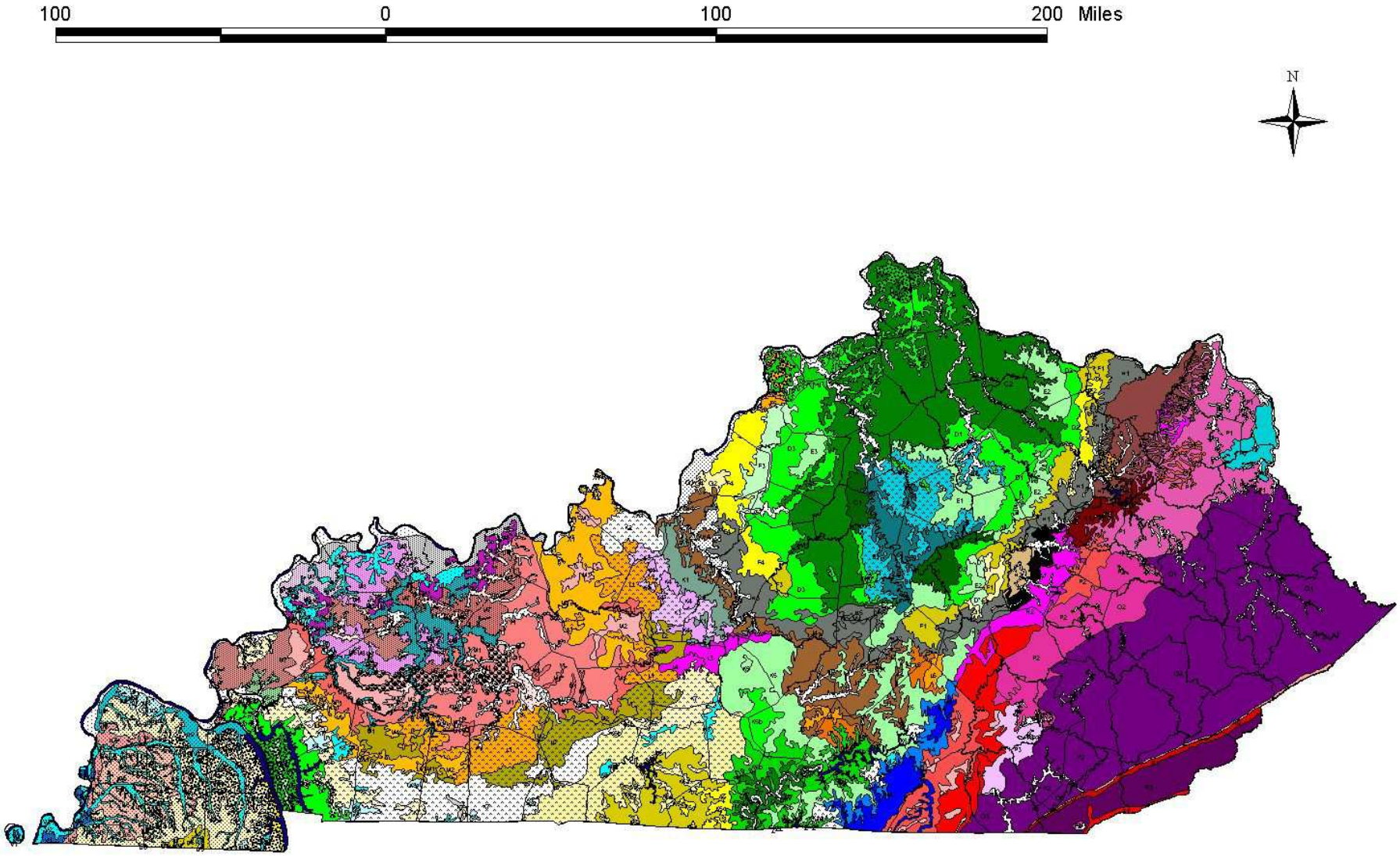
Berea Forest (based in Madison Co.): almost 9000 acres are owned and managed by Berea College for sustainable timber production. "A white oak giant is felled... to be part of the refurbished Mayflower II."

Sheep in the Olmstead Parks of Louisville ca. 1900-1905; plans to continue this potentially useful management were not continued.

APPENDIX 1A. Ecoregional Sections of Kentucky; from the Atlas by Campbell & Medley (2012).



APPENDIX 1B. Land Type Associations of Kentucky, adapted from STATSGO mapping of NRCS.
This is a highly reduced version of a much larger map; for details please contact the author.




KY LTA Legend
A. Inner Bluegrass Ravines
B1. Inner Bluegrass Plains
B2. Inner Bluegrass Valleys (Elkhorn)
B3. Inner Bluegrass Valleys (Licking)
C1. Garrard Siltstone Hills
C2. Eden Shale Hills
C3. Lower Kentucky Valley
C4. Lower Licking Valley
C5. Lower Licking Valley
C6. Licking River Ravine
C7. Salt River Valley
D*. E Bluegrass-Damp Flats Transition
D1. E Bluegrass-Eden Shale Hills
D2. Eastern Bluegrass Hills
D3. Western Bluegrass Hills
D4. Western Bluegrass Ravines
D7. Burkesville Valley Slopes
E1. East-central Bluegrass Plain
E2. Eastern Bluegrass Plains
E3. Western Bluegrass Plains
E4. Illinoian Till Plain (on limestone)
F1. Dolomitic Foothills
F2. Eastern Dolomitic Plains
F2. Dolomitic Foothills
F3. Dolomitic Plains
F5. Western Dolomitic Ravines
F6. Illinoian Till Plain (on dolomitic paleosol)
G1. Eastern Foothill Flats
G2. Louisville Lowlands (upper)
G3. Louisville Lowlands (lower)
G4. Louisville Lowlands (loess terrace)
H1. Black shale-siltstone Knobs
H2. Black shale-siltstone Knobs
H3. Black shale-siltstone Knobs
H4. Black shale-siltstone Knobs
H5. Black shale-siltstone Knobs
H6. Black shale-siltstone Knobs
H7. Siltstone Hills
I1. Bottomland in the Knobs
I2. Lower Salt Rv Bottoms & Terraces
I3. Calcareous Terraces (Licking Rv)
I4. High Terraces of Licking Rv
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)
K1. N. Shaley Karst Plain Transition
K11. Eastern Karst Plain
K12. Eastern Karst Plain (wet)
K13. Dissected Cherty Calcareous Plain
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
L2. Dripping Springs Hills (loessic)
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
N1. Silt- & Sandstone Cliff Section
N2. N Lime- & Sandstone Cliff Section
N3. Lime- & Sandstone Cliff Section
N4. Lime- & Sandstone Cliff Section
N5. Limestone Escarpment
N6. High Sandy Terraces (wet)
O1. N Sandstone Cliff Section
O2. Sandstone Cliff Section
O3. Sandstone Cliff Section
O4. Dissected Plateau (Corbin Sandstone)
O5. Undissected Cumberland Plateau
O5b. Undissected Plateau (Corbin Sandstone)
P0. Calcareous Shale Hills
P1. N Low Hills Belt
P2. Low Hills Belt
P3. London-Corbin Plain
P4. Appalachian Bottomland
P5. Vandalian Bottomland
Q1. N Rugged Eastern Hills
Q2. Rugged Eastern Hills
Q3. Jellico-Wartburg Mountains
Q4. Bottomland in Rugged E Hills
Q5. Wartburg Mts-Plateau Transition
R0. Pine Mt Base
R1. Pine Mountain
R2. Cumberland Mountain
R3. Black & Log Mountains
U1. Gravelly Uplands (on limestone)
U2. Gravelly Hills (on limestone)
U3. Gravel Hills
U4. Loess/gravel Rolling Uplands
U5. Loess Plains
U6a. Loess Rolling Uplands
U6b. Loess/sand Rolling Uplands
U7. Loess Hills
U8. Upper Coastal Plain Bottomland
U9a. Clarks River/Cypress Creek Wetlands
U9b. Loess Terraces
U9c. Loess Terrace Wetlands
U9d. Lower Obion Creek Wetlands
V1. Mississippi River Wetlands
V2. Mississippi River Terraces
X1. Ohio River Bottomland
X2. Lower Ohio River Bottomland
X2b. Lower Ohio River Terraces
X3. Central Ohio River Bottomland
X4. Central Ohio River Bottomland
X5. Upper Ohio River Bottomland
X6. Upper Ohio River Terraces
Y1. Bottomland in Shawnee Hills
Y3. Lower Cumberland River Bottomland
Y5. Central Cumberland River Bottomland
Z. Water

APPENDIX 2. Proposed projects at landscape or watershed scale

See map above (page 9) for locations. There is a division into areas with more concentration of natural features or with much potential restoration, versus areas with less concentration but with some potential to base local environmental operations. Asterisks below (*) indicate the areas with more concentration of natural features.

1. Brown County Hills (Indiana)*
2. Tater Knobs area (Indiana)
3a. Blue River watershed: north/west (Indiana); extends downstream*
3b. Blue River watershed: south/east (Indiana); extends downstream
4. Southeast Indiana Flats & Ravines (Indiana)
5a. Greater Cincinnati area: western (Ohio)
5b. Great Miami River corridor (Ohio)*
5c. Big Bone Hills (western Boone County, Kentucky)*
5d. Greater Cincinnati area: eastern (Ohio)
6a. Edge of Appalachia & Brush Creek area (Ohio)*
6b. Brush Creek & Shawnee State Forest area (Ohio)
7. Crooked Creek Prairies & Manchester Island (Kentucky)*
8. Kinniconick Creek watershead (Kentucky)*
9a. Lower Licking River: Eden Shale corridor (Kentucky)*
9b. Lower Licking River: Bluegrass section south (Kentucky)
9c. Lower Licking River: Bluegrass section northeast (Kentucky)
10a. Lower Licking River: Knobs corridor (Kentucky)*
10b. Lower Licking River: Knobs north (Kentucky)
10c. Lower Licking River: Knobs east (Kentucky)
10d. Lower Licking River: Knobs south (Kentucky)
11. Lower Kentucky River and Eagle Creek Corridors (Kentucky)
12a. Kentucky River Palsiades (Kentucky)*
12b. Elkhorn Plain and Elkhorn Creek watershed (Kentucky)
13a. Berea Knobs (Kentucky)*
13b. Central Kentucky Grasslands (Kentucky)*
14. Red River watershed (Kentucky); mostly upstream of COV*
15. Upper Green River corridor (Kentucky); mostly downstream
16a. Upper Rolling Fork watershed (Kentucky)
16b. Lower Rolling Fork watershed (Kentucky)*
16c. Fort Knox-Lower Salt River area (Kentucky)*
16d. Bernheim Forest-Cedar Grove area (Kentucky)*
17a. Salt River corridor, main stem (Kentucky)
18a. Louisville Lowlands, with urban-suburban parks (Kentucky)
18b. Oldham County Bluffs and Harrods Creek (Kentucky)
18c. Trimble County extension (Kentucky)

APPENDIX 3. Globally Rare Terrestrial Species.
These are provisional notes on estimated G1 to G3G4 species, based on Natural Heritage Data that was summarized by TNC (2001), plus general knowledge of the author. The lists of sites are not comprehensive (letters in parentheses are initially assigned ranks). Also, many other rare species of local interest are not listed, neither are the several tree species that have suffering great declines due to pests and pathogens (chestnut, hemlock, elms, walnuts, ashes). See general notes above on these other species. Several more or less extinct species in this region are not detailed here. They include several larger mammals (panther, bear, wolf, bison, elk, etc.) and some insects, notably *Nicrophorus americanus*, the American Burying Beetle (G2G3).

* Asterisks indicate plant species that may deserve some micro-management or propagation in gardens; ** more strongly deserving; *** largely dependent on such management to survive.

Suggested global status is indicated by provisional symbols that refine and update 'official' G ranks: g1 = critically endangered; g2 = endangered (typical G1); g3 = G1G2; g4 = typical G2; g5 = G2G3; g6 = typical G3; g7 = G3G4.

Abbreviations for regional sections and sites are as follows:
APP = largely in Appalachian transitions
COV+ = centered in Central Ohio Valley; locally extending elsewhere in ILP+
EBK = Eastern Bluegrass or Knobs
EOA = Edge-of-Appalachia
esp. = especially
GLA = Great Lakes area (southern parts)
ILP+ = centered in Interior Low Plateaus; often extending into midwestern regions and Appalachian valley.
inc. = including
MDW = centered in Midwest (esp. tall grass prairie-peninsula)
NBG = Northern Bluegrass
NVB = Nashville Basin
PAL = Kentucky River Palisades
OZA = Ozark region
R&V = Appalachian Ridge-and-Valley
SHH = Shawnee Hills (or Lower Ohio Valley)
WBK = Western Bluegrass or Knobs

A: FLOODPLAINS OR TERRACES

A1: Species typical of floodplains or terraces on rheic to submesic sites on base-rich soil in various regions (habitat classes 1,4,7); all require full sun.
Solidago rupestris (g7): esp. PAL.
**Sida hermaphrodita* (g5): NBG; EOA (B) "bigger & better minds need to think about this."
**Napaea dioica* (g6): NBG; Great Miami River Corridor; locally extinct.

A2: Species typical of floodplains on rheic to submesic sites on sandy soils in the eastern Knobs, within thin woods or along edges (habitat classes 1,4); these have largely Appalachian ranges within the Ohio River watershed.
Spiraea virginiana (g4): APP; Kinniconick Creek (A)
Cypripedium kentuckiense (g6): APP; Triplett Creek (A), Kinniconick Creek (A)
Aconitumm uncinatum (g5): APP; Kinniconick Creek (C)

Animals. The following declined or rare birds are typical of "riparian woodlands" (Ford et al. 2000): transients (e.g. acadian flycatcher, Louisiana waterthrush), Kentucky warbler, Swainson's warbler. Many aquatic species have also declined or disappeared from large sections of watersheds in this region; more globally rare species are listed below.

B: BROWSED OR BURNED WOODS

Species typical of browsed woods or edges, possibly with some burning on drier sites; mostly submesic to subxeric sites of Inner Bluegrass or similar sites elsewhere, with some extending onto xeric sites (habitat classes 7, 10 and diverse transitions).

****Trifolium stoloniferum** (g2): COV+; inc. Hidden Valley Lake IN (BC); Bluegrass Army Depot KY (B); Boone County Cliffs KY (B); Sulfur Well Wetland KY (B); mostly submesic thin woods with grazing or mowing or trails.
****Nabalus crepidineus** (g7?): ILP+; PAL, Great Miami River OH; mostly thin rich floodplain woods, locally along headwaters.
*****Trifolium kentuckiense** (g1): IBG endemic (2 sites); PAL transitions; rocky woods with much disturbance from cattle or deer.
****Paysonia** [*Lesquerella globosa*] (g3): IBG-NVB; Elkhorn Corridor KY (C); can be established on disturbed or rocky ground.
****Perideridia americana** (g6): ILP+; PAL; rocky upland woods.
****Onosmodium hispidissimum** (g7?): ILP+; esp. rocky pastures.
****Malvastrum hispidum** (g6?): ILP+; rocky pastures, roadsides

Animals. Although locally extinct, the larger animals of this woodland should be considered: bison, elk, bear, wolf and panther. They may never be reintroduced as free-roaming populations, but their ecological effects can be estimated and perhaps simulated through intelligent management using livestock.

C: LESS DISTURBED UPLAND WOODS (MOST IN HILLS)

C1. Species typical of wooded rocky ravines on mesic to xeric calcareous sites, especially Inner Bluegrass but also further out in some cases (habitat classes 5,11,12); most also occur in the Nashville Basin; most grow well in partial shade, but *Phlox bifida* is largely restricted to clifftops.
***Stellaria fontinalis** (g2): IBG-NVB; PAL; seeps on cliffs.
Cladrastis kentukea (g7): ILP+; PAL; rocky slopes
***Viburnum molle** (g7): ILP+; PAL; rocky slopes
***Phlox amplifolia** (g7): APP-OZA+; PAL etc.
***Boechera** [*Arabis perstellata*] (g3): IBG-NVB; PAL
Oxalis illinoensis (g5?): ILP; to be mapped; mostly more western
***Trillium nivale** (g7): MDW-ILP; PAL
***Draba ramosissima** (g7): R&V-PAL
Elymus svensonii (g5): IBG-NVB; PAL
****Paxistima canbyi** (g4): APP; PAL (Jess. Gorge); Berea College Forest KY (A); EOA OH (C)
***Viola walteri** (g6? in northern range); ILP+; PAL
Phlox bifida ssp. *stellaria* (g5): IBG-NVB; PAL (A)
Animals. The following mammals also tend to be observed most often in or near ravines, especially caves of the Palisades and along clifflines in the Knobs: *Myotis grisescens* (Gray Bat); *Myotis keenii* (Keen's Bat); *Myotis sodalis* (Indiana Bat); *Nycticeius humeralis* (Evening Bat); *Neotoma floridana magister* (Woodrat). The following declined birds are typical of larger forest blocks on uplands (Ford et al. 2000), especially in the Knobs or other hills around the Bluegrass, but they could gradually spread along the Kentucky River and Licking River, broader forest corridors are allowed to develop during future decades: e.g., cerulean warbler, worm-eating warbler, black-and-white warbler. Also, there are several invertebrates restricted to caves along the Kentucky River valley or in southeastern Ohio; see list appended below.

C2. Species of mesic ravines in the Knobs region, broadly defined, especially in se Ohio.
Sullivantia sullivantii (g6?) APP-OZA+; EOA; s IN

Animals. The green salamanders (*Aneides* aenias) occurs along siliceous clifflines in or near the "Edge of Appalachia"; there is a small extension west here from its largely Appalachian range.

D: THIN WOODLAND, GRASSLAND AND GLADES

D1. Species typical of thin woods and glades on submesic to xeric sites with less fertile soils, especially in Eden Shale Hills, dolomitic foothills to Knobs or similar sites further out
****Euphorbia purpurea** (g6) APP; EOA
****Orbexilum onobrychis** (g7) ILP+; scattered roadsides, remnants
****Trifolium reflexum** var. *glabrum* (g5) SE USA; virtually extinct across its northern range in COV, SHH, etc.
***Clinopodium** [*Satureja*] *glabellum* (Michx.) Kuntze (g6): ILP local
*****Solidago shortii** (g2) COV endemic; Blue River IN; Blue Lick Springs KY (A)
Viola egglestonii (g7?): ILP endemic; Pine Creek Barrens, Bouteloua Barrens, etc.; rare in PAL

D2. Species typical of thin woods and glades on submesic to xeric sites in the western Knobs
***_Orbexilum stipulatum_ (g0): Falls of Ohio; globally extinct?
**_Asclepias sullivantii_ (g6?): MDW; Floyd Co. IN (old record)?
*_Echinacea simulata_ (g7) ILP-OZA; Jim Scudder Glade etc.
*_Symphyotrichum pratense_ (g7): SE USA; Pine Creek Barrens, etc.
**_Leavenworthia exigua_ var. _laciniata_ (g3): WBK endemic; Pine Creek Barrens etc.)

D3. Species typical of thin woods and glades on submesic to xeric sites, mostly in the eastern Knobs but in several cases also extending to western Knobs
*?_Scutellaria arguta_ (g7?)" APP; note taxonomic uncertainty
Thaspium pinnatifidum (g6?): APP; EKN; Licking River etc.
Calamagrostis porteri ssp. _insperata_ (g5): COV-OZA; Harrison Co. IN (A); Virginia Pine / Chestnut Oak (IN, KY); Grassy Knob Ridge System KY (B); recheck Bernheim Forest.
Carex juniperorum (g5?): EKN-GLA; Bath Co. KY (A); Crooked Creek Barrens KY (C); EOA (A).
**_Rubus whartoniae_ (g4?): ILP; esp. on Devonian shale in Knobs; Jefferson Memorial Forest KY (C) on/near acid black shale outcrops; still needs taxonomic work.
**_Delphinium exaltatum_ (g6): CAP; EOA (A)
**_Silphium terebinthinaceum_ var. _luciae-brauniae_ (g5?): EBK; EOA
**_Agalinis auriculata_ (g5): MDW; EOA (A); Crooked Creek Barrens KY (C?)

Animals. Several declined birds of "grasslands and savannas" (Ford et al. 2000) would have occurred before settlement in more open land, especially on dolomitic foothills between the Bluegrass and Knobs: e.g., Henslow's Sparrow, grasshopper sparrow, loggerhead shrike, bobolink. Ford et al. (2000) also listed declined birds of "barrens, glades and old fields" (presumably with more bare or rocky ground and perhaps more brushy vegetation) but it is not clear how these habitats and faunas differ: e.g., blue-winged warbler, prairie warbler, Bewick's wren. They also listed prairie warbler and Bewick's wren for "short-rotation pine" as a distinct habitat type (largely artificial today). Ford et al. also made several inaccurate or illogical statements about habitat types, for example: (1) "Throughout the Bluegrass region, much of the habitat was blue ash-oak savanna (see Martin et al. 1993)"; (2) "Barrens and glades, however, represent stable early succession habitats." Curiously, in TNC's 2001 plan for the ILP, the only birds listed as official targets are loggerhead shrike and Bachman's sparrow, the latter only for AEDC in TN!

There are also several globally rare insects that probably used to be widespread in these habitats. Species with relatively recent records include the following.
Callophrys irus, Frosted Elfin (G3) in Garrard Co.; larval foods include the pea family (Fabaceae), indigo (_Baptisia tinctoria_), lupine (_Lupinus perennis_), and rattlebox (_Crotalaria sagittalis_).[2]
Hystrichophora loricana An Olethreutine Moth (G2G4) in Garrard Co.; feeds exclusively on scurfpea (_Orbexilum onobrychis_).

E: SWAMPY WOODS AND WETLANDS
Another broad habitat class with rare species comprises swampy woods and associated openings, especially on less fertile acid soils between the Bluegrass and adjacent Knobs or glacial plains. These areas have clusters of locally rare plant species, plus in northern and western transitions (including old records from the Greater Louisville area) several globally rare or declining animal species.
Gratiola viscidula (g7): ATL-OZA; Bath Co. KY; Rowan Co. KY; formerly Estill Co.

Animals.
(a) Louisville Crayfish (_Orconectes jeffersoni_): Jefferson Co. KY endemic; Beargrass Creek; Knob Creek
(b) Two snakes: Kirtland's Snake (_Clonophis kirtlandii_) and Copperbelly Water Snake (_Nerodia erythrogaster neglecta_); both largely in MDW and SHH.
(c) Bousfield's Amphipod (_Gammarus bousfieldi_): SHH+; Doe Run KY (Meade Co.); also known from Jefferson Co. KY; Clark Co. IN and southern Illinois.
(d) Some declined birds are typical of "forested wetlands" in general (Ford et al. 2000): e.g., cerulean warbler, yellow-billed cuckoo, Swainson's warbler, wood thrush.

APPENDIX 4. Globally rare aquatic fauna in each significant remaining watershed. These notes are based largely on TNC's plan for the ILP, plus miscellaneous other Natural Heritage data. Asterisks (*) indicates locally extinct, perhaps gone from this stream. Several species might be added after further review, for example, the Paddlefish (*Polyodon spathula*) used to occur in all larger streams of the Mississippi watershed; NatureServe lists this species as G4 but it has become rare or absent in major sections of its northern range.

Ohio River (main stem): details to be determined.
**Cryptobranchus alleganiensis*, Eastern Hellbender (G3G4)
**Acipenser fulvescens*, Lake Sturgeon (G3G4)
**Alosa alabamae,* Alabama Shad (G2G3)
Atractosteus spatula, Alligator Gar (G3G4)
Noturus stigmosus, Northern Madtom (G3)
**Cumberlandia monodonta,* Spectaclecase (G3)
Cyprogenia stegaria, Fanshell (G1)
**Epioblasma obliquata obliquata,* Catspaw (G1)
**Epioblasma torulosa rangiana*, Tubercled Blossom (G2)
**Epioblasma triquetra*, Snuffbox (G3)
**Hemistena lata,* Cracking Pearlymussel (G1); globally extinct?
**Lampsilis abrupta,* Pink Mucket (G2)
**Leptodea leptodon,* Scaleshell (G1G2); globally extinct?
**Obovaria retusa,* Ring Pink (G1)
Plethobasus cyphyus, Sheepnose (G3)
**Plethobasus cooperianus,* Orangefoot Pimpleback (G1)
**Pleurobema clava*, Clubshell (G1G2)
**Pleurobema plenum,* Rough Pigtoe (G1)
**Pleurobema rubrum,* Pyramid Pigtoe (G2G3)
**Potamilus capax,* Fat Pocketbook (G2)
**Quadrula cylindrica cylindrica,* Rabbitsfoot (G3)
**Quadrula fragosa,* Winged Mapleleaf (G1); globally extinct?
Simpsonaias ambigua, Salamander Mussel (G3)
**Villosa fabalis,* Rayed Bean (G2); globally extinct?

Kentucky Rv (Dix Rv, Elkhorn Cr etc.): now mostly extinct here.
* *Cryptobranchus alleganiensis*, Eastern Hellbender (G3G4)
**Atractosteus spatula*, Alligator Gar (G3G4)
Epioblasma torulosa rangiana, Tubercled Blossom (G2)
Fusconaia subrotunda subrotunda, Long-solid (G3)
**Obovaria retusa*, Ring Pink (G1)
**Pleurobema clava*, Clubshell (G1G2)
**Pleurobema pyramidatum*, Pyramid Pigtoe

Lower Licking River (below Cave Run Dam, with tributaries)
Cryptobranchus alleganiensis, Eastern Hellbender (G3G4)
Ammocrypta pellucida, Eastern Sand Darter (G3)
Noturus stigmosus, Northern Madtom (G3)
Cyprogenia stegaria, Fanshell (G1)
Epioblasma triquetra, Snuffbox (G3)
Fusconaia subrotunda, Longsolid (G3)
Leptoxis praerosa, Onyx Rocksnail (G1G3)
Plethobasus cyphyus, Sheepnose (G3)
Simpsonaias ambigua, Salamander Mussel (G3)

Rolling Fork River
Ammocrypta pellucida, Eastern Sand Darter (G3)
Noturus stigmosus, Northern Madtom (G3)
Cyprogenia stegaria, Fanshell (G1)
**Epioblasma torulosa rangiana,* Northern Riffleshell (G2)
Epioblasma triquetra, Snuffbox (G3)
**Obovaria retusa*, Ring Pink (G1)
**Plethobasus cooperianus*, Orangefoot Pimpleback (G1)
**Pleurobema clava*, Clubshell (G1G2)
**Pleurobema rubrum,* Pyramid Pigtoe (G2G3)
**Quadrula cylindrica cylindrica,* Rabbitsfoot (G3)
Simpsonaias ambigua, Salamander Mussel (G3)
Also, two rare caddisflies occur in Marion Co. and elsewhere (Floyd et al. 2012), as follows.
(a) *Hydroptila howelli* Houp, Houp & Harris (G2G3): counties Larue/Marion, Laurel, Menifee
(b) *Hydroptila kuehnei* Houp, Houp & Harris (G1G2): counties Edmonson, Larue/Marion, Meade, Metcalfe

Kinniconick Creek
Epioblasma triquetra, a Snuffbox (G3)
Percina macrocephala, Longhead Darter (G3)
Simpsonaias ambigua, Salamander Mussel (G3)

Red River: this stream is only transitional to the Central Ohio Valley; these species may not occur within the COV sensu stricto.
Etheostoma denoncourti, Golden Darter (G2)
Etheostoma microlepidum, Smallscale Darter (G2G3)
Leptoxis praerosa, Onyx Rocksnail (G1G3)
Pegias fabula, Littlewing Pearlymussel (G1): "Although extant in the Red River...this species does not seem defendable in the ecoregion."

Blue River: this stream is transitional to the Lower Ohio Valley.
Etheostoma maculatum, Spotted Darter (G2)
Fontigens cryptica, Hidden Springsnail (G1)

APPENDIX 5. Globally rare invertebrates largely or completely restricted to caves.

KY: Kentucky River Palisades
Jessamine and Woodford Cos.
Pseudanophthalmus abditus, Concealed Cave Beetle (G3)
Pseudanophthalmus solivagus, A Cave Obligate Beetle (G1G2)
Woodford Co. (Church Cave, Clifton Cave, Swope Cave).
Pseudanophthalmus horni, Garman's Cave Beetle (G3)
Pseudanophthalmus umbratilis, A Cave Obligate Beetle (G3)

KY: Southern Bluegrass (Boyle, Garrard and Mercer Co., including Harbeson's Station Cave, near Perryville)
Pseudanophthalmus conditus, Hidden Cave Beetle (G1G2)
Pseudanophthalmus elongatus, A Cave Obligate Beetle (G1G2)
Pseudanophthalmus puteanus, Old Well Cave Beetle (G1G2)

KY: East-central Bluegrass (Madison Co., Adams Cave)
Pseudanophthalmus catoryctos, Lesser Adams Cave (G1G2)
Pseudanophthalmus pholeter, Greater Adams Cave Beetle (G1G2)

KY: Western Bluegrass & Knobs (Jefferson Co.)
Pseudanophthalmus troglodytes, Louisville Cave Beetle (G1)

KY: Southern Knobs (Marion Co.)
Pseudanophthalmus parvus, Tatum Cave Beetle (GH)

KY: North-central Bluegrass (Harrison Co., Beaver Cave)
Pseudanophthalmus sp., A Ground Beetle (G?)

IN: Western Knobs (broadly defined); Blue River
Fontigens cryptica Hidden Springsnail (G1)
and probably other sites to check.

OH: Edge-of-Appalachia (?mostly Adams Co.)
Buckskin Cave #1: *Apocthonius hobbsi*, A Pseudoscorpion (G1G2)
Cave Hill Cave: *Pseudanophthalmus krameri*, Kramer's Cave Beetle (G1G2)
Fern Cave: *Caecidotea filicispeluncae*, An Isopod (G1G2)
Freeland Cave: *Pseudanophthalmus ohioensis*, Ohio Cave Beetle (G1G2)
Frost Cave: *Caecidotea rotunda*, Frost Cave Isopod (G1)

APPENDIX 6. The Bluegrass Region: "Land of Cane & Clover". This is a non-technical summary of this region in Kentucky, originally presented with photos for the newsletter of Kentucky Nature Conservancy during the 1990s.

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"Brothers: the fertile region of Kentucky is the land of cane and clover—spontaneously growing to feed the buffaloes, the elk and the deer; there the bear and beaver are always fat..." [Simon Girty, addressing assembled tribes before marching on Bryan Station in 1782.]

Many millions of years ago, the Bluegrass Region was pushed up by forces within the earth's crust, exposing a 'dome' of bedrock that is older than anywhere else at the state's surface. These limestones and calcareous shales were deposited 440-450 million years ago (in the Ordovician age), and are teeming with fossils of various shellfish and coral-like organisms. This ancient, shallow seabed was fed by nutrients on western shelfs of the massive, volcanic mountainous subcontinent whose remnants today are the Blue Ridge Mountains. These rocks have weathered to produce some of the most fertile upland soils in North America, with a particularly high phosphate content in some karst plains, though less so in hilly sections with more shale and recent glacial deposits. In regions surrounding the Bluegrass, erosion has exposed successively younger rocks. The Kentucky River used to meander across the central Lexington Plain, but additional uplift (perhaps 10-20 million years ago) has led the river to entrench, partly along a fault line, forming the "Palisades" gorges. The Bluegrass Region extends northward into southern Ohio and Indiana, where it assumes a different character due to the old glacial deposits, which cover up the bedrock completely north of Hamilton County, Ohio.

The native forests, especially on more fertile soils, are distinct from all other regions. Characteristic trees include black maple, bitternut hickory, Ohio buckeye, Kentucky coffee tree, hackberry, black walnut, ashes (blue, white, green) and oaks (chinquapin, burr, shumard, northern red, etc.).

The "rich herbage" and salt springs or "licks" in this region have attracted large populations of various grazing animals throughout the ages. Mastodons, mammoths and other extinct species roamed these plains as the last ice age waned, leaving concentrations of bones at some of the larger licks. Their disappearance may have been brought on by the hunting of early Native Americans. Later Indians probably used fire to maintain open grassy oak, ash and walnut woods and canebreaks, promoting deer, elk and, eventually, bison ("buffaloes"). The extensive upland canebreaks that existed before settlement may have been largely created and maintained by burning and browsing of the woods.

Bison appear to have been frequent in Kentucky only after Indians burned sufficient forest within the past thousand years or so. They followed an extensive network of animal trails, parts of which may have been extremely old. Some plants were probably associated with the trails and licks, e.g., Short's Goldenrod and Running Buffalo Clover. The trails were easily followed by humans, and some even turned into modern highways. Eventually, there were more permanent settlements during the mound-building Adena and Fort Ancient periods. However, it seems that Indian settlement declined 50-100 years before the first contacts with pioneers, perhaps due to diseases and other cultural disruptions that had spread earlier from the coastal colonies to "Kentucke"—this was an Indian word probably meaning something closer to "the land of cane and clover" than "the dark and bloody hunting ground".

Due to its salt springs, rich soils and open woods, which were easily cleared, this was the first region of Kentucky to be intensively settled by Virginians. Early on it became the agricultural, financial and political 'heart' of Kentucky. Much of the original wealth of Kentucky came from this productive farmland, and it is no accident that Lexington, in the Inner Bluegrass, has become the socioeconomic center of the state. At first, livestock feasted on the "rich herbage" in these woods, and amazing crop yields were obtained in the freshly plowed fields. Much land soon became converted to pasture for cattle, or, later, in more prosperous sections,

for horses, with calcium and phosphate building the bones of champions. Sheep also had their day, especially in the hills, before disease took its toll.

The overgrazed native vegetation became largely replaced by grasses and legumes introduced from the Old World, beginning with English bluegrass and white clover in the richest woodland pastures. Within 50-100 years, 70-90% of each county had been replaced by farmland, and the remaining timber, mostly on steeper slopes along rivers and streams, became heavily harvested. Although this region had supported concentrated populations of game animals before settlement, bison, elk, bear, beaver and turkey soon disappeared, and for a time even white-tailed deer became rare. Since 1910-20, much farmland has been abandoned in the "Hills of the Bluegrass" (on Eden Shale), leading to recovery of much young forest, deer and other wildlife. However, within reverted forest, some original plant species may not return for a long time, due to soil erosion, other disturbances, and lack of seed. The Kentucky River, locked and dammed, has lost much of its natural quality, including most aquatic plants and mussels, but the Licking River is less changed. Demands for water supply from the larger streams will probably increase as the population increases and cities expand.

In addition to the lost large animals, several plants appear to have been particularly sensitive to the loss of natural habitat in this region, including Bladder-pod (*Lesquerella globosa*) and Marble-seed (*Onosmodium hispidissimum*) in drier woods, Running Buffalo Clover (*Trifolium stoloniferum*) and Giant Wood-lettuce (*Prenanthes crepidinea*) in moist grazed woods, False-indigo (*Baptisia australis*) along rocky river banks, and Tape-grass (*Vallisneria americana*) within the rivers.

Today, there are few sites in this region that are managed purely for their natural qualities, and these sites do not represent all the ecological subregions. They are mostly scattered along the Kentucky River and its tributary ravines, where the central Palisades section has been a major focus of effort by state government and The Nature Conservancy. Much forest and many rare plant species survive in the varied topography of this section. Also notable are Boone County Cliffs and Dinsmore Woods State Nature Preserves, on glacial deposits in the north, and, nearby in Grant County, the Lloyd Wildlife Preserve, which is a small but impressive old-growth forest managed by Kentucky Fish & Wildlife that deserves much more care and attention.

There are still opportunities to set aside large areas of less inhabited land in the Eden Shale Hills for eventual regrowth of the disappearing beech and white oak forests. However, there is an even more urgent need to protect and restore some of the native forests on the richer plains, especially more open savanna-like woodland with blue ash, burr oak and cane. Before settlement, such woodland was restricted, globally, to the Bluegrass Region, and, except for some larger remnants on old traditional farms, it is now virtually eradicated. [A small reprieve may have occurred during the Civil War.] Within these largely agricultural and suburban landscapes, we will need new approaches to conservation, perhaps working eventually with botanical and zoological parks.

APPENDIX 7. The Knobs Region: "Where the Mountains kiss the Bluegrass" (Estill County motto).

This is a non-technical summary of this region in Kentucky, originally presented with photos for the newsletter of Kentucky Nature Conservancy during the 1990s.

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Surrounding most of the Bluegrass Region, and extending north into Indiana and Ohio, is a somewhat nebulous region that geographic writers have sometimes recognized only in part, or in combination with its flanking regions. This region is a complex of broad floodplains, terraces, foothills, erosional remnants ("knobs") and escarpments that are transitional from the Bluegrass to surrounding higher plateaus. Although the region's width ranges from about 30 miles, to only 10 miles in some southern sections, its characteristic knobby hills are easily recognized as one travels east, south or west from the Bluegrass. These hills contain a series of younger rocks, mostly laid down during the Silurian age (ca. 410-440 million years old), Devonian age (ca. 360-410 million), and Mississippian age (ca. 330-360 million). The Silurian seabeds contained shellfish and other organisms similar to those of the older Ordovician age (underlying the Bluegrass Region), but during the Devonian age fishes first appeared. Still younger, Pennsylvanian rocks cap some of the Eastern Knobs, which are ancient remnants of erosion along the edge of the Appalachian Plateau. There is an alternation of basic and acidic rocks in this sequence, but in general the rocks of this region form poorer soils than the Bluegrass Region.

A great variety of vegetation types has developed in this region, reflecting the variety of rock types and topographic positions. At the wet extreme, swampy forests, more extensive than anywhere else in central or eastern Kentucky, developed on the bottomlands between the hills themselves. These bottomlands are often poorly drained, due to dense clay and fragipan layers, as well as their low topographic position. Unfortunately, most of the original bottomland forest has been cleared and drained. On the bottomland, there are also some rare plants of open areas, especially in rights-of-way on high terraces, suggesting that some grassy open woods occurred before settlement. Similar vegetation may even have occurred on the broad siltstone-based flats of some foothills (e.g., Maxey and Sharkey Flats). Fires, often set by Indians, probably kept some areas open on both the uplands and the bottomlands.

At the dry extremes, especially on rocky soils and south-facing slopes, open woods, grasslands and rocky "glades" were maintained, often with unusual wildflowers. In a few places, especially on the Mississippian rocks, south and west sides of the hills are so dry and fire-prone that the vegetation is still mostly brush and grass. These small remnants of "barrens" or "prairies" harbor some plant species that are very rare in Kentucky, but typical of the Great Plains further west—an example is the Prairie Satin Grass (*Muhlenbergia cuspidata*). Even some moister slopes around the knobs may have been influenced by fires—beech, a fire-sensitive tree species, is mysteriously absent from some such areas.

Clifftops in the Eastern Knobs are particularly pretty spots from which to look over the Bluegrass. Several of these hills were important references for the pioneers and some are still called "Pilot Knob". Extensive grassy plains and abundant game were reportedly first viewed by Daniel Boone from one of these knobs. Native American use of the lowlands was closely linked with cultures centered in the Bluegrass, and the projecting knobs offered special ceremonial places. One of the last Indian villages known in Kentucky, "Eskipakithiki", was situated in old fields and prairies between the low knobs of southeastern Clark County during the 1750s. The Salt Lick area of Bath County also seems to have been a focus of recent Indian settlement and burning activity, and there was much probably much influence from larger animals. The "Knob Lick" of Bath County can still be seen, with over 5 acres of bare eroding shale and some prairie remnants around it, including the recently described, globally rare Cedar Sedge (*Carex juniperorum*). Several major animal trails ran through the Knobs Region before settlement, including an important northeast-southwest route along the edge of Appalachia, and east-west routes along the southern boundaries of the Bluegrass.

Virginian settlement was rapid along the better drained bottomlands, and some also occurred on richer limestone soils in the hills. In contrast, many parts of the wetter bottomlands and less fertile uplands remained forested until artificial drainage and fertilizers enabled new farmland to be developed during the 20th century. Even with modern fertilizers, the upland soils in this region are not intensively farmed, and much forest remains. In early settlement times, some layers of Devonian rocks became a major source of iron ore, leaving small scars on the land and requiring much timber for charcoal to feed the furnaces. During the 1980s, there were proposals to mine the extensive Devonian 'black shale' for oil-extraction, but this remains uneconomical. The more hilly uplands currently have much neglected forest or abandoned farmland, since modern habitation has become more convenient on the bottomlands. Forest fires are still frequent locally, though probably less than during Indian times.

Some of the upland forests and drier grassland remnants are now owned by federal and state government, The Nature Conservancy, private colleges and foundations, but only some of these lands are permnently committed to nature conservation and restoration. Several large (5-10 square mile) areas of essentially uninhabited land, including some with rare plant species, remain in private hands. There is a particulary urgent need for conservation on the bottomlands, where the various vegetation types on well-drained and poorly drained soils have now been much reduced and disturbed. The few remaining bottomland forests—all in private ownership—could serve important functions for improving water quality, timber production and wildlife habitat, in addition to their natural history interest. Several plants appear to have become endangered or locally extinct due to habitat disturbances, especially on bottomlands, for example, Sundew (*Drosera intermedia*), Rose Pogonia (*P. ophioglossoides*) and Grass Pink (*Calopogon tuberosus*) on boggy terraces; Short's Goldenrod (*Solidago shortii*) and Stipuled Scurf-pea (*Orbexilum stipulaceum*) at the Falls of the Ohio—the latter appears globally extinct.

1. Northwestern Section: mostly plains, much influenced by old Ohio River terraces (Louisville Lowlands) and wind-blown periglacial dust (Bedford-Lagrange Plains), but some steeper ravines (Jeffersonville Bluffs); today mostly urban or agricultural with little forest remaining except in ravines; virtually no sites committed to nature conservation.

2. Western Section: diverse natural landscapes, from the Bardstown Plains, with dolomitic glades and grasslands; to the Lower Rolling Fork Knobs, with forested black shale slopes; to the Lower Salt River Hills (and N Muldraugh's Hill), with siltstone and limestone slopes, open and grassy in places; several sites more or less committed to nature conservation, including Pine Creek Barrens, Jefferson County Forest, Bernheim Forest, Vernon-Douglas Preserve, Jim Scudder Preserve, Thompson Creek Glades, and much further potential in Fort Knox area.

3. Southern Section: little or no Silurian fringe, but many Upper Rolling Fork (and Green River) Knobs with Devonian shales, plus Upper Green River Hills (and S Muldraugh's Hills) with much Mississippian siltstone and some sandstones; virtually no sites committed to nature conservation, except for the Center College land.

4. Eastern Section: very diverse natural landscapes, from Ordovician and Silurian foothills to Pennsylvanian hilltops; few sites committed to nature conservation—Maywoods and Pilot Knob Preserves, but much current potential in Berea Forest and Daniel Boone National Forest.

5. Northeastern Section: very diverse natural landscapes, including the Beasley Hills, with Silurian dolomites, and the extensive Kinniconick Hills and Licking River Knobs, with much siltstone; virtually no sites committed to nature conservation (except the Rowan County Sphagnum Swamp), but much current potential in Daniel Boone National Forest and on private land along Kinniconnick Creek.

APPENDIX 8. Notes on Berea Forest's Management Plan.
Starting in 1897, Berea College has acquired about 8500 wooded acres in the hills east of campus, which are mostly managed for watershed protection, timber production, and educational uses. The results of this program deserve more general reporting to the community, since this is one of the oldest professionally managed forests in the region. John Perry (2012) has produced a good summary of the forest's history, and Clint Patterson (2013) has produced a recent management plan. This plan provides some insight to the philosophy of the college's managers: "A principal failure of the environmental movement of the late 20th century in the United States was that it generally failed to connect human economics and conservation when addressing natural resource issues. The complex enmeshment of industrial age consumers and the ecosystems that enabled their consumption was rarely explored."

Their plan led to the following statement in 2015: "Demonstrating Berea College's long-standing commitment to sustainability, Berea College and New Forests announced today the successful listing of the Berea College Forest Carbon Project with California's Climate Action Reserve Program. Through the Berea College Improved Forest Management Project, carbon offset credits can be used for compliance in the Air Resources Board of California's greenhouse gas cap and trade program. The project encompasses the College's Oak-Hickory and Oak-Pine forest near Berea, Kentucky. By registering the Improved Forest Management project and selling carbon offsets in the California cap and trade system, Berea College will make a commitment to maintain current forest carbon stocks and manage the forest for both increased carbon sequestration and sustainable timber production. The project will have the combined benefit of generating significant revenue for Berea College and assisting in the protection of the College's forest for future generations. It will also serve as an example of an environmentally-friendly alternative revenue stream that other Appalachian forest owners can investigate for their own property." These goals may be admirable, but there will be a need to understand how timber extraction from the forest influences the 'carbon footprint' of the whole operation, and there will be a need to monitor the fate of extracted wood—how long will it remain wood before rotted or burned?

A special aspect of the current plan is its focus on producing oak lumber of large dimensions, as reported in relation to a recent sale: "Logging white oak trees in the Berea College forest to be used in the Mayflower II restoration project at the living-history museum, Plymoth Plantation, in Plymouth, Massachusetts. Almost twice the normal length of sawn lumber, trees that can provide 30-foot planks are difficult to move and saw. UK forestry professor Terry Conners and UK forestry graduate student Clint Patterson were instrumental in finding the timber for the project."

The Management Plan of 2013 confirms two general goals. "(1) To manage the Berea College Forest based on up to date forest science, maintaining and improving physical facilities and records while enhancing, studying and utilizing varied resources: wood products, water, recreation and wildlife. This is to be accomplished with concern for the educational value and ecological health of the Forest as well as the financial well-being of the College.
(2) To provide education and service to the Berea College community in forestry, natural resource and land management related matters." The Plan includes much discussion about the need for production of timber from the forest in order to support the community's economic needs. However, there is no information on how much wood or money the community needs from the forest, and exactly who the "community" is—the forestry program itself, or the whole college, or the whole town or a wider region? Moreover, the plan mentions "old growth" only once: "The legacy tree/stand approach described above is the best way to retain old growth characteristics over an extended period of time and still maintain canopy tree diversity." These "legacy trees and stands" would have some limited timber management, but favoring retention of many large trees rather than economic production as the dominant goal. Together, as currently outlined, these areas cover about 500 acres, only 6% of the whole forest.

The plan makes some reference to the rationale of biological conservation planning. It is claimed that "A coarse-filter approach as outlined by the Nature Conservancy...is the best approach for the Berea Forest. Rare, threatened, or endangered species that require a fine-filter approach over a wide area are not present." However, this dismissal of issues for rare species seems premature. There is little reference to biological inventory (such as the floristic survey of Ralph Thompson in 2008), or to the kinds of habitat classification that TNC's analysis has been based on, or to the most appropriate methods for restoration of degraded or destroyed habitats that should exist here. And, unfortunately, the plan degenerates in places to reiteration of an old forestry and wildlife biology mantra: "At this time, early successional habitat—young forest stands and fields—necessary for many species is probably the habitat type most lacking. Increased harvesting will promote this type of habitat." Such statements ignore the obvious fact that most of the landscape elsewhere in this region has an abundance of young forest and fields. Moreover, many of the so-called "early successional" species to which such statements presumably refer, at least the plants, are actually quite 'conservative'—in the sense that they will not generally appear in fresh openings, but are remnants from ancient openings. Ancient openings were widespread before settlement along foothills of the knobs, but none of these features are mentioned in the plan. The plan should really be presented within the context of the whole southern part of the 'Central Bluegrass' landscape (section 1 in the map above)—where varied scattered remnants of the original vegetation can provide clues for the history of Berea Forest.

Established biological interest in 'mixed mesophytic forest' of Appalachian coves by Lucy Braun, Bill Martin and others is challenged in an odd way. The plan states: "While these sites are thought of as diverse, fire put the species mix in the mixed mesophytic cover in the pre-settlement forest. In its absence, silviculture is necessary to maintain tree diversity. These sites may be the most difficult to diversify, because yellow-poplar can dominate small openings and maples dominate in lower light situations." There is no evidence to support this invocation of burning and cutting in the plan.

The plan claims that increased logging will benefit diversity of neotropical migrant birds, in particular: "According to Biologist Chuck Hunter, formerly chair of Partners in Flight for the Southeastern United States, 70% of the species of concern [with significant global declines in population] are early successional species. Even-aged regeneration harvests can provide habitat for early successional 'shrub nesters' that use young forests. Fewer, larger clearcuts are desirable because they increase interior habitat and decrease edge and do not fragment mature forest as much..." This rationale may be partly valid, but there is a need to distinguish "early successional" habitats in clearcuts or old fields from the more continually maintained open grassy woodland, shrubland or grassland that used to exist on foothills here. Clearly, it would be foolish to claim that logged areas, no matter how large, can provide significant benefit to most rare grassland birds, since regeneration of trees is rapid. Moreover, the dense thickets of woody resprouts and seedlings that grow up in logged areas have different structure than more stable shrubland that used to occur in zones between woodland and grassland. Birds like loggerhead shrike, field sparrow and blue-winged warbler appear to prefer more extensive and stable shrubby vegetation that would not be produced by logging cycles (Ford et al. 2000). [The broad classification of habitats by Ford et al. remains unsatisfactory—it is not clear how their "grassland and savanna" class differs fundamentally from their "barrens, glades and old fields" class, and there is much structural plus dynamic diversity within each of these two classes.]

There is no biological analysis of the whole flora and fauna in the forest, in order to determine which habitats are required and which species are rare. However, some 'wildlife fields' and 'best-management-practices', such as reduced logging by cliffs, caves and streams, are clearly designed to 'fine-tune' a general program for timber production. Moreover, there clearly are imperiled species here that do require a 'fine-filter' approach, often suggesting 'micro-management'. Indeed, although the plan initially reject focus on a 'fine-filter' approach, it does specify such actions, including "progeny orchards", for two trees: (a) chestnut (*Castanea dentata*),

which is being replanted in the forest using the 15/16th American hybrids with Chinese; and (b) *Juglans cinerea*—"Inventory conducted in 1950 shows butternut ("white walnut") to be as common as beech on the Forest. The butternut canker has eliminated that component." Much micro-management for timber production should be considered a 'fine-filter' approach, especially if selected species are planted. For old fields on lowlands, the plan notes: "Black walnut, northern red oak, and swamp white oak are the trees found on these sites that justify silvicultural focus due to economic and ecological value. Favoring these species in thinning or introducing them in enrichment plantings after harvest is desirable."

The plan even suggests that some 'fine-filter' approach could help promote a few animals. For amphibians, it notes: "Protection and establishment of small vernal pools located in shade or forest edge is important for this purpose." And the plan notes an old 1950 record of scarlet snake (*Cemophora coccinea*) from the forest. This species has virtually disappeared from the Central Ohio Valley, but could conceivably be reintroduced to open grassy or shrubby pine woods maintained by appropriate continual disturbance—rather than a logging cycle of 50-100 years. The plan appears to hope for the latter: "Snakes like open, high sunlight areas and frequent recent regeneration harvests (clearcuts)." But if frequent clearcuts, as are common in the hills of Kentucky, benefit this species why has there been such drastic decline?

The plan also appears to advocate a 'fine-filter' approach in its management of perceived invasive species: "Non-native species should be targeted for elimination on an ongoing basis. When stands are evaluated for harvest or site preparation before harvest, non-natives can be assessed. Problem areas can also be identified during marking when the stand is covered thoroughly. They can be treated prior to sale. Herbicide is usually necessary for control of invasives." Moreover, the native grape vines (*Vitis vulpina*, *V. baileyana*, *V. aestivalis*) are also targeted for reduction: "Wild grape development is currently damaging much of the forest. Top breakage and tree mortality from grape is common. Areas of several acres have been reduced to scrub arbors due to grape. When not treated before regeneration harvests, they can smother regeneration. However, wild grape makes important biodiversity contributions in both food and cover. At this point, it has progressed to a damaging level and management is necessary."

The plan notes that problems with alien plants are worst at lower elevation in the transitions to woodland typical of the Bluegrass region: "Production silviculture is impractical here. Some invasive control is warranted, but resources are limited to target such a degraded forest environment. Asian bittersweet and tree of heaven can be controlled and should be targeted to prevent spread. Bush honeysuckle, burning bush, privet, and winter creeper can be controlled along trails or in areas where desirable subcanopy shrubs/small trees can hold their own. Winter creeper can be cut off trees to prevent seed production. Grape vines can be cut to save the current tree cover. The ecological health and trail aesthetics are degraded by the invasives. It would be a good area to utilize a research program focused on invasive control (e.g. goats), in addition to the invasive control activities begun in 2012."

In this author's experience (JC), grape vines can be a valuable ally in the fight against invasive species, especially bush-honeysuckle (*Lonicera maackii*). Around Lexington, *Vitis vulpina* often smothers the bushes, and if the bushes are also cut they then support development of dense grapevine tangles—which can be viewed as a valuable component of native biological diversity, albeit hard to walk through. Moreover, although most foresters deplore grapevines, there is rather little published evidence that vines greatly damage the overall "forest health"—broadly defined. I would advocate leaving grapes if possible where dense alien shrubs are present, unless they get in the way of killing the bushes.

But the plan's suggested use of goats does provide some hope for restoration of these transitions to Bluegrass woodland. Initial trails have been conducted by Sarah Hall and others; results are eagerly anticipated. It is unfortunate that so little research on use of livestock in woodland has been conducted in this region so far.

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Back Cover: Berea Forest, looking west from Big Hill towards the Pilot Knob (different from the Pilot Knob in Powell County).