Restoring the Plains of Elkhorn

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RESTORING THE PLAINS OF ELKHORN

Natural History and Conservation Planning in Fayette County, Kentucky

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Slope near bridge over West Hickman Creek—one of many opportunities in town to replace alien bush honeysuckle with attractive natives, here purple phacelia and roughleaf dogwood.

Preface

I arrived in Kentucky during the 1970s, when what I call “the second age of conservation” was unfolding. There was general excitement about dealing with environmental problems across the planet, and there was new legislation for addressing problems in the U.S.A. Major federal actions had included formation of the Environmental Protection Agency and passing of the Endangered Species Act. At more local levels, a new generation of ecologists, conservation biologists, landscape architects and environmental engineers were being hired directly by government or acting as consultants, often to engineers. Under President Carter, the Comprehensive Employment and Training Act provided funds to a small incipient non-profit organization known then as the Bluegrass Land and Nature Trust. The aim of this grant was to survey landscapes across all of Fayette County, which had merged with the city of Lexington in 1972. I worked briefly on that survey, carrying an explanatory letter from Mayor Jim Amato in case of questions from landowners. A report was written but quickly forgotten or ignored. I have a copy, and it should eventually be unearthed for background to this current document.

There was a curious incident during this survey that did not involve me directly but some other field workers. They had gone down to the Elk Lick Falls area, then already owned by Mary Wharton. Although she was a founding member of the Land and Nature Trust, she did not know about the impending visit or had not yet given permission. She was annoyed and reprimanded the workers. Although trivial, this incident got me thinking about how the right hand does not always know what the left hand is doing in conservation, even within the same county, and even within the same organization. As the “second age” kept going, I came across more and more examples of this kind of thing, and sometimes with much more significance or expensive consequence. This trend usually involves difficulties in communication or consensus-building among the various professional groups that are involved in conservation.

Wild strawberries (*Fragaria virginiana*). This tasty native is now uncommon in the county, and most people grow up thinking that the alien “fake” strawberry (*Duschesnea*) is the real thing.
[image from https://www.ncwildflower.org/plant_galleries/details/fragaria-virginiana]

Here, in brief, are some significant shortfalls that I am familiar with in this county.

Raven Run Nature Sanctuary. There is still inadequate planning for maintenance of old fields in order to allow persistence of uncommon to rare species that depend on dry or rocky openings, including state-endangered plants that have virtually disappeared (*Malvastrum* and *Onosmodium*); even wild strawberries—a delectable wild edible—have become rare.

Hisle Park. This new park just north of town has much potential for varied natural features, including restored ancient woodland, canebrakes, old fields mowed for summer-nesting birds, and expansion of the city's recently established tree nursery on the east side. But interested people and neighbors have not yet fully organized into a support group for the park.

Cane Run at Coldstream Park. In 2016-17, following negotiation with EPA and state, the city was led to spend $1.25 million on a so-called "restoration" project with largely dubious value, artificially rebuilding 4415 feet of an ancient stream channel that sinks for most of the year into karst. Many hundreds of trees had been planted here in 1999/2000 as the first major "Reforest the Bluegrass" event, but had to be destroyed. The worst damage was avoided after I complained, but the project has still wasted a lot of money with no evidence of net benefit.

Urban Forestry Management Plan. Although this first plan is a great advance for local government, and many collaborative meetings with groups of citizens were held in 2017, some significant gaps remain in the planning. For example, there is no mention of the need for local nurseries to grow more trees, and no mention of some species that deserve much more attention (such as our native mulberry, slippery elm, buckeye, basswood and black maple). Also, much of the historical information is erroneous, e.g. the presettlement environment did not "contain... woodland pastures rather than dense forests" (p. 22). Deep woods with sugar maples were widespread on the uplands; woodland pastures were largely created by more prosperous Virginian settlers. And it concerns me that those collaborative committees have disbanded.

North American or “red” mulberry (*Morus rubra*). Another tasty native that has greatly declined; now frequently confused with the invasive Chinese or “white” mulberry (*M. alba*). [Image from http://www.tradewindsfruit.com/morus-rubra-red-mulberry-seeds]

Tree planting plans. Although much good tree planting does occur, there is still no clear goal for how much of the city or the whole county should be wooded. And even on land owned by the city, we generally lack clear proactive indications of where trees are desired (including riparian corridors) and where not. So if trees are donated, much communication is needed to determine where the best sites are located, and where utilities should be avoided. It would be particularly useful to have a simple summarized plan for each significant site (or groups of sites), showing the ideal design for artificial and natural features. These summaries could then be circulated to neighbors and other interested people for feedback and regular update.

Tree transplanting. There is much potential to transplant significant trees up to 10-20 feet tall out of the way of construction projects, but there is usually little planning for this. The city owns a large tree spade, but it has limited use; a skilled backhoe operator can safely move most trees of this size; and even hickories with taproots can be dug by hand given sufficient time.

Protection of uncommon to rare species. Among trees, the Zoning Ordinance (Article 26) lists several "significant" species for preservation, and the UFMP mentions "legacy" species. But the list needs to be increased based on historical information and on remnants today. And the city has no ordinance to protect sites with special shrubs, wildflowers or rare wildlife. The federal Endangered Species Act would apply to very few species (e.g. some bats and clovers), and only if federal funds were being expended.

Reduction of invasive aliens. Although the city and its partners have made considerable effort in some areas to reduce honeysuckle and other aliens, there is still no centralized plan for such work—with committed funds for persistent control to avoid regrowth and wasted effort. And the Weed Ordinance should be updated to include the worst invasive aliens of woodland, as well as objectionable weeds in yards and roadsides. The Callery pear, Amur honeysuckle and wintercreeper have become serious impediments to horticulture in both shade and sun.

Wild plums: *Prunus munsoniana* (left) and *P. americana* (right). These were important sources of food for native people before 1600 AD, with trees often surrounding villages. Interest for food has waned, but *munsoniana* in particular has some delicious cultivars [1 Sep 2018].

The “second age of conservation”, with a proliferation of diverse professional approaches, now involves too much confusion. We need a “third age” to be based on more regular exchange of ideas, data and resources among all organizations devoted to ecological improvement within defined localities or regions. It is especially important to integrate planning at the three basic levels of ecological organization: (1) landscape/watershed; (2) habitat restoration; (3) species recovery, starting with functional groups. In Fayette Co., it would be very useful to hold a tight annual conference—perhaps a day long—where each group would outline its progress and prospects. Such meetings would allow collective review of goals, better focus on critical questions for research, and more collaborative efforts in funding or other economic applications. And then during the year, it would very useful to have monthly field trips and work days, soliciting volunteers where possible and touring sites in educational programs.

Following are some suggested priorities for overarching goals and themes in this process.
Landscape/watershed level: deepen and broaden protection for “natural zones” along the river; plan watershed work in more detail, clarifying distinction of needs for urban versus rural; conduct thorough economic analysis of costs and benefits for varied types of large projects.
Habitat level: research use of livestock to simulate original herbivore effects in woodland; explore more potential for effective artificial headwater impoundments within urban areas; also conduct more detailed research in natural remnants of wetlands and in methods to restore.
Species level: develop partnerships for more growing of desired native plants in nurseries, with initial focus on species that can be readily propagated and have public interest (e.g. mulberries); strengthen plans to reduce invasive alien plants, avoiding waste from abandoned efforts.
It would be particularly useful for the UK Arboretum Woods, selected parks and greenways to become centers for careful monitored reintroductions of desired species. Results from such work should then be properly documented, so that the community could learn from these trials. And successful reintroductions could become convenient sources for further local propagation.

A crowded “Reforest the Bluegrass” event (Hisle Park, 15 April 2017. Regular work days and field trips are essential, but ideally more dispersed into smaller neighborhood projects.
[Image from https://www.wkyt.com/content/news/Reforest-the-Bluegrass-helping-plant-roots-for-Lexingtons-future-419534843.html]

The document below provides background for these themes, with more specific suggestions for goals, and a discussion of how we might actually link ecology with economy. This initial draft (Feb 2019) is rough, and it will need further work before general release. In addition to this document, I intend to develop a short succinct version. That short version will focus on essential observations, practical goals and brief notes on the need for more information. I also want to add extensive appendices with more technical information and more references. The project could eventually evolve into an updatable synthesis, with progress or failure to meet goals clearly documented for the community. All of this effort may seem ambitious, but don't we need something along these lines to establish more common ground?

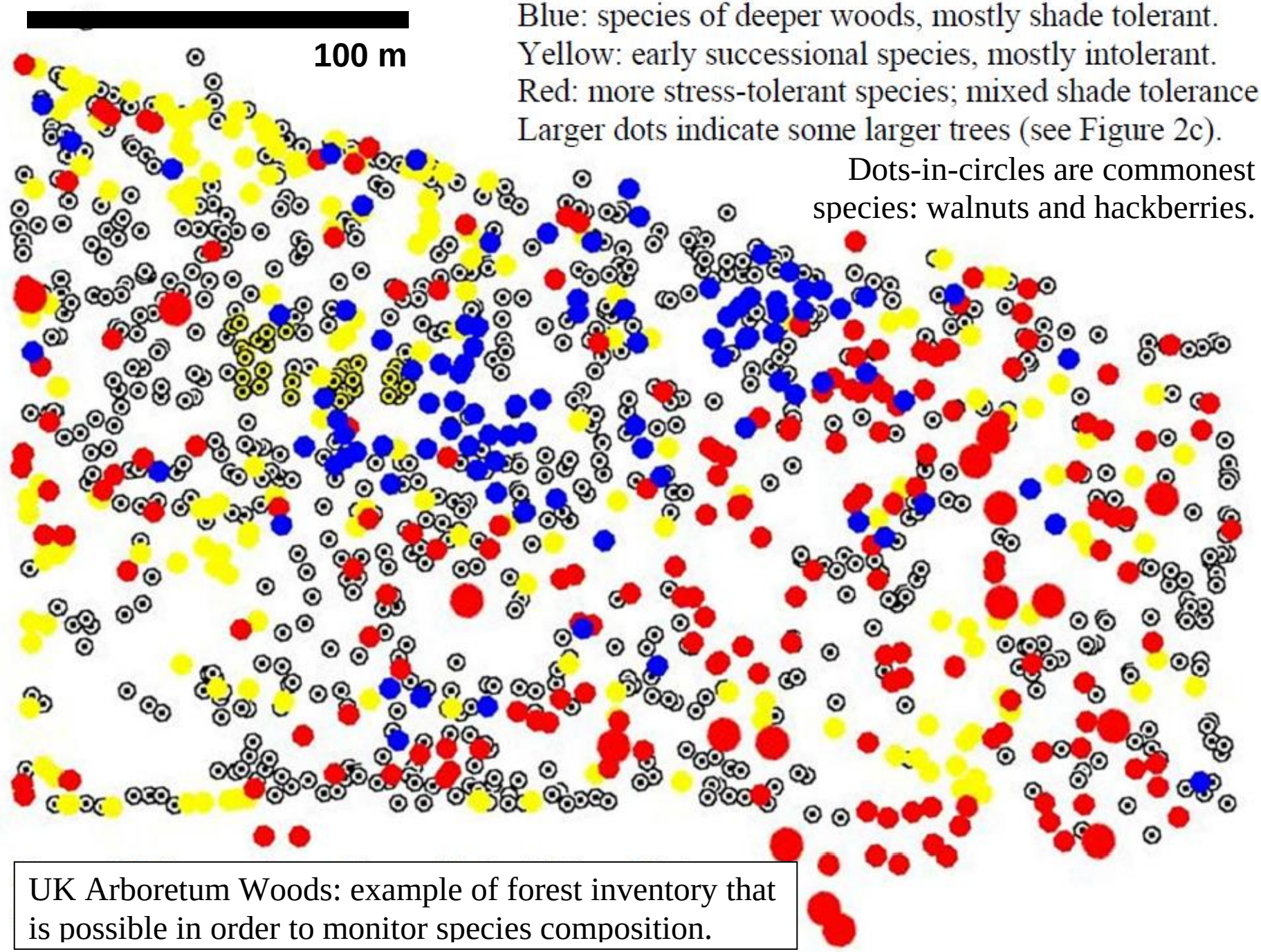
Currently envisaged appendices are as follows.

Maps: more detailed features of geology, soils and topography
estimated original pattern of vegetation before 1775
surviving woodland blocks, special habitats and rare species
woodland or farmland with legal protection or management for conservation
condition of watersheds and locations of projects to improve quality

Habitats: information from early observers about the original landscape
modern basis for classification of habitats, based on ecological gradients

Species: annotated lists of native vascular plants, with focus on conservative or rare
annotated lists of native vertebrate animals, with focus on conservative or rare
as above but focussed on aliens, with notes on methods for reduction and results

Continuing monitoring and assessment
information relevant to success or failure in meeting goals at specific site
economic accounting in terms of effort expended, and measurable benefits
general links to varied information shared among interested people



Blue: species of deeper woods, mostly shade tolerant.
Yellow: early successional species, mostly intolerant.
Red: more stress-tolerant species; mixed shade tolerance
Larger dots indicate some larger trees (see Figure 2c).

Dots-in-circles are commonest species: walnuts and hackberries.

UK Arboretum Woods: example of forest inventory that is possible in order to monitor species composition.

PART 1
Background in Natural History

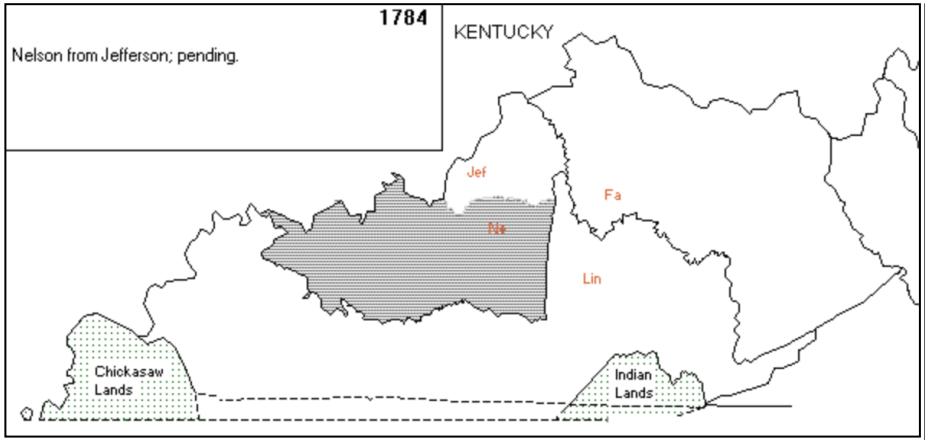
Closeup of central Bluegrass in Filson's 1784 map of Kentucky. Lexington was settled at the junction of ancient trails, initially formed by large herbivores then followed by native people.

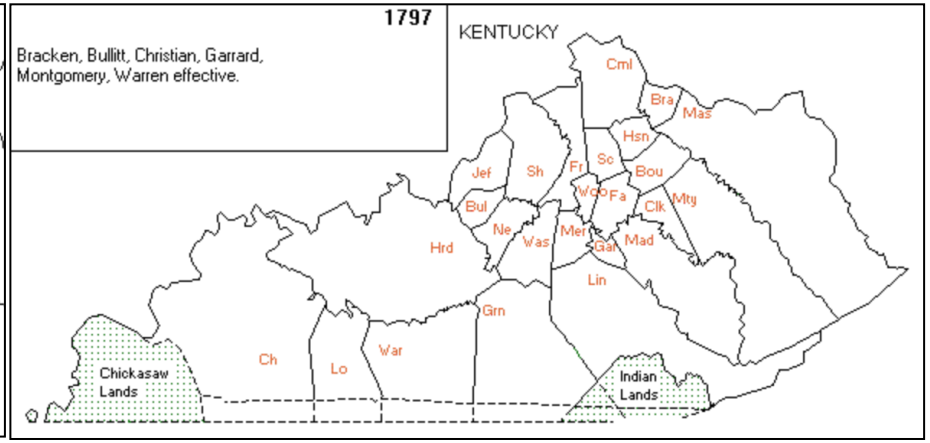
Introduction

The settlement of Kentucky by people from Virginia, just as the settlement of all North America by people from across the Atlantic Ocean, has been driven by two powerful causes—to find new land for economic expansion (ideally with exports), and to find some kind of new harmonious (or sustainable) life in this colonized land. These two themes have often conflicted (as in Ayn Rand versus Rachel Carson), and there continues to be argument or even anger today about how to combine them. The economic motive involves understandable forces of financial capital, with obvious traditional roles for government and business. But the quest for harmonious life muddles along through a multitude of individual stories, inadequately interacting with development of overall policy for the community. This quest is rarely, if ever, articulated as a shared vision for the future.

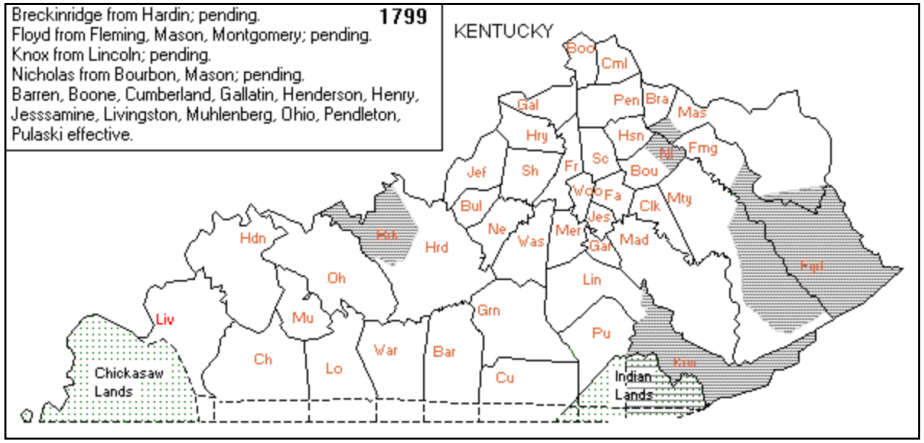
Fayette County, Kentucky, has an intense story of hunting, warfare, woodland clearance and agricultural development during its first 250 years—especially before the Civil War. Then since 1970 or so, there has been a complex concatenation of efforts by government to improve planning for a more modern future, with sporadic interaction from varied non-governmental organizations and lobbying groups. My central point in this booklet is that Fayette County could, if it—its People—wanted, begin to develop a deeper plan for some kind of harmonious future, based on a careful balance of economic and ecological interests.

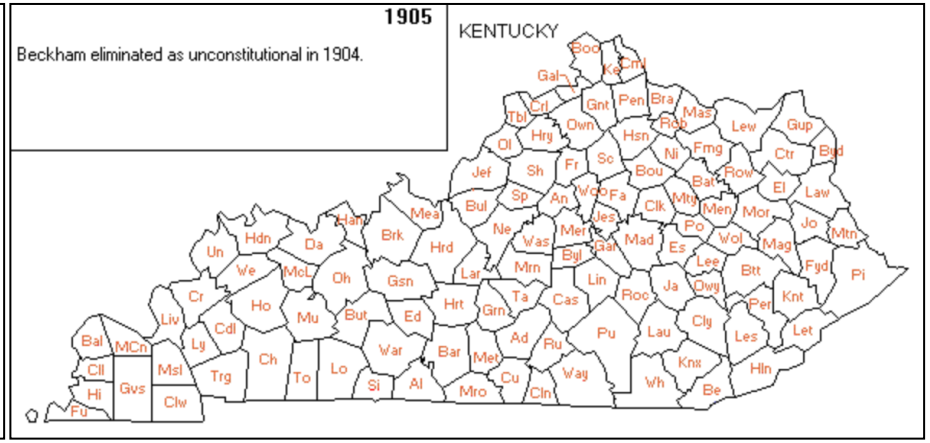
The words environment, ecology, protection, conservation, restoration, recovery, landscape-design, biodiversity, native-versus-alien species, sustainability, and allied terms, often get applied to particular programs or projects. However, the general public is often confused about the underlying goals implicit in these terms. Even professional people who are focussed on applying these words to their actions often differ greatly amongst themselves in the details of their meaning, due to their varied practical, intellectual or aesthetic approaches.





Formation of Fayette County. Upper left in 1784: initially one of three Virginia counties, with Jefferson (based at Louisville) and Lincoln (based at Harrodsburg then Stanford). Upper right in 1797: much reduced by subdivision of region. Note Indian lands to southwest and southeast.

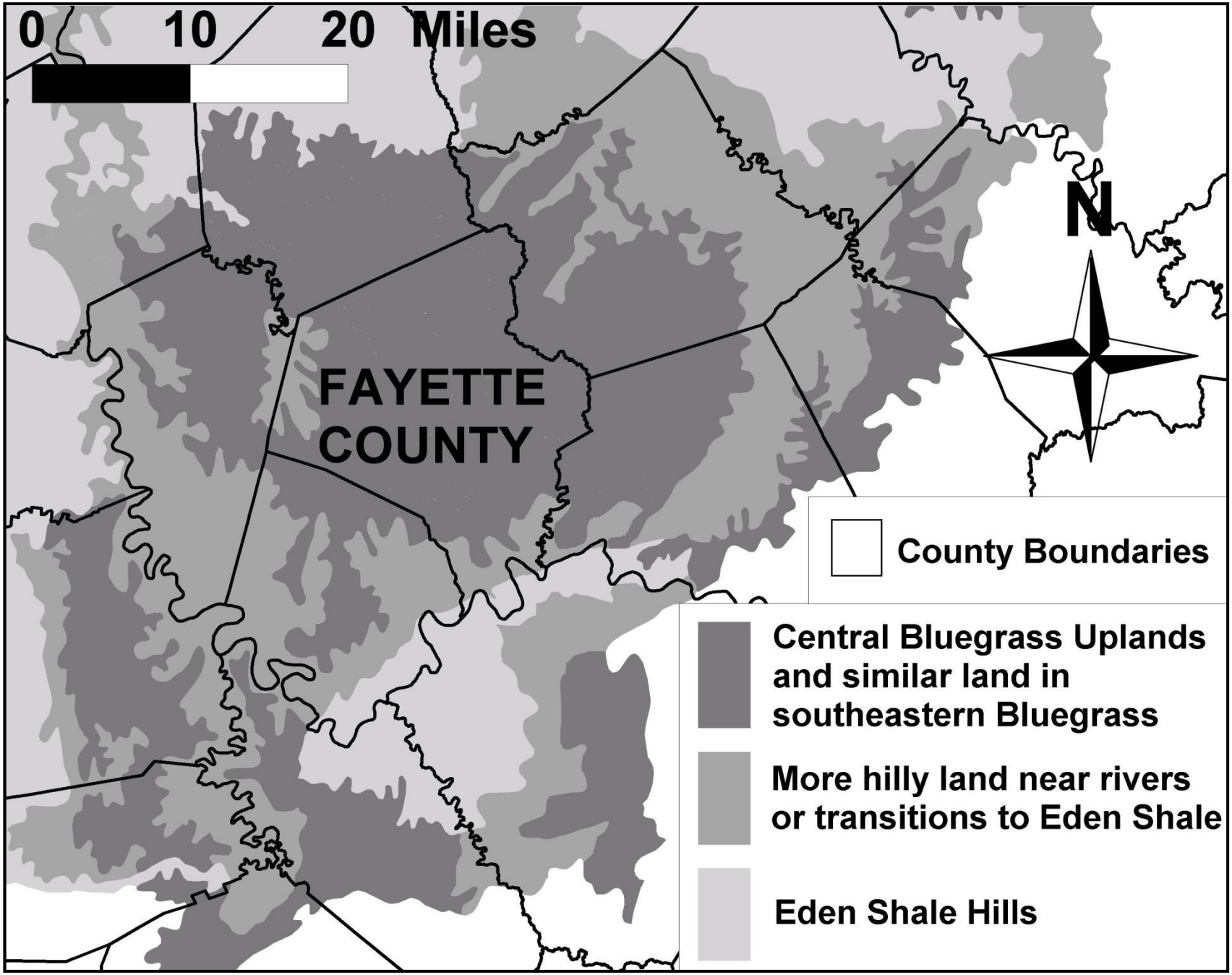




Lower left in 1799: with split of Jessamine County to south, and further subdivision of region. Lower right in 1905: showing final subdivison across state, except for lack of McCreary Co.
[https://www.sos.ky.gov/admin/land/resources/PublishingImages/Animated1796.gif]
[see also http://www.mapofus.org/_iframe/ky-maps.htm]

Both “ecology” and “economy” are derived in part from the Greek word “oikos” for “house”—a poetic metaphor of the whole community within which we live, together with its varied spaces and functions. At root, ecology and economy are somewhat confusable: ecology seeks to understand how overarching natural forces control our world (from “logos” = word or reason); economy starts from human organization (from “nomos” = law or custom). Some philosophers even want to break down the division between concepts of Man versus Nature. I use the words “ecology” or “ecological” in a moderate sense to imply overall human understanding of our world (global, regional or local), together with its living components (flora, fauna and microbes) and their environments (in air, water, soil and rock). Ecology has traditionally been focused on the more natural world and how humans interact with it, but it can also be applied to largely human affairs, especially where there is a need for more objective analysis of artificial environments and natural resources (as in “political ecology”). In contrast, economics often focusses on financial affairs within human society, but it can also seek to account in financial terms for our relationships with natural resources.

The booklet aims to condense what can become complex into a set of clear themes for balancing ecology and economy in the county. I outline the three fundamental levels of organization for our understanding of the natural world—or “natural history”. Thinking about these problems, teaching about them, lobbying about them, and doing something about them, can all be well-served through these three levels—landscapes (including watersheds); habitats (with their intergradient relationships); and species (with special attention to natives versus aliens). This view comes from classical cosmology, regarding spheres of operation within each other, included at successively smaller scales. It is of course a fantasy, but we have to start somewhere. At each of these three levels of organization there are central questions to be addressed in how we attempt to approach a harmonious balance within the level, and then how we coordinate between the levels. Such questions should be addressed by the community.


0 10 20 Miles
N
FAYETTE COUNTY
County Boundaries
Central Bluegrass Uplands and similar land in southeastern Bluegrass
More hilly land near rivers or transitions to Eden Shale
Eden Shale Hills

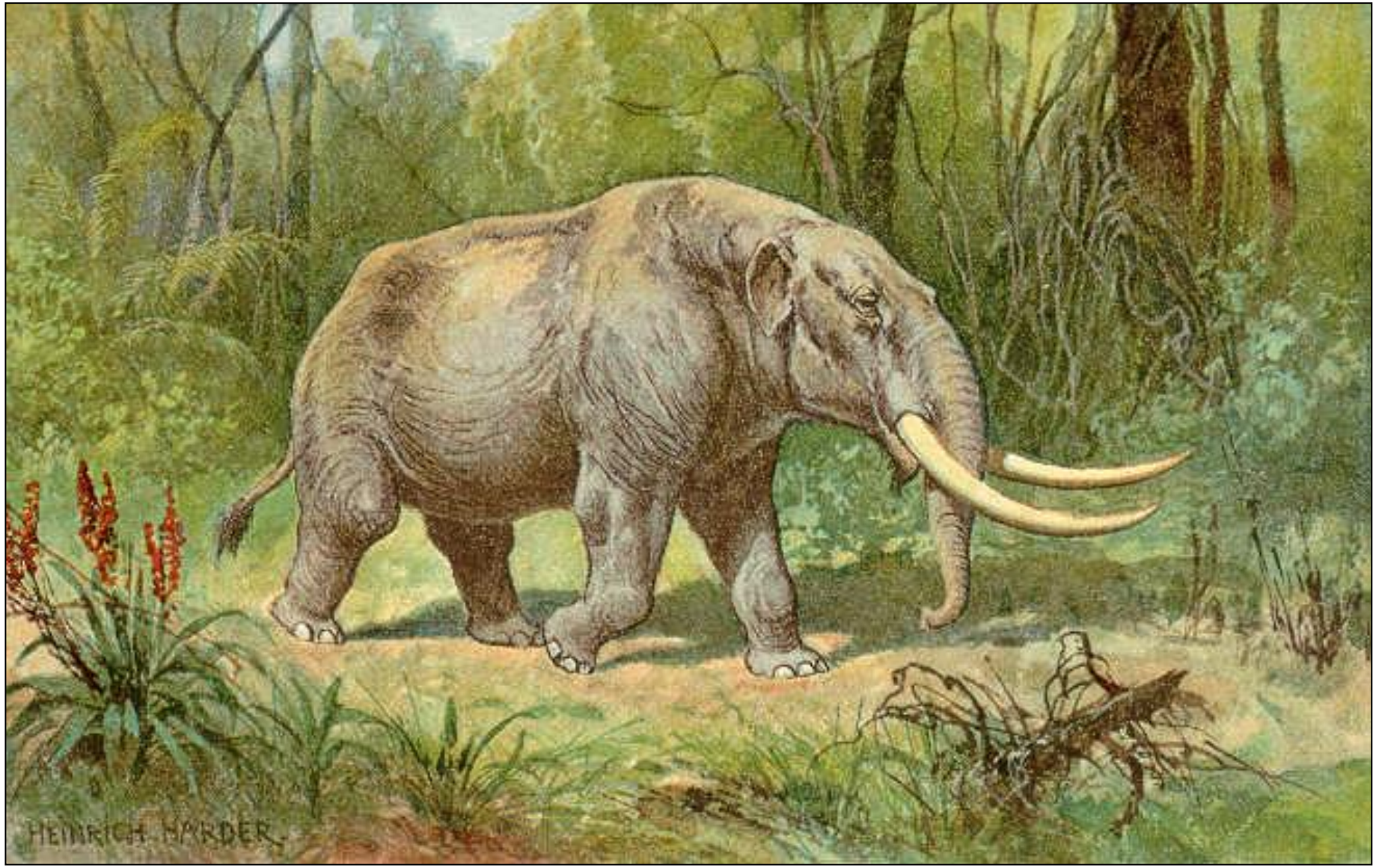
At the landscape level, we first need to understand what natural region we live in, and how it differs from adjacent regions. Along with this understanding, our local plans need to focus on how much of this distinctive land should be protected for more natural things, and to what degree. To a large extent, our history of land use and planning by the community already influences these matters. After more than two centuries of development, the pattern of remaining woods within rural areas has been somewhat fixed by agricultural economics, with the larger blocks of woods mostly confined to steeper slopes, streamsides and our few patches of wetland. Within urban areas, such restrictions have become more intense, although sometimes relaxed. It is always good to review maps of our current condition, to think about what adjustments should be made—with more woods desired in some areas or less in others, and to plan for the many details—including where exactly to promote watershed and riparian protection, more nature reserves and parks, woodland pastures, wildlife management areas, arboretums or botanical gardens, and perhaps strips of native vegetation along roads.

At the habitat level, we run into semantic problems about how to describe the great variation in natural or artificial habitats. We need clearer language in order to plan for varied potential outcomes. We also have to deal with cultural biases about how we want our wilder places to appear and function. There is inadequate local education and research into variation of habitats. There are plenty of globally applicable textbooks (or websites) on ecology and conservation, and there is some technical information from conservation organizations that is relevant to our region, but there is virtually no popular account that would allow the average high school or college student to understand the details of our Central Bluegrass Region. Wharton and Barbour (1990) made an initial attempt to fill this void, but we need to update that book and to make it more presentable for the general public. A central practical issue for such presentation is: what habitats are most degraded and how should these be restored?

Cope's Tapir (*Tapirus haysii* = *T. copei*): about 2 m long and 1 m high. Hay (1923) received pieces of skull from "an old stream-deposit" at Yarnallton in Fayette Co. This extinct species occurred in North America during 1-2.5 million years ago; the genus survived until ca. 11,000. [https://www.deviantart.com/dinogod/art/Tapirus-haysii-426703515]

At the species level, there is a vast amount of biological information in the scientific literature, but the average citizen has little time for detailed understanding. The central issue is: which native species most deserve special efforts at recovery, and which alien species most deserve special efforts at reduction? Special effort for natives implies "micro-management" with direct action to recover selected species through seed collection, propagation, planting or further enhancement of their particular local habitats. For aliens, it implies similar work of the opposite type: locating and removing the most problematic species to a reasonable extent. There is a lot of subjectivity and uncertainty in how such efforts play out, partly because we have little long-term experience. Also, it is easy to waste effort on imperfect projects or failures—in terms of costs and benefits of various types. Moreover, in some cases it may be more reasonable to rely on appropriate "macro-management" of whole habitats within protected landscapes, rather than "micro-management"—for example, mowing or browsing or burning vegetation at the right season may shift the balance from aliens to natives.

We need to integrate these ecological themes, and to give them an economic context—leading into general concepts for how we might proceed as a community. I suggest that interested people should engage in more regular exchange of information and ideas, and that more collaborative work should be planned. Although local government has had several decades of experience dealing with management of wilder parks, riparian zones, tree plantings, and now honeysuckle reduction, we still have little general overview of how the whole balance of economy and ecology should develop within government. There are non-profit organizations that have interests in some aspects of this balance, but they do not seem to join forces enough. The original wilderness has indeed become a "house" but with too many rooms; we need to make sure that the doors work, with regularly oiled hinges. Some walls may need to be broken down to a large central room, for free speech independent of governmental or academic silos.



Mastodon (*Mammut americanum*): about 5 m long with tusks and tail; 2.5 m high. Teeth were cusp-shaped, distinct from mammoth and elephant; often chewed woody plants. It became extinct ca. 10,000 years ago. A fossil tooth from Fayette Co. was at Univ. of Ky. (Hay 1923).
[Image from Heinrch Harder (1858-1935), ca. 1920; https://commons.wikimedia.org/wiki/File:Mastodon_color.jpg]

A Brief Ecological History. Based on archaeological and fossil evidence, the Central Ohio Valley appears to have been a major focus of human hunting, with at least seasonal settlement, for over 10,000 years. This focus was probably driven by the concentrations of large animals, hunted for food, which in turn was driven by the unusually high soil fertility, with much calcium and phosphate for rapid bone development. During the Fort Ancient period (1000-1700 AD), several villages established in the central Bluegrass, including northern parts of Fayette County. After Virginian settlement, the wild animals were largely replaced by livestock of Eurasian origin, with horses potentially providing the greatest financial or social interest.

Interactions here between humans, animals and trees have been intense. Larger animals, including mastodons and mammoths, appear to have passed through central Kentucky in seasonal migrations, with trails connected to mineral springs. Extending concepts developed by Vera (2000) in Europe, it is likely that the woodland of this region coevolved with large animals, which probably had strong effects along complex networks of trails among the trees. A toxic tree species like coffee tree may have been largely dependent on herbivores to consume more palatable trees that would otherwise compete with it, and to disperse its seeds. Although some authors have suggested that the native woodland was also burned often by native people, as is documented in the "barrens" of western Kentucky, there is zero evidence of fire in the Central Bluegrass during the century or two before Virginian settlement.

The decline of larger wild animals has now left conservationists with a quandary—do we try to simulate the effects of these animals in restored woodland, or do we give up and move towards a distinct future condition? While we cannot, of course, completely restore the past condition, a central point of this booklet is to advocate at least for better understanding of that inherited condition. If we wish to maintain a relatively "native" flora and fauna then it behooves us to inquire in some detail about how the ecologies of native and alien species differ.


Left: Constantine Samuel Rafinesque (1783-1840): first botanist to reside in Ky., 1819-26. Right: Charles Wilkins Short (1794-1863): first botanist to reside in Ky. for most of his life. These men had radically different approaches to life in general—maverick versus steady. Rafinesque wrote little about the Bluegrass; Short started a detailed “Florula Lexingtoniensis”.

The Emergence of Academic Approaches. There were a few scientific observers in this region before 1800, but then C.E. Rafinesque (affiliated with Transylvania University) and C.W. Short (a medical doctor) resided in Lexington during 1820-40 and made many botanical observations. Rafinesque, an aspiring polymath, tackled many biological and archaeological subjects. Short worked with Robert Peter, a professor of chemistry in the new Agricultural and Mechanical College who also wrote much about relationships of plants to soil. Their work provides much insight to the original condition of this landscape but, sadly, their research did not blossom into a significant program at the University of Kentucky. Natural history—the descriptive precursor to much ecology and environmental science—did develop at the university to a limited extent during 1930-80, especially in the Funkhauser Building with its museum and herbarium. However, its last champions (W. Barbour, R. Keeney, W. Davis, W. Meijer et al.) have not been satisfactorily replaced. The main center for natural history in Kentucky today has become Eastern Kentucky University at Richmond.

Curiously, two somewhat independent women came to play central roles in the natural history and conservation of this region during the 20th century: Lucy Braun, based at Cincinnati but widely travelling, and Mary Wharton, based in Lexington. Although largely botanical, they worked with others on general matters related to overall conservation of the Central Ohio Valley, with its peripheral hills. Wharton also founded what remains the only properly endowed nature preserve in Fayette County—Floracliff on Elk Lick Creek. Today, this preserve is becoming a fully fledged center for natural history, with many workshops in varied subjects. Such programs are needed to reignite the public's latent interest in biological diversity, and to provide a model for management of more natural lands. Our educational system and local government has significant resources, but it has been difficult to focus them on central problems for conservation in this community.

Left: E. Lucy Braun (1889-1971) Right: Mary E. Wharton (1912-1991)

[http://voyageurmedia.org/wordpress/portfolio/lucy-braun/; https://www.flickr.com/photos/floracliff/3817532921]

The Emergence of Conservation and Environmental Protection. Although "conservation" of land for diverse public uses spread across the nation over a century ago, in Fayette County this movement was limited to establishment of the university campus in the 1880s and a few city parks, notably Woodland Park about the same time. During the "second age of conservation" in the 1960s and 1970s, environmental affairs became significant, along with more professional urban planning at the local level, plus new regulation at state and federal levels in matters of energy, air and water. While these advances have generally been well accepted by the community, some aspects of water management remain problematic. The current program to reconstruct much of the sewer system, and to manage riparian zones in different ways, has led to considerable disturbance along existing wooded corridors, or to uncertainties in how to restore more natural or more healthy conditions. For example, the Coldstream Park project on Cane Run sought to reconstruct an ancient sinking stream into an artificial floodplain, with dubious or false justification—the city pursued this as a legally acceptable alternative to being fined for poor water management over the decades, rather than as a well-designed environmental enhancement.

Conservation of undeveloped land, and its appropriate management, has continued to evolve in the county, but these "earthly" matters have not received nearly as much consistent regulation or funding as the other "elements" of our environment—water, air and energy (or fire). There is, arguably, a continual need for more trees, parkland, and preserved wilder land as the population grows or yearns more for reconnection. Recent advances in urban forestry within local government and the university are encouraging, but clear goals have remained elusive—Where should we plan for larger blocks of woods? Precisely where should more trees be fostered, and which species are most desirable? Can we experiment with "woodland pasture" or other simulations of the inherited condition? To what extent should we reduce the invasion of alien shrubs and trees, especially along roads and riparian zones?

Cane Run: ca 150 m (500 ft) downstream from Citation Blvd. before engineering (4 Sep 2013).

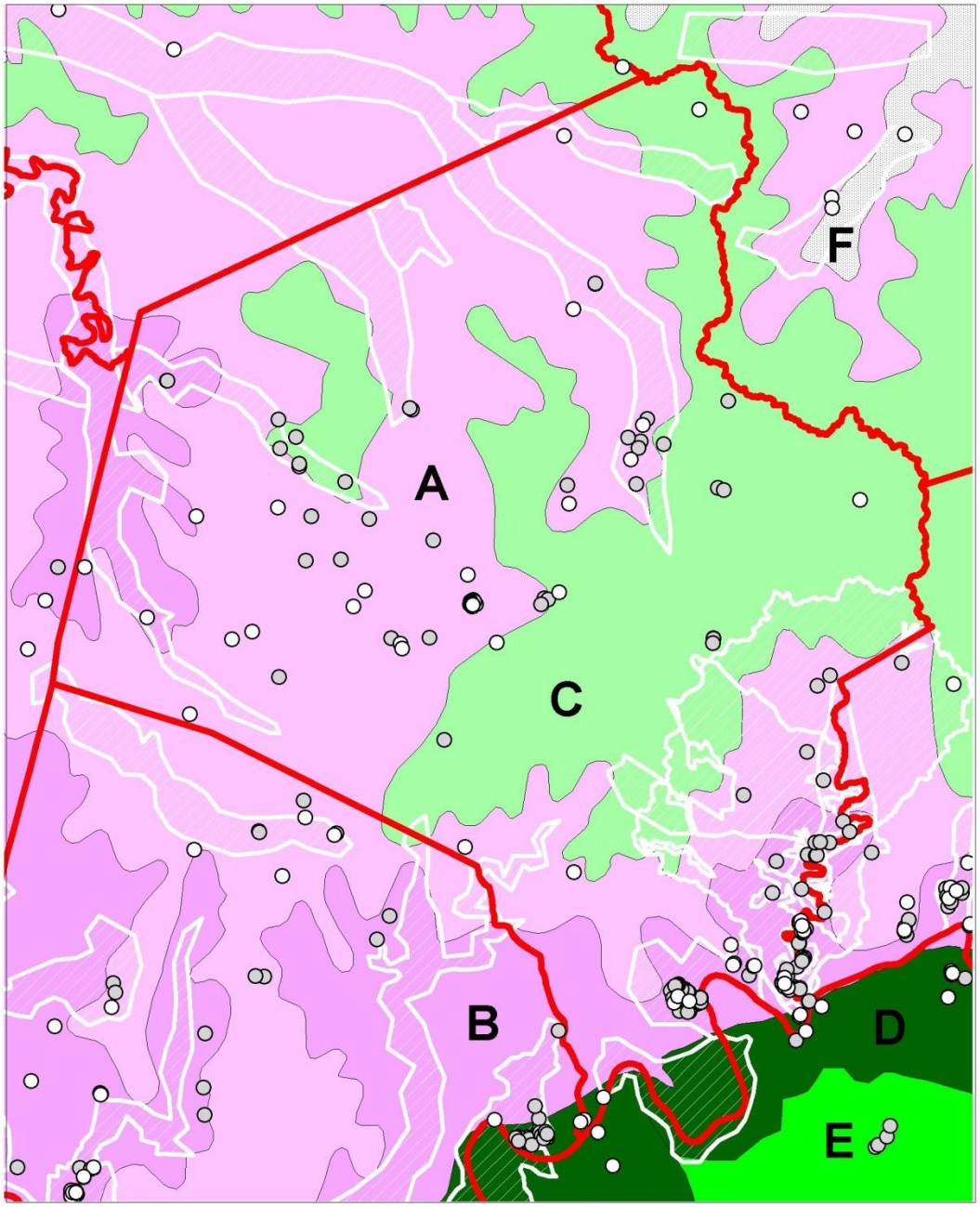
Cane Run: same location as above, after engineering (9 Feb 2019). Next pages: view from upstream before and after expensive removal of riparian woodland—what was the benefit?

PART 2
Goals for Conservation

Goals for conservation: the landscape and watershed level. Fayette County lies near the center of the whole Central Ohio Valley, which can be defined as the Bluegrass Region plus peripheral hills (Knobs), ancient terraces and transitions to glacial till plains. In terms of physiography, the county is restricted the central Bluegrass (see map), containing part of the Inner Bluegrass and transitions to the Eden Shale Hills (including Garrard Siltstone in D). The Inner Bluegrass (A) is a distinctive region based on older, Middle Ordovician limestones, which are locally phosphatic and have formed deep well-drained soils on gentler uplands. More dissected zones along the Kentucky River and other large streams have generally more shallow or rocky soils (B). The Eden Shale Hills lie mostly on calcareous shale and siltstone of Upper Ordovician age, but there is some interdigitation with Inner Bluegrass limestones (in C).

Currently, forest in the county is concentrated on steeper slopes along the Kentucky River and its major tributaries, mostly within the Inner Bluegrass but also including a small section of the Eden Shale Hills. Local government has already ruled that this forested zone, in general, should be treated as a "Natural Zone" for planning, with strong restrictions on commercial use, residential development or other infrastructure. Moreover, there are legally protected areas here on private land (Floracliff) and on public land (Raven Run).

The largest tributary of the river is Boone Creek, where there has been some private effort to protect land, but there have been conflicting ideas about how to manage this extensive ravine, and there is no government-funding. The whole Boone Creek watershed is shared with Clark County, with virtually no urban influences. This watershed is in relatively good condition for the region, and it would be reasonable to put more focussed effort on protecting and improving it. Other large streams have their headwaters in the Lexington area: Hickman Creek, South Elkhorn Creek, Town Branch (with Wolf Run), and North Elkhorn Creek. Efforts to protect and restore these headwaters are more challenging, as detailed further below.



Some Natural Features of Fayette Co.

A-F (colored): see landtype legend below

Red lines: county boundaries

White hatching: corridors of special interest

White dots: state-rare species locations

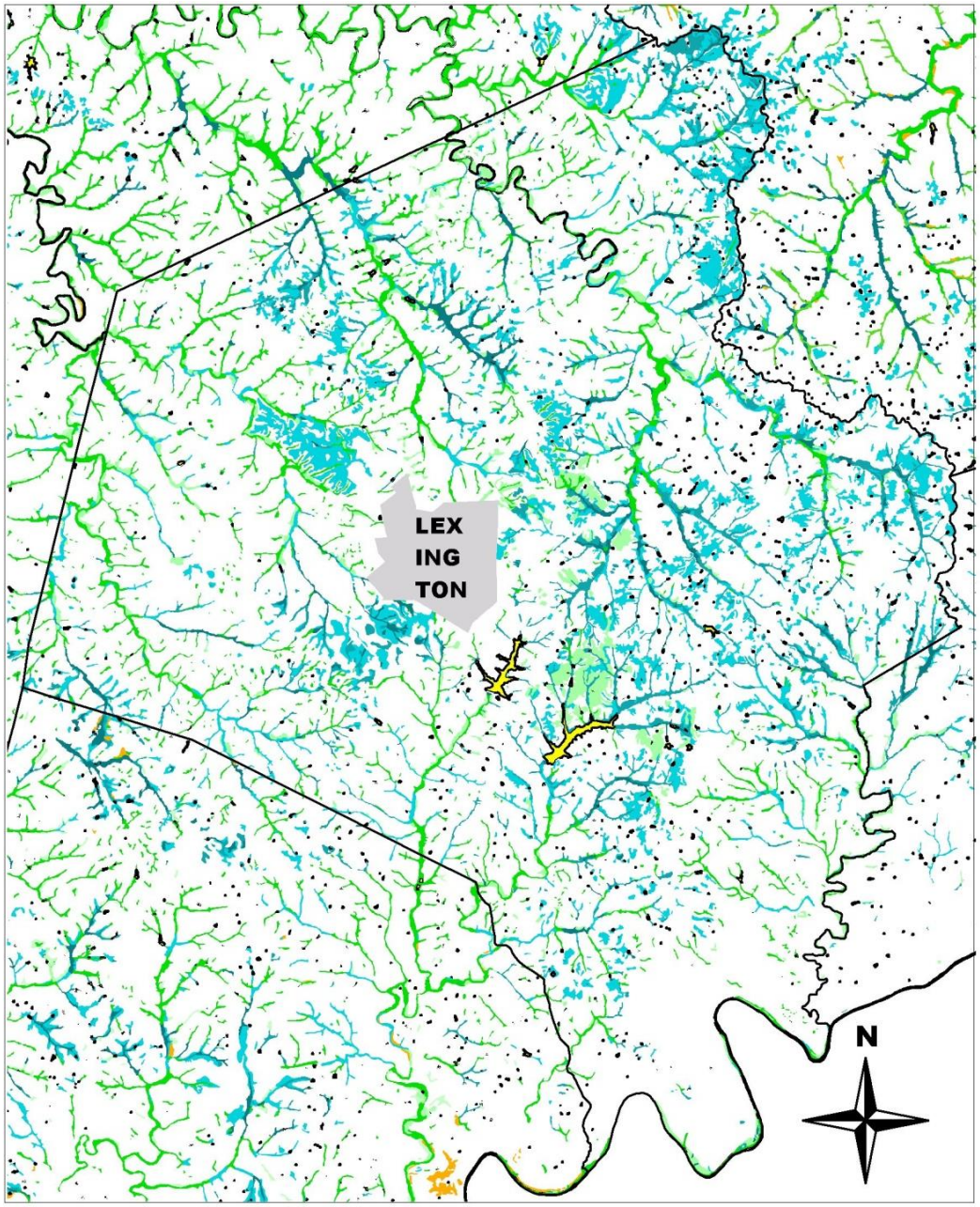
Grey dots: other conservative species data

These data are old in some cases, and species have disappeared at many sites. The species include birds, bats, northern leopard frog, cave beetles, and several vascular plants. Plants on the plains (A) include cane, pea-vine, running buffalo clover, giant wood-lettuce, lowland coneflower; also remnants of deeper woods (hyacinth, running rue-anemone, wood-nettle, bluebells etc).

Landtype Associations
(from STATSGO soil associations)

- A. Inner Bluegrass Plains
- B. Inner Bluegrass Ravines
- C. East-central Bluegrass Plains
- D. Garrard Siltstone Hills
- E. Eastern Bluegrass Hills
- F. Inner Bluegrass Valleys (Licking)

0 5 10 15 20 Miles



Floodplains and Wetlands of Fayette Co.

Greens and blues: see legend below

Black lines: county boundaries

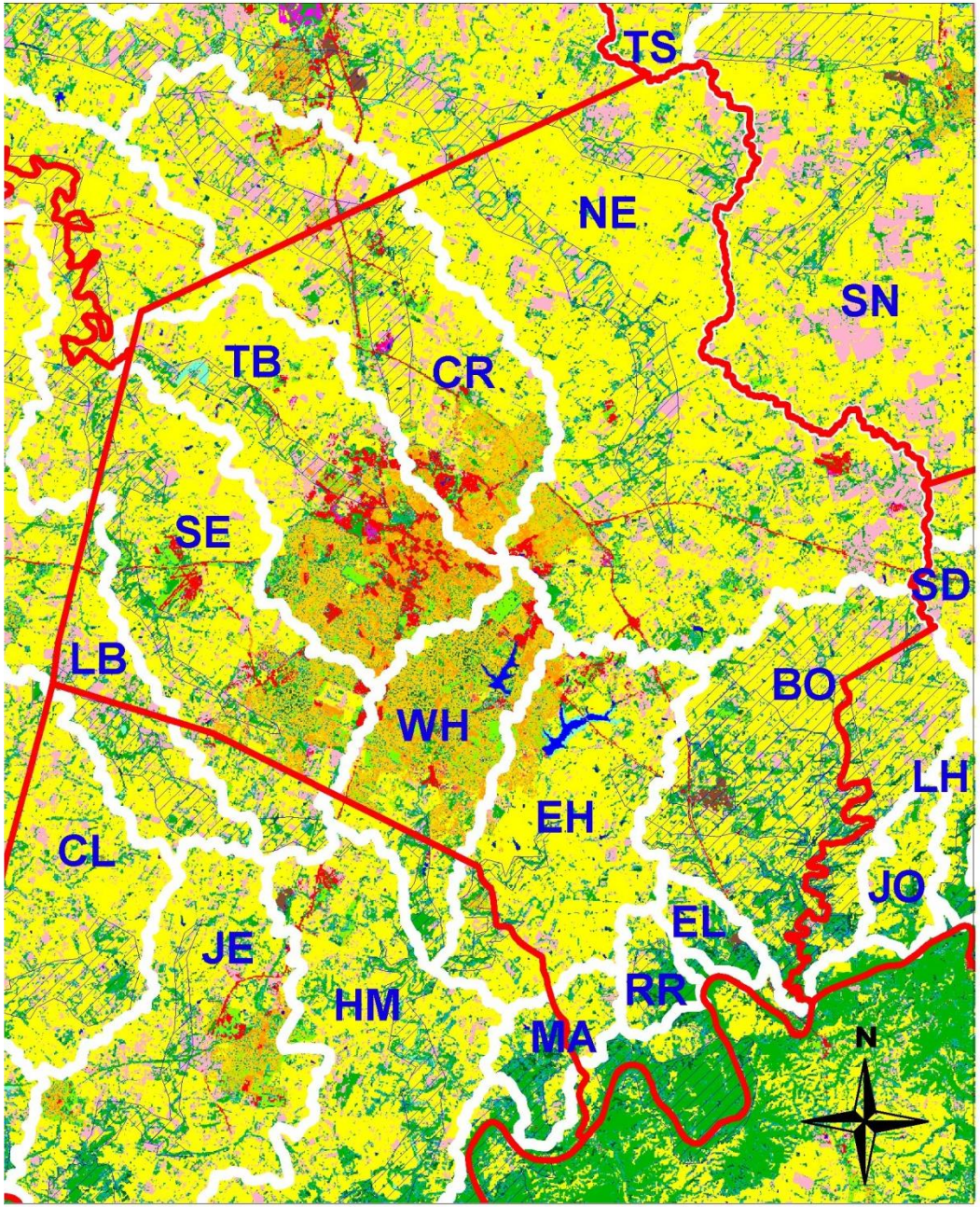
Larger streams all have narrow strips of floodplain along them (mapped in green).

Wetlands and areas transitional to wetlands (mapped in blue) are concentrated in the northeast sector of the county. Here the soils have more clay content, being formed in residuum from the formerly overlying Eden Shale. Although there is relatively little surface bedrock that is Eden Shale, most of the soil in this sector is derived from ancient weathering of this rock, and it is less fertile.

Floodplains and Wetlands (from county soil map)

- **Well-drained alluvial terrace or toeslope**
- **Well-drained fresh alluvium (riparian)**
- **Moderately well-dr. (transition to wetland)**
- **Somewhat poorly drained (wetland)**
- **Poorly drained (wetland)**
- **Artificial pond or lake**

0 5 10 15 20 Miles



Watersheds of Fayette Co. (white lines)

BO	Boone Creek
CL	Clear Creek
CR	Cane Run (to North Elkhorn Creek)
EH	East Hickman Cr (to Hickman Cr)
EL	Elk Lick Creek
HM	Hickman Creek
JE	Jessamine Creek
JO	Jouett Creek
LB	Lees Branch and Sinking Creek
LH	Lower Howards Creek
MA	Marble Creek
NE	North Elkhorn Creek
RR	Raven Run
SD	Strodes Creek (to S Fk Licking Rv)
SE	South Elkhorn Creek
SN	Stoner Creek (to S Fk Licking Rv)
TB	Town Branch (to South Elkhorn Cr)
TS	Townsend Cr (to S Fk Licking Rv)
WH	West Hickman Cr (to Hickman Cr)

National Land Cover Data: major classes (from 1990s LandSat; ky4001sp.bil]

- Urban land
- Suburban land
- Row-cropped farmland
- Pastured farmland
- Woodland

0 5 10 15 20 Miles

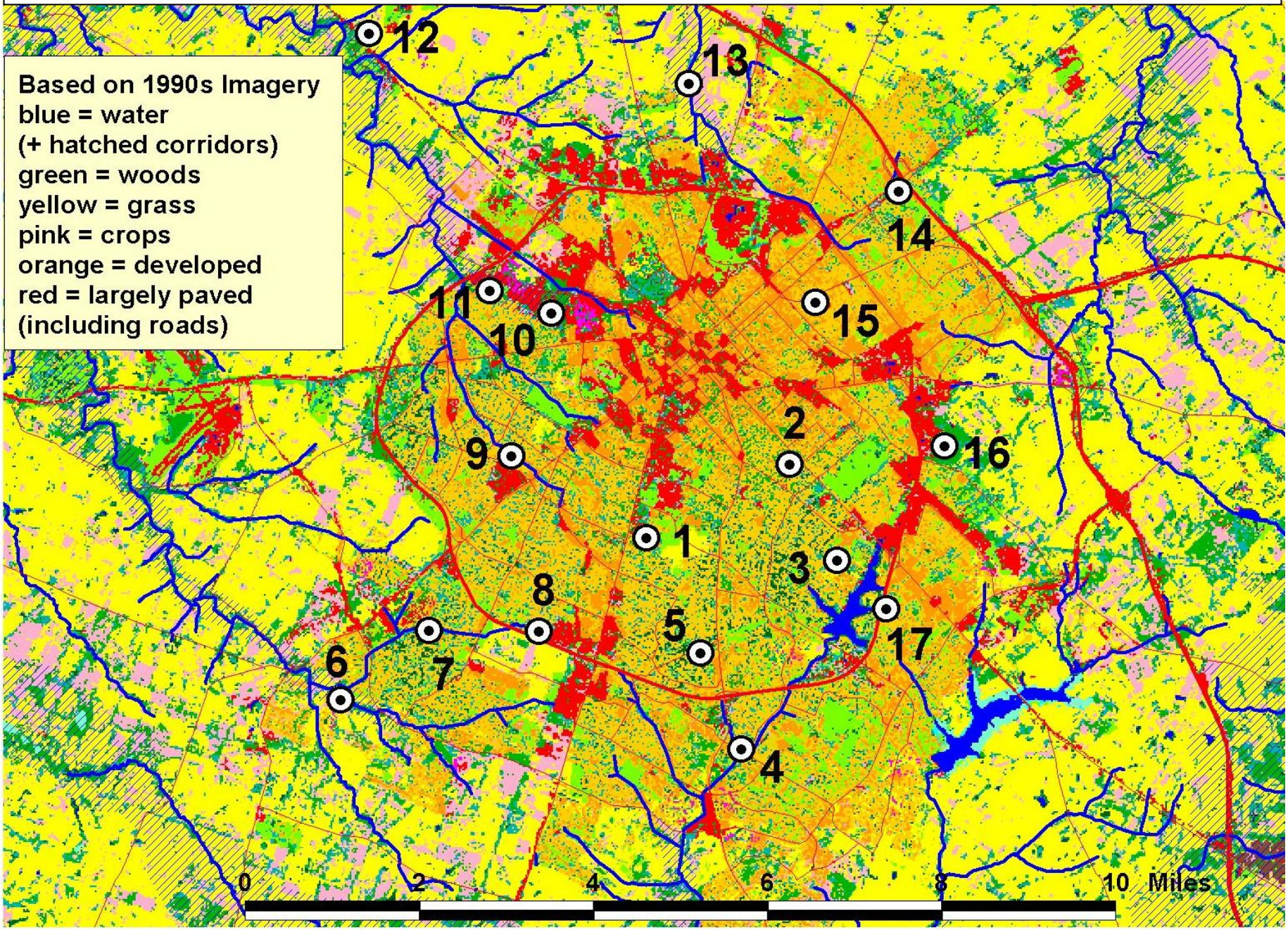
Blue-hatching: indicates more significant corridors

On the more gentle uplands that prevail over most of the county, the general lack of wilder lands can be discouraging at first sight for planning conservation. One could focus on the few better remnants of the original woodland, as indicated in the accompanying map. But, in addition, one might conceive of a long-term plan to connect and restore remnants along some obvious riparian corridors. Given the general interest in riparian restoration for watersheds, it makes sense to widen these zones where possible to include adjacent uplands. Local government, backed by state and federal, has already committed much to enhancing the immediate riparian zones, but it has not focussed enough on incorporating adjacent non-flooded lands with distinct needs for restoration and management.

Another special type of opportunity for restoration on uplands lies in the community's parks. Although designed primarily for diverse recreational uses, several sections of these parks also provide room for more native vegetation and wildlife. In a few obvious cases, much of the park is designed for relatively wild conditions, including McConnell Springs, Veterans Park and Hisle Park, as well as the more extensive Raven Run Nature Sanctuary (734 acres) along the river. Although even these parks may not allow strictly natural conditions with largely native species throughout their area, considerable progress can be made in varied transitions from artificial to natural.

There are of course many additional narrower or smaller opportunities for native plants and animals to persist or even flourish in some cases, including extensive zones along roads and railways plus the many backyards of individual people. But there are also great challenges for serious restoration at these smaller scales. The ecological conditions at these sites, in terms of soils, wildlife, varied disturbances and other factors, will depart severely from the original habitats of most native species. Moreover, several aggressive alien species have now come to dominate parts of our landscape, especially in urban areas.

Lexington: sites with special interest for restoration of native vegetation. For details of each site see following: http://www.bluegrasswoodland.com/uploads/Restore_Lexington.pdf



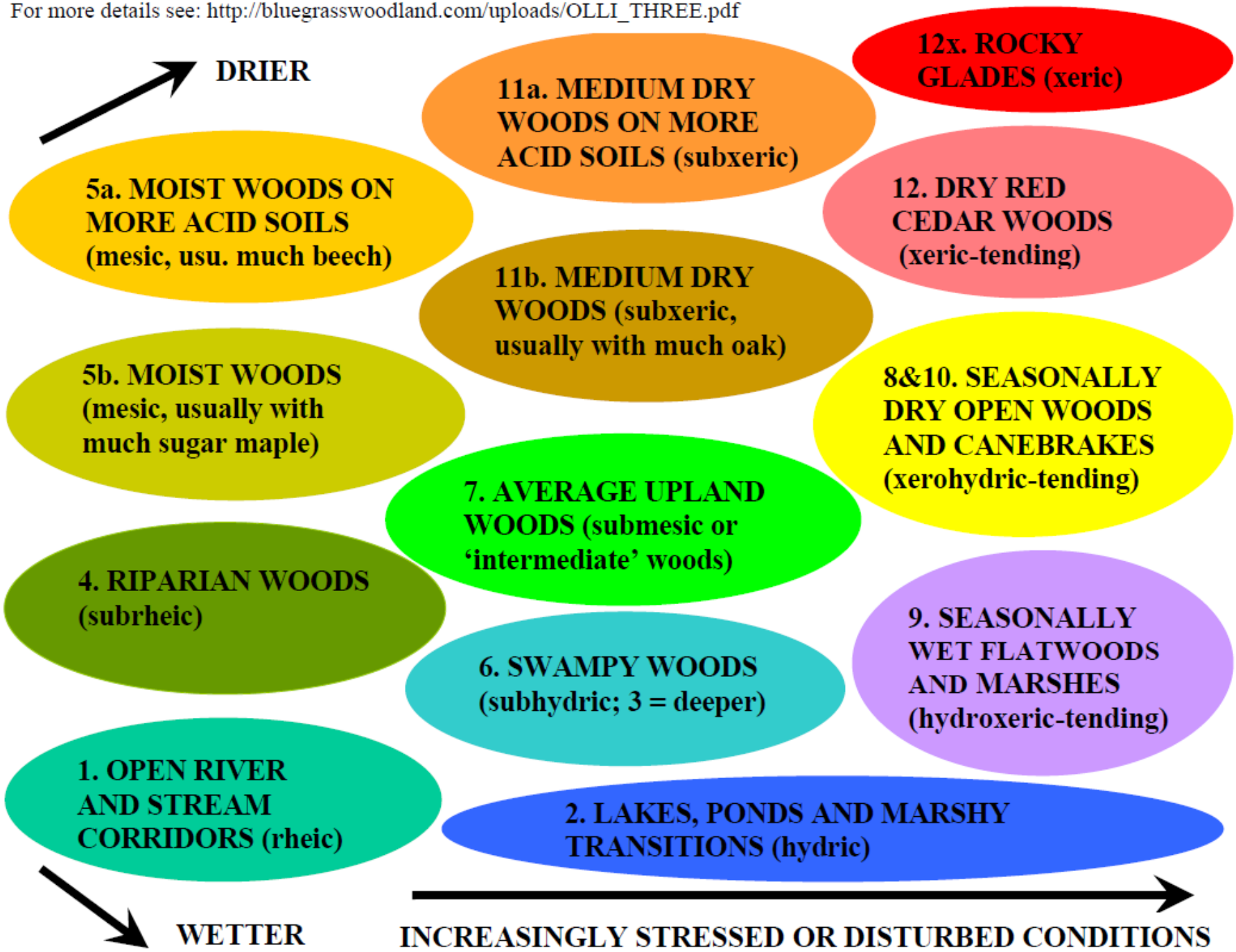
Goals for conservation: the habitat level. It is sometimes assumed that simply protecting land from artificial developments will be sufficient to foster natural ecology and native species. This is a naïve view in our modern world, where most larger wild animals have become at least locally extinct; original vegetation has generally been cleared; much soil has become eroded, compacted, drained or plowed; and invasive aliens have become locally dominant. So it is useful to identify sites where more natural habitat conditions can be restored with some efficiency, rather than expending a lot of effort at sites with more difficulty in initial restoration or in the continual maintenance that most sites will require. A practical habitat classification is needed to organize our planning, based major ecological gradients. In ravines and dissected land along larger streams, there is a relatively complex sequence, as follows (greek terms are in parentheses). Asterisks at left indicate classes with priority for special protection or restoration.

**1 (rheic). River corridors or larger streams plus their scoured riparian transitions, especially on cobble or bedrock; with rice-grass, river oats, big bluestem. As a natural habitat, this relatively open aquatic zone has been devastated by dams on the river, which would have to be removed for restoration. But scoured or concreted urban streambanks are suitable for some plants.

4 (subrheic). Riparian woods, frequently flooded but generally covered by continuous tree canopy: with elm, boxelder, sycamore. Although largely degraded, this remains widespread and often recovers without help, at least the trees. Aliens can be problematic, especially in town.

5 (mesic). Moist woods that have relatively little wetness or dryness, especially north-facing: with sugar maple, basswood, northern red oak or bitternut. This is relatively secure near the river, and it can slowly recover by itself. But isolated upland remnants deserve special efforts.
*5a. Variants on more acid soil: with beech, tulip tree. These used to occur on river terraces and more sheltered sections of the Eden Shale Hills. Most is now cleared or highly degraded. Restoration would need much planting of trees, especially the slowly reproducing beech.

For more details see: http://bluegrasswoodland.com/uploads/OLLI_THREE.pdf



11 (subxeric). Medium dry woods, mostly on rocky slopes or ridges: with oaks, ashes, hickories, elms, sugar maple. This is mostly secure in ravines, and tends to slowly recover by itself. However, bush honeysuckle and other aliens are often problematic.
*11a. Variants on more acid soil: with white oak, black oak, pignut hickory. This was formerly widespread on poorer soils (especially Eden Shale), but it is mostly cleared or highly degraded. Restoration would need much planting of white oak and other typical tree species.

12 (xeric). Dry red cedar woods (xeric): with red cedar, oaks, ashes, elms, hickories, shrubs. This is relatively stable on shallow soils near outcrops, but since settlement it has also become a widespread successional type in drier old fields. It is not a priority for special action.
12x. Open variants on cliffs and flatrocks; with stonecrop, prickly pear. These are relatively stable and secure in some cases, but there may be sensitive remnants along ancient trails.

To this complex "ravine series" of hilly land can be added the following "wetland series".

**2 (hydric). Lakes, ponds, marshy transitions: with buttonbush, pondweeds, other aquatics. Natural sites are few and much degraded, but many new ponds have been created. For proper restoration, we need better understanding of original hydrology, vegetation and wildlife uses.

*6 (subhydric). Swampy woods, mostly along back-channels of larger valleys, and along streamheads on uplands: with white elm, green ash, swamp white oak. Although this is generally much degraded, there are widespread small remnants. Better remnants tend to recover from disturbance, but pest/pathogens have reduced elms and ashes, and there are few oaks left.

**9 (hydroxeric-tending). Seasonally wet thin flatwoods and marshes: with sedges, shrubs, oaks. This was probably uncommon before settlement, except where promoted by beavers, or perhaps the wallowing of larger animals. Restoration will need better understanding of original hydrology, vegetation and wildlife uses.

The only natural pond of Fayette County in fair condition: on Sulphur Well Road. Cecil Ison and I made a provisional core here for pollen-analysis by Eric Grimm at Illinois State Museum.

The habitats outlined above mostly have limited extent, in some cases with relatively unusual hydrology. In contrast, the following “plains series” was widespread on the rolling uplands and plains around Lexington, and deserves major emphasis in restoration.

*7 (submesic). Average upland woods, formerly the most widespread vegetation type. Its intergrading variants appear to have included: sugar maple-bitternut hickory (with less disturbance); black walnut-Ohio buckeye (less palatable to herbivores); white ash-red elm (more palatable); and oak-hickory (varied species, with more moisture-stress). Although remnants are widespread, most are highly degraded and lack the formerly characteristic running buffalo clover. As well as replanting of lost plants, a naturalistic disturbance regime is needed.

**8 (submesic). Thickets formerly maintained by repeated browsing, but now perhaps restorable with appropriate bush-hogging or other management. This vegetation would have occurred especially along major animal trails or around licks and wallows (or perhaps burned in limited areas on drier soils): with cherry, black locust, haws, prickly ash, plums, sumacs, briars, cane. The original extent was small in total, but it may have prospered locally during early settlement at woodland edges. Potential remnants are widely scattered but now highly degraded and unstable, mostly lacking the cane (*Arundinaria*) that used to be locally dominant.

**10 (xerohydric-tending). Seasonally dry open woods and canebrakes, especially along major animal trails or around licks and wallows (or perhaps burned in limited areas on drier soils): with bur oak, honey locust, cane, diverse forbs and grasses; partly developed by Virginian settlers into “woodland pasture”. This may have been savanna-like in places, but that term has been misapplied to combinations of 7, 8 and 10. True grassland was probably not extensive.

Various microhabitats could be added to this list, or perhaps conveniently included: caves** (5,11 etc.), cliffs (in 5,11,12), springs** (1), streams (1,4,6), ponds** (2,6,9).

Restored canebrake along Cane Run in Coldstream Park, planted 1999/2000 but now covering a few acres. There are no remnants of cane along this creek, despite its name [20 Oct 2011].

Goals for conservation: the species level—natives. Given the potential for lists of species to become excessively complex for practical use, it is important to craft groupings that have some ecological or functional association: A-F below. Detailed lists of species and recovery plans can be added later, but we first need a programmatic summary. Although there are many uncertainties to be resolved through further research, we can make provisional suggestions.

It is important first to note that some uncommon or even rare species do not currently need special micro-management in Fayette County, just protection of land and restoration of habitat. We hope that such species can include virtually all birds, except of course those that have become globally extinct: passenger pigeon and Carolina parakeet. It is remarkable that blocks of woodland or grassland that are large enough will generally allow rare bird species to recover. For example, several uncommon to rare grassland birds were known to nest during 1970-90 in the sections of Masterson Station Park that were unmowed during the summer: loggerhead shrike, dickcissel, savannah sparrow, grasshopper sparrow, Henslow sparrow, bobolink. Unfortunately, the city refused to maintain or expand this habitat, and these species largely disappeared from the park (M. Flynn, pers. comm.). Some larger birds of open habitats have suffered more persistent declines: barn owl and bobwhite quail. But their recovery may still be largely dependent on sufficient habitat with safe nesting sites: large trees or old barns for the owl; and unmowed grassland with limited predation for the quail. Birds of woodland edges and deeper woods generally recover where habitat is sufficiently extensive, including the yellow-crowned night-heron (of riparian woods and ponded areas), and turkey (which has spread across the state after successful restocking).

The world of insects is beyond the scope of this initial summary, but we can reasonably hope that recovery of declined or even rare species is possible with sufficient habitat, including food sources. For example, monarch butterflies respond to sprouting milkweeds after mowing.

Bobolink (*Dolichonyx oryzivorus*). During 1975-90, this rare bird nested at Masterson Station Park; but the city refused to maintain habitat. [https://www.allaboutbirds.org/guide/Bobolink/id]

A. Selected aquatics: disappeared mussels, fishes & plants (especially habitats 1 & 2). Even in better streams, several species have declined, and in the locked-and-dammed Kentucky River many species typical of free-flowing systems are gone. Ky. Dept. of Fish & Wildlife are perfecting methods to raise rare mussels and fishes in captivity, then releasing them into restored streams. However, there are no prospects for such releases in streams of Fayette County. The closest priority for such work would be the South Fork of Licking in adjacent Bourbon and Harrison Counties. In addition to strict aquatics, several species typical of shore-lines have largely disappeared, especially plants along rocky banks of the Kentucky River and plants typical of natural ponds or seeps. Some of these plants need to be brought into cultivation and seed-storage for future use in restored systems. Some plants typical of scoured rocky banks of larger streams may become usefully planted along urban streams with flashy hydrology: willows, dogwoods, indigo bush, blue indigo, river oats, big bluestem, switch grass.

B. Most bats: threatened with white-nose-syndrome (especially caves in habitats 5 & 11).. There is now enhanced interest in bats due to this disease, and measures are being developed to safeguard their habitats and populations. Unfortunately, little progress can be shown yet in reducing effects of the disease. Ideally, caves should be fenced or gated in order to prevent human disturbance of hibernacula. The USFWS has called for a moratorium on caving activities in affected areas and strongly recommends decontamination of clothing or equipment in such areas after each use. Disturbance of feeding habitat should be reduced within critical distances from hibernacula. USFWS has published general recommendations for forested regions of the state, but they are difficult to implement within the central Bluegrass. Most species are severely affected, but big-eared bats appear to be largely immune. The northern long-eared bat is a small species that has suffered particularly severe declines, and it now has federally threatened status. There is some evidence that small bats like this can significantly reduce populations of mosquitoes.

Ring Pink (*Obovaria retusa*), a globally imperiled mussel that used to occur in the Ky. Rv. Others included Clubshell (*Pleurobema clava*), Pyramid Pigtoe (*Pleurobema pyramidatum*). If dams were removed, such species could be reintroduced after propagation by USFWS. Rare fish might be expected by recover by themselves, including the eel, northern madtom and tippecanoe darter. [https://upload.wikimedia.org/wikipedia/commons/7/79/Obovaria_retusa.jpg]

C. Simulation of wild ungulate effects: with/without bison & elk (especially habitats 6-10). We know that ungulates and other mammalian herbivores can have significant selective effects of plant species, sometimes reducing aliens more than natives. Management of deer alone may not be enough for restoration. The native elk, bison, sloth and mastodon have disappeared, with no foreseeable hope for recovery as free-ranging animals. However, there is considerable potential to use livestock in controlled browsing for simulation of the former ecological conditions. We know that sheep, goats, horses or cattle can reduce some invasive alien plants under some conditions. Unfortunately there has been little research into these matters within eastern North America, and there has been virtually no progress within Kentucky. Griffith Woods in Harrison County still offers the best opportunity in the region for this kind of research. In Fayette County, there have been a few trials, mostly on private land and not yet properly assessed or demonstrated to the public.

D. Imperiled species of submesic and subhydric uplands (especially habitats 6-10). These span the range of formerly typical upland habitat, from wooded to open, but generally benefit from some disturbance. The only globally rarity in this group is running buffalo clover, but other plants are rare across the state (e.g. *Floerkea*, *Lilium*, *Stenanthium*). In addition, some species are locally abundant on steeper wooded slopes but have largely disappeared from uplands in the Central Bluegrass, such as wild ginger, wild hyacinth, peavine, alexanders and cane; but some plants are easily reseeded (e.g. wild ryes, jewelweeds, phacelias). Several shrubs and trees that remain common in hilly land could be added to this list as priorities to propagate for restoration on the plains; these include plums, hawthorns, viburnum, pawpaw, hornbeams, spicebush (shrubs); and some oaks, hickories, slippery elm, sugar maples, buckeyes and basswoods (trees). Dispersal ability appears slow in most of these species, which do not generally show up within restored habitat; in contrast, more weedy species often remain within disturbed woodland. [The northern leopard frog might be added here for possible recovery.]

Plot established in 2005 at Griffith Woods (Harrison Co.) to study effects of excluding deer. It is one of eight plots designed for research by the UK Dept. of Forestry, but not continued. This plot clearly shows the effect of deer browsing wintercreeper. [Photo from Scott Gleeson]

Lilium michiganense, the midwestern lily of thin submesic woods, appears to have been almost eradicated, especially by free-ranging hogs; recovery would now depend a lot on propagation. [Image from https://www.minnesotawildflowers.info/flower/michigan-lily]

Northern leopard frog (*Lithobates pipiens* or *Rana p*.). This species of wet meadows is rare in Kentucky and has been declining across much of its range. It is known from northern Fayette County, and it is possible that recovery could be enhanced through better pond designs and artificial reintroductions. [https://fw.ky.gov/Wildlife/Pages/Northern-Leopard-Frog.aspx]

E. Imperiled plants of drier woods or glades (especially habitat 12). Globally rare species include glade-mallow, bladder-pod, hispid gromwell, Harris' goldenrod and Walter's violet (see Latin names in Appendix); others are less rare but still worthy of recovery, including prickly pear, pink stonecrop, glade St John's wort, and rock pink. Some of these cannot be expected to expand their range by much, since they are restricted to small areas of rocky or xeric extremes. But an effort is needed to safeguard germplasm in cases of declines due to climate change or invasive aliens. Others in this group are less restricted to these habitat extremes, and could be increased on deeper soils in dry woods and in associated openings, perhaps through use of appropriate browsing or burning. Some may even be used in urban environments along rocky roadcuts, walls or concreted edges. It is likely that such species have declined greatly due to both excessive disturbance in farmland plus insufficient disturbance in remaining woodland.

F. Trees with acute pathogens, pests or other special threats (especially habitats 6 & 7). The obvious examples are ashes, butternut and elms. Currently, most ash trees, except blue ash, are being killed by the Emerald Ash Borer. Although parasitic wasps may be used to slow the pest, spread of these wasps will not be fast enough to make much difference during the the initial epidemic. For the long-term, we need to collect more ash seed, and to study how remaining seedlings in the woods (which escape the borer) will respond after the epidemic abates. In the case of butternut, its almost complete loss from the region is due to a fungal canker. But it is possible to replant seedlings from more resistant trees that have been found, especially in Appalachian regions. Many large American elms have been lost to Dutch Elm Disease, but some survivors exhibit resistance. The slippery elm has declined much more since settlement, probably due to livestock browsing on its palatable bark, as in basswood. It is one of the native trees that most deserves propagation for replanting. Red mulberry may also suffer from bark canker before full size is reached, but this needs more research.

The “Walnut Woods” on Shady Lane at the back of the UK Arboretum. Wintercreeper began to dominate the ground after 1980, when mowing was ceased. Although research on vegetation here began in the 1970s, there has not yet been a coordinated study for compete removal.

Goals for conservation: the species level—aliens. Some problematic alien plants are listed below; alien animals (e.g. starlings) are not addressed here but deserve further consideration. Macro-management of habitats, or planting of competitive native species, can sometimes reduce these species. But more focussed micro-management often requires manual labor and herbicides. Notes below emphasizes woodland rather than grassland, because grassland was rare in the original landscape. Restoration of old fields should generally lead to a more woody condition, such as thickets of locust and cane, which tend to eliminate alien plants in the fields.

Herbs: garlic mustard, chickweed, gill-over-the-ground, stilt-grass. In the first two cases, there is evidence that sheep or deer can sometimes reduce their abundance. Such effects are probably most useful during the fall and winter, when there is less collateral damage to native spring-flowering plants. But in the case of gill (*Glechoma*) and stilt-grass (*Microstegium*), these are highly unpalatable to mammals, and deer have probably contributed to their rise in the woods, especially along trails. It is likely that most of these aliens can be reduced in the shade by aggressive native plants such as purple phacelia, wood-chickweed, wood-nettle, wild ryes and rice-grass (*Leersia virginica*). We need planting trials with these natives.

Vines: especially winter creeper; also Japanese honeysuckle, etc. Winter-creeper (*Euonymus fortunei*) is perhaps the most problematic invasive plant across the region, persisting on the ground in shade as well as climbing trees and cliffs. There are no native evergreen vines to replace it, except perhaps crossvine in some cases. Chemical control is possible using triclopyr or 2,4-D plus a strong surfactant such as Pentra-Bark; glyphosate alone is much less effective. Most invasive woody vines tend to be evergreen, and livestock can often reduce them, based on varied circumstantial evidence; again, we need proper research. Native herbivores also browse on these species in some cases. Dense deer herds can virtually eliminate spread of winter-creeper on the ground, but it is not easy to reduce browsing on natives during spring!

Gromwell (*Onosmodium hispidissimum*). This is endangered in Kentucky and may be globally rare (G3G4). The only record in Fayette County is from Raven Run, where there has been insufficient maintenence of open habitat for this species.

Shrubs: bush-honeysuckles privets burning-bush multiflora-rose etc. The spread of Amur bush-honeysuckle (*Lonicera maackii*) since 1970 has become the most obvious invasion within woodland. This species is most successful in thin woods and edges where native understory has been removed, but it can also spread into moderate shade. It is often reduced in the deep shade, especially under maples, oaks and hickories, especially where browsing by deer is intense as well. Thus, some discussion of control can again be shifted up to the level of overall habitat restoration, but larger bushes generally need to be cut down and poisoned as part of restoration plans. Controlled herbivory using deer or livestock may be possible, but we need much more research. Most invasive shrubs in this region are more or less palatable for mammalian herbivores. Burning-bush is especially palatable to deer, and it is not spreads little, although it is locally common around residential areas. Multiflora-rose has been common for over 50 years, but does not persist in deeper shade; pests and disease also reduce it.

Trees: callery pear, tree-of-heaven, white-mulberry. These three species are locally abundant invasive trees. They generally need intensive micro-management for control, but succession to deeper shade also tends to eliminate them. The pear has become abundant during the past 30 years, now being a widespread invader of old fields, roadsides and woodland edges. Manual removal using saws and herbicides is needed for restoration, and the dangerous thorns on its low branches cause difficulty in dense thickets. Tree-of-heaven also needs manual removal, and its vigorous lateral suckers require persistence control over several years; in contrast, its wind-dispersed seeds do not usually spread far. White mulberry has been present since early settlement but it is only a local problem. Most rural areas do not have dense white mulberry, perhaps due its high palatability for deer, rabbits and other mammalian herbivores. Unlike the other two trees, white mulberry may be largely controlled using deer and livestock. But in residential areas and along major streams, large trees are established and require cutting. We also need to plant the native red mulberry, often confused in nurseries.

Callery pear (*Pyrus calleryana*), known originally as Bradford pear in a cultivar. Probably due to pollination with new cultivars, it rapidly became a major invasive problem after 1990. It is marketed by nurseries as thornless, but seedlings and suckers do develop dangerous thorns.
[Image from www.walterreeves.com/landscaping/pest-plants/bradford-pear-wildly-sprouting-thorny-bushes/]

PART 3
Connecting Ecology and Economy

Connecting ecology and economy: the landscape and watershed level. Across the whole county, central questions should be: how much landscape and watershed can be devoted to relatively wild conditions, or at least transitions to wilder conditions, and where should these areas be located? As the human population becomes denser, there is increasing interest in the economic costs and benefits of such land use. These economic aspects are briefly explored here, but they deserve a more thorough statistical and scientific approach. Moreover, for overall political decisions of the community, many people will involve non-economic factors as well or instead: the roles of wilder lands (or waters) in aesthetic pleasure or scientific inquiry, and in supposed altruistic or spiritual themes. These roles are implicit here but not elaborated.

"Ecosystem services" of woodland or grassland have been investigated across the nation, but local details need to be calculated. Ecological benefits of woodland include the following.
1. Energy. An obvious immediate benefit is the reduction in regular mowing, although some occasional cutting or mowing may still be desirable under trees. Then as shade develops, there is cooling of land and water, especially in urban areas. There is also more carbon storage in wood (for possible fuel), other biomass and soil (via roots), with long-term benefits for climate.
2. Air. There is reduction of wind, dust and noise, especially close to roads or industrial sites.
3. Water. There is reduction of flashy runoff from urban areas, especially during summer due to interception of rain by leaves and uptake from roots. Also, fissures from roots may allow more water to enter the karst system. Slower surface runoff reduces erosion and other pollution.
4. Soil. This may be improved slowly through leaf litter and roots, depending on circumstances. Much original soil probably had more organic content before settlement, especially soil with blackish "mollic" upper horizons, but this content appears to have declined in general.
5. Overall benefits for human health. While direct or indirect benefits to health are often supposed, there has been little scientific assessment; the current "Green Heart" project in Louisville will provide more rigorous insight (https://louisville.edu/greenheart).

Some mollic soils of the region, originally with ca. 1-10% organic matter in surface horizon, but degraded in many areas: left, fluventic hapludoll (Huntingdon); typic argiudoll (?Loradale); right, mollic hapludalf (McAfee); see also Shelbyville (m. hap.); Ashton (t. hap.); Donerail oxyaquic arg.); and Dunning (fluvaquentic endoaquoll). Images from Karanathasis (2018).

Due to all of these ecological benefits, but perhaps especially the immediate aesthetic interests, there appear to be significant positive effects of well-wooded environments on property values, thus taxable revenue, and on increased tourism. Maintenance costs for the community may be reduced, especially due to cooler summer temperatures in houses and on road surfaces. The broadly defined "aesthetic" interests in diverse botanical surroundings, along with diverse animal life, are perhaps the paramount factor for many people when they decide how to invest their efforts. And for some people, especially in more rural environments, there are significant economic returns from production of wood or food from native vegetation; these are detailed further under "habitat" or "species" levels.

However, there can also be costs from woodland or even from scattered trees along roadsides or in yards, which sometimes detract from interests in a more natural environment. More precise assessment of these costs is desirable across the community in order to present a balanced accounting of the pros and cons, and to plan for reduction or mitigation of costs.

1. There is less room for buildings or other urban development.
2. There is danger from trees falling onto buildings, roads, and utility lines.
3. Undesirable plants can occur in less managed areas, from messy-looking to invasive weeds.
4. Problems or fears about "wildlife" may develop—deer, coyotes, foxes, bird-flocks or snakes.
5. In transitional areas with mowed grass or hard surfaces, there is work to remove leaves.
6. There is less room for producing food, which many people would like to keep close to home.

Benefits for native shrubland—potentially with thickets and canebrakes—or from native grassland lack the obvious effects of trees but they gain more in potential interest for diverse aesthetic interests, wildlife and food production. We need more micro-economic exploration here in the varied possible transitions from woodland to mowed grass to hard surfaces. This exploration will be most useful if based on understanding of original habitats and their changes.

Collecting leaves from city streets. What is optimal ecological use? Perhaps to suppress weeds and build carbon in soil? [https://www.lexingtonky.gov/news?field_related_departments_target_id=246]

Springs, ponds and streams were obviously critical to the early settlement of Fayette County, but, unfortunately, some of them have become excessively abused as destinations for sewage and runoff from built or paved surfaces. Due to mounting legal challenges during the 1990s and 2000s, local government began a program of repair, redesign and reconstruction. Both regular (sanitary) sewers and drains from roads (storm sewers) are being addressed. If ecology and economy are to be considered together then, a central question is: should the improvements seek to restore naturalistic conditions as much as possible? – Or, given the fundamental changes in rural and urban land, should we abandon that goal and design artificial systems to manage the flow and quality of water? There has been some confusion about this range of goals, especially when words like "restoration" get used.

Uncertainties or controversies in our approaches to watersheds might be reduced if we decide, as a community, to focus more naturalistic restoration on more rural streams with potential for more woodland to be established, or for improvements in agricultural practices. Such streams include the upper section of North Elkhorn Creek, all of East Hickman Creek and all of Boone Creek, plus the much smaller Elk Lick Creek and Raven Run. In the more urban watersheds, there is much less potential for true restoration, especially along upper sections of South Elkhorn, Town Branch, Cane Run and West Hickman Creek. Here we may need wholly artificial features in headwaters to improve the outflow, rather than faked stream "restoration" like putting in meanders that were absent before settlement (but now profitable for some contractors). We could pursue construction of more headwater ponds for long-term storage; also detention basins, rain gardens and rain-barrels for short-term. Such ponding features can reduce intense flash flood events that cause so much erosion and channeling of streams. It is possible that more extensive use of these features could greatly improve conditions down-stream, but there has not been a thorough study of this option. Sufficient construction of such features might be expensive and difficult, given limited space, hence given lower priority.

Major reconstruction of stream channel in headwater of Wolf Run near Stone Road. After broadening and filling with rock and wood to slow flow, this artificial channel may benefit the watershed downstream, including small adjacent remnant of green ash swamp [16 Sep 2013].

Connecting ecology and economy: the habitat level. Benefits or costs of restoration can be summarized for the three broad classes of habitat outlined above: ravines, wetlands and plains. The complex "ravine series", from river corridor to clifftops, is clearly a priority for protection of land from development. Restoration here in woods with deeper shade and with browsing by deer can be less problematic than on the plains, since most alien plants appear to be limited by these shade or browsing. However, former woodland types on more acid soils are slow to recover, due to past clearance of slowly reproducing beech, tulip, white oak and associates; some of these tree species will deserve special propagation for recovery. There is currently little interest in a major effort to restore these woodland types, which formerly covered much of eastern and southern sections of the county. But a long-term vision could be developed if some major landowners in more hilly sections become more interested in the potential of these lands for forested values. It is notable, for example, that some tulip poplar stands in the Jacks Creek area currently have high marketable value, and a large block of land in this section of the county could be conceived for diverse recreational and productive uses. Also, there are still a few stands of mature beech and white oak here, and seed could be collected to grow for restoration elsewhere in the county.

The open river corridor habitat has been decimated by damming of the Kentucky River, and there is no current prospect to remove dams. The river provides our major source of water, together with the Jacobson Reservoir. Moreover, there is recreational interest in the river for boating and fishing in its current condition. Nevertheless, a long-term vision could be developed to remove one or more of dams, though perhaps not in the Fayette County section (Pool 9). There could be significant interest in new recreational opportunities on a more free-flowing river. It would be interesting to explore adjustments in water sources, still using the river somewhat but adding more sources from reservoirs on the uplands. Development of such reservoirs could be combined with goals to reduce flashy flow and to improve water quality.

The “hillbilly” section of Fayette County, around Jacks Creek Pike and north of the river. The Eden Shale Hills here are mostly wooded. Much useful forest management could occur here.

The “wetland series” generally deserves a more deeply scientific approach, since original conditions have virtually disappeared. There is, first, a continual need for education about the ecological differences between these habitats with stagnant water, as compared to free-flowing streams and their riparian corridors. Restoration of free flowing systems is generally more straightforward since they are more extensive, together with remaining strips of the original vegetation. It is also important to understand difference between natural ponds and artificial ponds, which are usually more permanent with less fluctuating hydrology at margins. It is likely that beaver formerly increased the degree of ponding but we have few indications of what beaver ponds were like in this region. There has been little relevant research so far, but there would be much interest from studying the few remnants of original wetlands and ponds. For example, there are buried microfossils (seeds, pollen, spores) in ancient upland ponds that can reveal much about the original environment, going back thousands of years. A few sites have been provisionally investigated, and they showed some promise for valuable data.

It is also important to understand in more detail how diverse native wetland species relate to subtle changes in hydrology and soil conditions. There are historical records of several wetland plants in Fayette County or nearby that are disappeared completely from the region. Some of these are interesting attractive species that might be reintroduced into a distinctive wetland horticulture, such as meadow anemone (*A. canadensis*), marsh marigold (*Caltha palustris*), mid-western loosestrife (*Lysimachia hybrida*) and featherbells (*Stenanthium gramineum*). There could be special aesthetic interest in the spectacular lotus that formerly grew in “a pond on the borders of Jessamine county, within six miles of Lexington” (Short 1837); this edible species has nutritional value. In wetlands, from springs to ponds, many native plants (e.g. cattails) and alien plant (e.g. watercress) are edible, as of course are the fish (or bullfrogs) within ponds. We need to explore such economic potential, with sites like The University of Kentucky Arboretum offering good opportunities for effective demonstration.

Rocky banks of the Kentucky River upstream from Raven Run, with locally abundant big bluestem and river goldenrod in open scoured habitat. However, many plants and animals have disappeared from the corridor due to damming. [www.uky.edu/KGS/geoky/county/fayette.htm]

The “plains series” of habitats, as outlined above, used to form most of the landscape, ranging from relatively deep woods dominated by sugar maple and bitternut hickory, to more open woods, thickets and clearings typified by bur oak, locusts and cane. All variants of this woodland have been much reduced or degraded, especially more open areas that appear to have been maintained by more regular browsing of herbivores. Restoration generally appears to be a difficult and expensive prospect. Yet at the center of the discussion we need to have is the potential role for large herbivores in the restoration, and their potential harvest for meat, skin and bone. As in much of the modern world, management of wild animals or livestock for harvest has become spatially separated from centers of human population. There are diverse causes and consequences for this profound adjustment in human ecology, which will not be elaborated here. Return to closer relationships with large animals could involve deep physiological and psychological aspects in humans, as well as as more locally sufficient economy. As well as meat, restored woodland could provide good native fruits, nuts and greens.

There has been increasing agreement among ecologists that large herbivores did play a major role in the original Bluegrass woodland, as in temperate woodland on eutrophic soils elsewhere in the world. However, the community of conservation scientists in Kentucky has failed to convert this interest into properly organized trials or studies of restoration using livestock, or even studying relevant effects of our largest remaining wild herbivore—the white-tailed deer. We know that the “woodland pastures” developed by Virginian settlers, using varied livestock, became significant remnants of the original woodland. And we know that intense browsing by livestock or deer today can greatly reduce the invasion of alien shrubs and vines. There has been a fear among some conservationists that excessive browsing will damage native species, but it appears that many of these species actually depended on disturbance from large animals before settlement. The season of disturbance may have a significant role; late summer and fall may be the optimal season for browsing, when alien plants are more exposed.

American lotus (*Nelumbo lutea*): here in Hardin Co., but formerly at the southern edge of Fayette. A spectacular edible species, it can be introduced to shallow shorelines. [5 Aug 2018]

Wild hyacinth (*Camassia scilloides*): an unusually large remnant at Griffith Woods (Harrison Co.). From this important site, we can learn how to restore habitat in the region. [29 Apr 2016]

Remnant of wild hyacinth at Firebrook subdivision along Harrodsburg Road. This population could be enhanced or transplanted to nearby sites; only one other patch is known in Lexington.

Connecting ecology and economy: the species level. How can we fund recovery of imperiled species, and how might we benefit? Following are provisional notes on groups outlined above.

A. Selected aquatics. The USFWS has been funding a national program to propagate imperiled mussel and fish species, but unless watersheds are extensively restored (ideally removing dams on the Kentucky River), there is little justification for reintroductions in Fayette County. A future vision for restoration might use these species as emblems. There may, however, be an immediate role for propagation of some riverine plant species to be used along urban streams.

B. Bats. As noted above, prospects for recovery from disease are dismal in the foreseeable future. However, a few relatively simple and cheap actions may help, such as erection of boxes for overwintering, and planting of shagbark hickories, which are preferred for summer roosting. The potential benefits of bats in consumption of insects remain highly uncertain.

C. Simulation of wild ungulate effects. In Illinois, Dennis (1997) has provided perhaps the only proper published research on effects of different seasons for browsing in woodland of eastern North America. Her results suggest that the optimal season for cattle to promote native species over aliens is between Jul-Nov and Dec-Mar. However, more refinement of such research is needed for greater precision. There is ample evidence that browsing by ungulates can greatly reduce some problematic invasive aliens, especially evergreen vines like wintercreeper, Japanese honeysuckle and English ivy. But we need to understand how the balance with natives is affected in different seasons. There has been some economic analysis of "wildlife ranching" in North America, but mostly restricted to western regions where large tracts of land could be profitably devoted to production. In Kentucky, such management may be unlikely to develop at present, except perhaps on state or federal land where combined with ecological restoration, tourism and special production of meat or other products for premium markets. The best example is at Land-Between-the-Lakes in western Kentucky.



Many species have disappeared from the Kentucky River but might be reintroduced if a section became free-flowing again. For example, plants (above): river indigo, threadfoot, eelgrass. And mussels (below): ringpink, clubshell, pyramid pigtoe.



Northern long-eared bat (*Myotis septentrionalis*): a small species of bat, with length 3-3.7 inches and wingspan 9-10 inches. It has been greatly affected by white-nose syndrome.
[Image from https://www.fws.gov/arkansas-es/Species/mammals/NLEB.html]

American bison or “buffalo” (*Bison bison*). Herds of 10-1000 were frequently noted in the central Bluegrass during 1770-1775, especially during spring and fall. They fed on the “rich herbage” in woodland here, with much nutritious wild rye, buffalo clover, peavine and cane. Canebrakes in southeastern states may have formed an important refuge during winter.
[http://cdn1.creativecirclemedia.com/kentuckytoday/original/1518191745_f30f.jpg]

D. Imperiled plants of submesic and subhydric uplands. Except for a few globally rare species, there is little prospect of funding for propagation from state or federal government. Instead, we need community-based nurseries with support of local government and interested non-profit organizations. As outlined above, several locally uncommon native trees, shrubs, wildflowers and grasses deserve much more local propagation. Potential uses for such species, with local markets, are many: some grow rapidly to produce deep shade (e.g. basswood); some produce wood with special qualities (e.g. coffee tree); some produce unusual organic dyes (e.g. blue ash and butternut); some produce showy blossoms that deserve much more horticultural use (e.g. hyacinths and bluebells); some produce large edible nuts (e.g. shellbark hickory) or fruits (e.g. pawpaw); many others provide diverse nutritional or medicinal uses.

E. Imperiled plants of drier woods or glades. As in D, propagation needs to be developed though community-based nurseries. There are several species that could be used much more in urban "xeroscapes" on rocks, pavements, built walls or roofs. The University of Kentucky Arboretum, and the campus in general, could play a special role here, focussing on the special needs for recovery of more sensitive species, with appropriate research.

F. Trees with acute pathogens, pests or other special threats. As outlined above, there are obvious needs to target some species for action, but local coordination has not yet developed in most cases. For example, during the current collapse of ash populations, there has been little effort to collect seed from both species of white ash: diploid *Fraxinus americana* and the hexaploid *F. biltmoreana*. The Arboretum (again) could help coordinate such efforts, with state and federal support. Another obvious example for action is the native "red" mulberry, which has been confused so much in nurseries with the alien "white" mulberry (usually red-fruited as well). In addition to historic declines in native mulberry, perhaps with disease, there can now be hybridization with the alien. Yet it would not be hard to begin a propagation program.

Pawpaw (*Asimina triloba*). This small suckering tree, with extraordinary fruit, was once common on uplands, but it is now largely restricted to more hilly land. Short (1828) stated: “once the paradise of pawpaws, where immense orchards of large trees were everywhere...” [https://www.pinterest.com/pin/339458890649865880/]

The mid-western red plum or “goose plum” (*Prunus munsoniana*). It used to be widespread in villages of native people, and was also grown by settlers before 1920. There is much potential for cultivation and breeding for fruit production and ornamental use. Unfortunately, our native trees in the rose family have been eclipsed in the horticultural world by aliens. [31 Mar 2017]

Prickly pear (*Opuntia cespitosa*): much potential for “xeroscaping” in urban environments
[P. Adanick; and http://kentuckynativeplantandwildlife.blogspot.com/2013/01/plant-of-week-eastern-prickly-pear.html]

Targeted reduction of invasive alien species has been funded in selected areas during the past few decades by government or affiliated non-profits (e.g. National Fish & Wildlife Foundation). However, well-planned programs with stable funding are rare, and there is a continual danger that initial efforts will be abandoned. The salient exception is Floracliff Nature Preserve, where Mary Wharton and her trustees have established an endowment for regular staffing and real long-term planning. For broader development of programs to reduce aliens, we could look beyond funding challenges to beneficial uses of alien plants. In some cases, invasive species might be harvested or converted for practical uses (wood, browse, biomass, even human food); prospects for using livestock to restore woodland have been outlined above. Also, the actual physical human work of removal can be beneficial in terms of exercise, and more interesting than the gym. With further education, we can at least hope that some sectors of the public will become more interested to shift the balance towards natives. As a first step, we need more effort from local government to reduce them on public land. At a minimum, it should become general practice to cut vines off trees and remove honeysuckle.

Examples of alien plants that could be harvested for food or other value are as follows.
Herbs: watercress (salad greens); garlic mustard (cooked greens); mulberry weed (cooked greens); parsnips (roasted roots); gill-over-the-ground (varied medicinal uses).
Vines: wintercreeper, Japanese honeysuckle, kudzu (forage for sheep or other livestock).
Shrubs: Amur honeysuckle, burning bush, multiflora rose (forage for goats or other livestock). It is also notable that chipped shrubs and tree branches make excellent mulch for weed control and soil building. Programs to reduce aliens should be linked with good uses for their chip.
Trees: Chinese mulberry and Callery pear (hardwoods with special qualities). The mulberry was formerly planted for potential silk production in North America, but that difficult industry became abandoned. The species is still often planted for its abundant fruit, which are relished by many species of bird, and it can also be used as forage for livestock.

Watercress (*Nasturtium officinale*). This subaquatic Eurasian plant is much used as a nutritious salad or cooked greens. In the Americas, it was spread by settlers for food, and it is now widespread. It occurs in many springs and streams of Fayette Co. I consume large amounts. [Image from https://wildplantguide.com/foraging-watercress-facts-need-to-know/]

Garlic mustard (*Alliaria petiolata*): a seriously invasive alien that can be cooked for greens.
[Image from http://londonmiddlesexmastergardeners.com/invader-month-garlic-mustard/]

Mulberry weed (*Fatoua villosa*): a recent invader, especially in flowerbeds, but can be cooked.
[Image from https://bwwellsassociation.files.wordpress.com/2017/02/img_5998-mulberry-weed.jpg]

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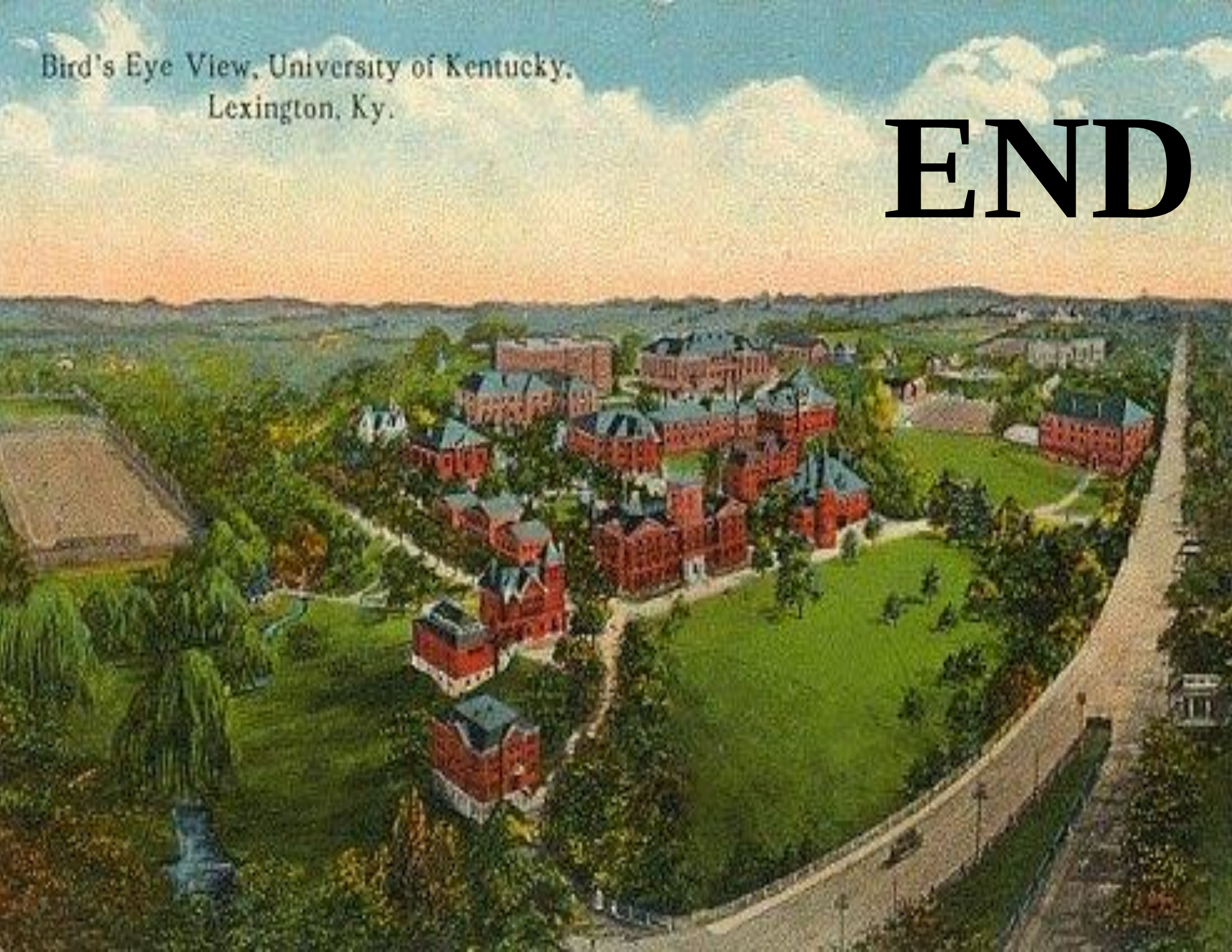
Back cover: University of Kentucky about 1910 [http://www.kykinfolk.org/fayette/uk_birdseye_1914.jpg]



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