PART FOUR

Notes for a series of four classes on "Natural History and Conservation Planning in the Central Bluegrass Region of Kentucky" initially presented for Osher Lifelong Learning Institute at the University of Kentucky in April of 2016

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4. Species-groups: outline of biological diversity, at least among vascular plants; focus on groups of species that most deserve 'micro-management' or propagation for recovery.

The groups outlined below could become defined as targets for micromanagement, involving careful selection of sites, local improvement of habitats, and artificial propagation in some cases. A secondary value is to use the more showy examples of these species as 'charismatic' vehicles for increasing public interest and funding. But that approach can be abused if no real benefit to the species results from funded actions. There is, unfortunately, no easy way for school systems and the general public to grasp the essential features of our flora and fauna. "Bluegrass Land and Life" by Wharton and Barbour (1991) does allow considerable insight but such information needs to be continually updated and summarized for modern audiences. It is important to distinguish species that really deserve a focussed effort at recovery, from species that tend to recover by themselves. The most deserving plants are those that have declined much since settlement and that remain uncommon or absent even if habitat is restored (due to slow dispersal, growth or reproduction). Even some widely scattered species that are somewhat 'conservative', like cane, roughleaf dogwood and bur oak, deserve to be propagated and replanted at most sites for restoration. Such species should be included in nurseries designed to support restoration, but are not listed here as specific targets for recovery.

Some alien species should also be targeted—for reduction! The most obvious of these are invasive plants in the woods: especially bush-honeysuckle, winter-creeper and garlic-mustard. But it is important first to consider how 'macromanagement' of habitats can reduce the invasion by these plants. For example, intense browsing during fall can probably increase the proportion of native plants, which are mostly dormant or less prone to be eaten during that season. And mass-plantings of more competitive (yet often conservative) natives can also reduce the invasion. Another special problem is the advent of alien pests and pathogens on some common trees (elms, walnuts, ashes). Prevention is generally impossible, and resistant trees should be selected or bred. An alien disease has also attacked most bat species, and there may no useful human response.

Following are examples of globally or regionally imperiled plants that should be targeted for recovery, with propagation in most cases.

Stream corridors and riparian zones: indigo (*Baptisia australis*) may have disappeared from the wild; others include aquatics (*Vallisneria americana*, *Ranunculus longirostris*) but waterfowl do disperse them.

Moist woods on rocky slopes, Braun's rockcress (*Boechera perstellata*); on mossy seeps, water-stitchwort (*Stellaria fontinalis*).

Medium dry woods, especially along trails: the newly discovered Kentucky clover (*Trifolium kentuckiense*); others include *Physaria globosa*, *Perideridia americana* and *Veronicastrum virginicum.*

Dry cedar woods, trails & glades: gromwell has virtually disappeared (*Onosmodium hispidissinum*); others include *Calamintha glabella, Viola egglestonii*, *Malvastrum hispidum*, and, in adjacent Eden Shale Hills, *Spiranthes magnicamporum* and *Solidago shortii*.

Some species on rocky points along the Palisades are also very rare, but they are much less imperiled due to stable habitats (*Phlox bifida*, *Trillium nivale, Cerastium velutinum*—the latter along trails).

Submesic woods, trails, canebrakes and glades on deeper soils: running buffalo clover is one of the most interesting species (*Trifolium stoloniferum*); others include *Dryopteris carthusiana, Galearis spectabilis, Camassia scilloides, Lilium michiganense, Floerkea proserpinacoides, Juglans cinerea*, *Nabalus crepidineus*; on poorer soils, *Gentiana alba* and *Orbexilum onobrychis*.

Wetlands of varied type, especially transitions to marshes and fens: the southern ladies' tresses occurs at only one site, here at the edge of its range (*Spiranthes odorata*); others include *Caltha palustris, Anemone canadensis, Lysimachia hybrida* and *Carex vesicaria.*

Two groups of animal species clearly deserve active recovery:
A. Aquatic species: especially imperiled mussels and fishes. Fish & Wildlife agencies are already much involved in this work.
B. Larger mammals: small herds of bison and elk should eventually be established at sites like Griffith Woods; there would be significant expenses in fencing and management, but great value for research. The mountain lion and gray wolf may eventually make their way back into wilder parts of Kentucky without direct human help.

SPECIES THAT DESERVE MICROMANAGED RECOVERY

Species can be classified in at least three quite different ways: (a) according to their estimated evolutionary relationships ('phylogeny' or 'family tree'), (b) according to their general appearance and mode of growth ('life-form' or 'functional group'); and (c) according to their ecological associations with different types of habitat and with other species (including 'ecological niche' and 'trophic level'). The focus here is on groups of species that deserve micromanagement for recovery, in addition to any restoration of their habitats. This selection and presentation of species involves all three major types of classification (a, b and c), but especially some aspects of their ecological trends (c). These species have declined greatly since settlement, more than can be explained simply by the reduction in their broadly-defined typical habitats. Causes of such declines are varied, apparently including changes in diverse 'trophic' relationships (nutrition, consumers, diseases), challenges to dispersal patterns in the modern landscape, and pollution of several kinds (water chemistry, herbicides, pesticides).

Humanity is currently unable to recover some species in a satisfactory manner, partly for technical reasons, but perhaps also due to lack of understanding or interest in more obscure cases. There are several examples of much loved ('charismatic') animal species that have been recovered due to active micromanagement, at least during early stages of programs. But many, many small or otherwise obscure species remain largely passed over for effective action. Unfortunately, this is still true for most of our locally rare plant species, and even some that are globally imperiled. With more organization among 'plants-people' (academic botanists, horticulturalists and restorationists), a lot more could be accomplished. There must, however, be a limit to our abilities—we can only deal effectively with the more obvious animals and plants. The great majority of species on Earth will receive no direct micromanagement for recovery. They will have to depend on how we protect their lands and restore their habitats.

ANIMALS

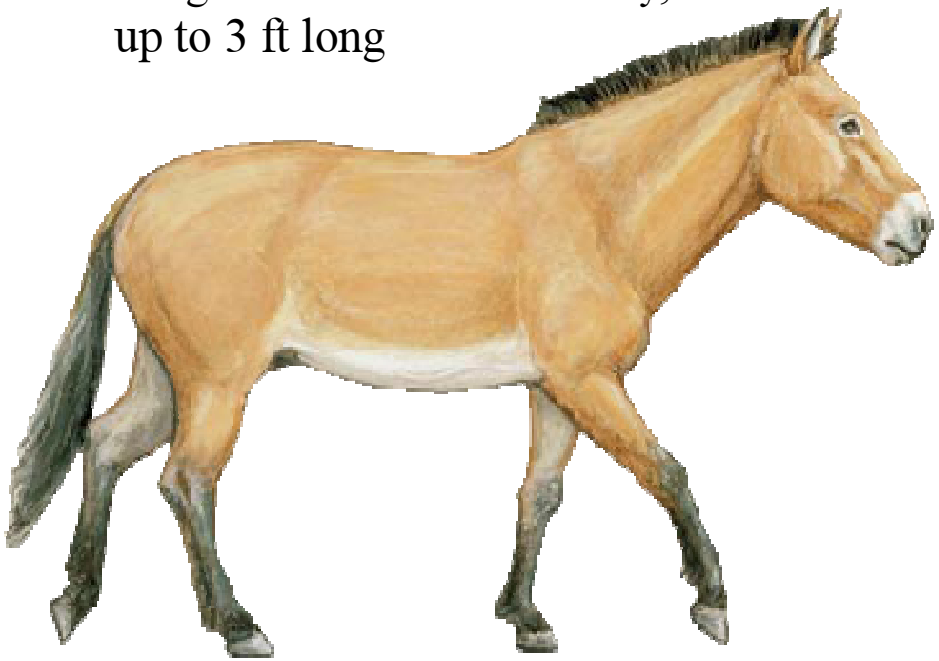
LARGE MAMMALS: extinct, extant and experimental

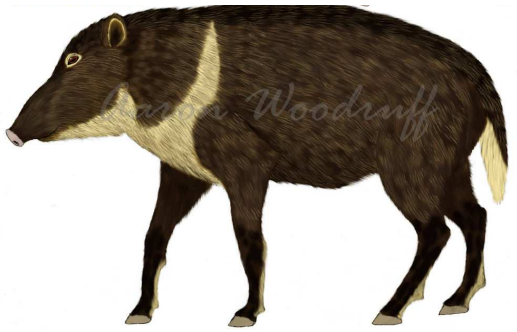
There is a wealth of evidence that large herbivores have had a significant influence on the ecology and evolution of vegetation in this region (Campbell 2012). The 'Pleistocene Megafauna' prevailed in North America for at least 3 million years but became largely extinct about 10-12,000 years ago. More recently, we have lost the bison, elk and mountain lion from most of Kentucky. It is impossible now to consider allowing these animals free range back into the Bluegrass region. However, it is reasonable to develop small enclosed populations of bison and elk for diverse purposes—public interest; ecological management; and for harvesting. There are already several private and public projects with bison and elk, but so far these have not been used in ecological restoration. Griffith Woods would be the best place to start.

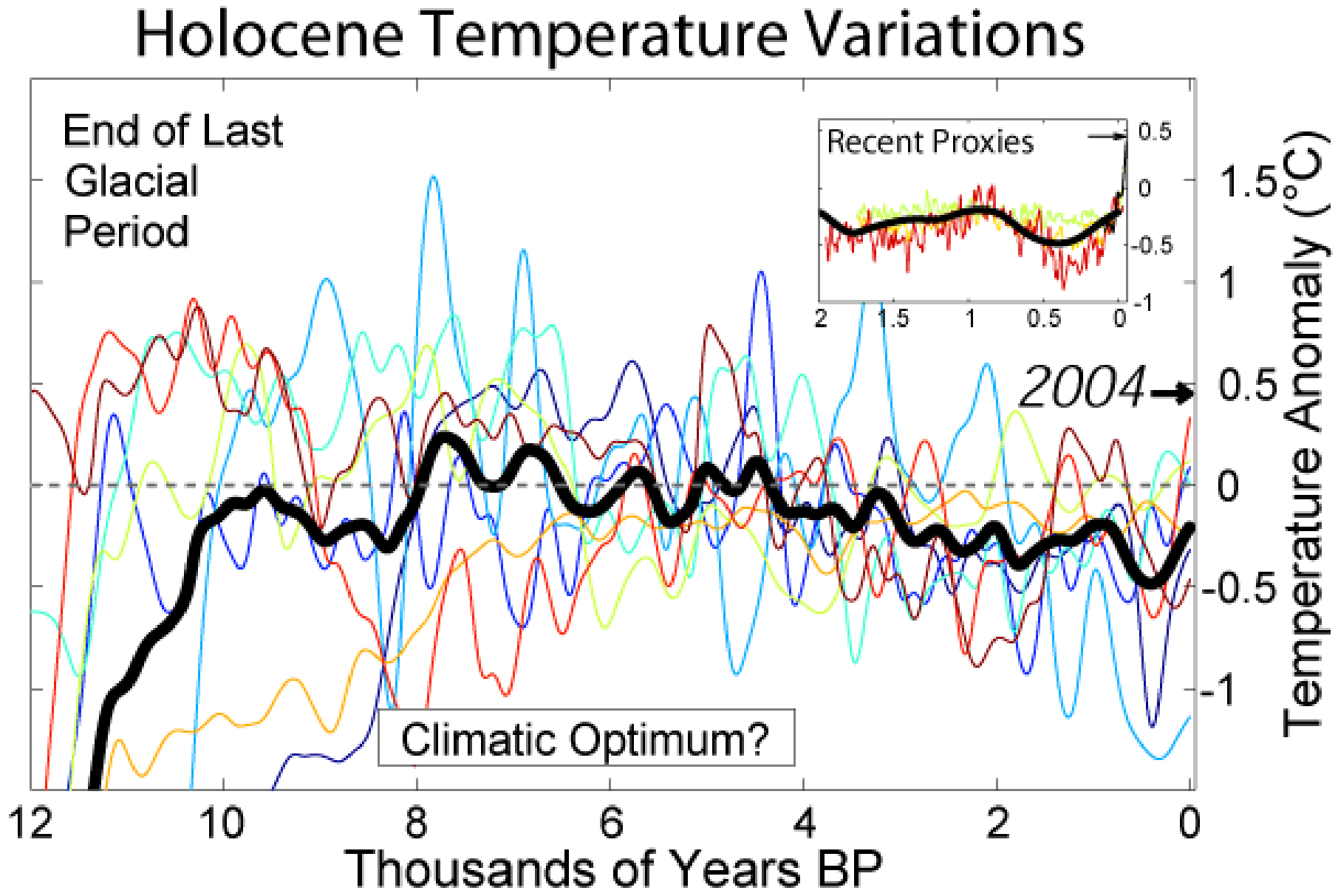
Organized protection and management by Kentucky Department of Fish and Wildlife Resources during the past 50-100 years has allowed recovery of deer, beaver, otter, wildcat and bear. Deer are now abundant across the Bluegrass region, even into the edge of cities. It is likely that increased seasonal hunting pressure would lead to a more naturalistic ecological effect of the deer. Currently, their intense browsing tends to continue throughout the year, and it appears often to be excessive. But when mountain lions and humans hunted before settlement, the deer probably declined much in productive landscapes during the fall and winter. We need much more research on how deer effects may vary through the year (Russell et al. 2001).

Livestock may also be used to simulate the effects of absent herbivores, but it has been difficult to develop interest in relevant experiments by the University of Kentucky or other potential partners. Diverse anectodal evidence and initial trials suggest that sheep and goats, in combination, could be effective. It is important to try using them for reduction of bush honeysuckle, winter creeper and even garlic mustard (reportedly eaten by sheep in fall/winter).

Upper left: Giant Sloth, up to 10 ft long
Lower left: Vero Tapir, up to 6 ft long
Below: Complex-toothed Horse, up 10 ft tall
Lower right: Flat-headed Peccary,
up to 3 ft long







Note that extinctions of megafauna were concentrated during 11.5 to 10 K years BP (2000 AD).
[https://commons.wikimedia.org/wiki/File:Holocene_Temperature_Variations.png]

American Bison

American Elk

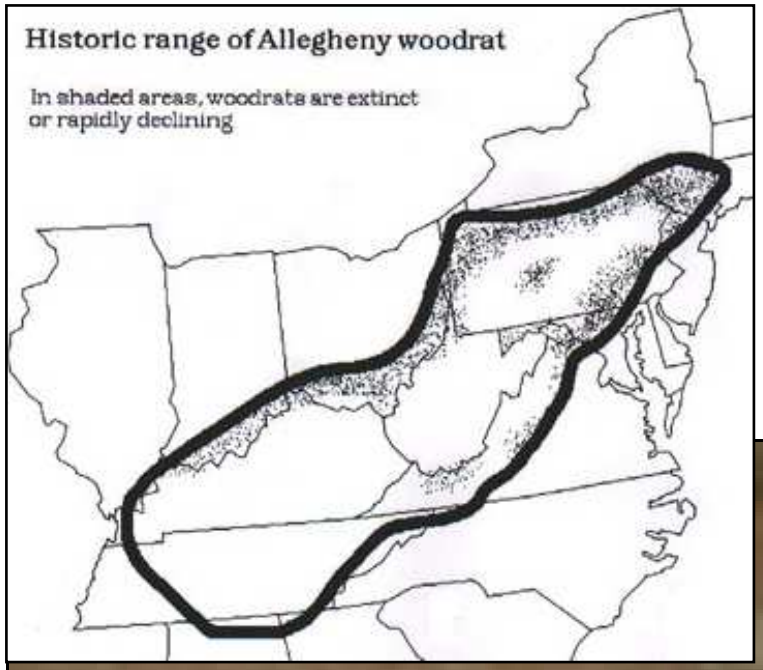
White-tailed Deer

American Beaver

SMALL MAMMALS: especially bats

Although several small mammals are rare or imperiled, it is generally futile to consider active micromanagement. Among rodents, there is however one that may deserve captive-breeding and releases—the Allegheny Woodrat (Blythe at al. 2015). This species is known from cliffs along the Palisades, but it is rare here and its status needs further assessment. Its general decline outside the central Appalachians may be due to the racoon roundworm, perhaps decline in nut crops (especially chestnuts), and competition from other herbivores (deer, turkies, bears).

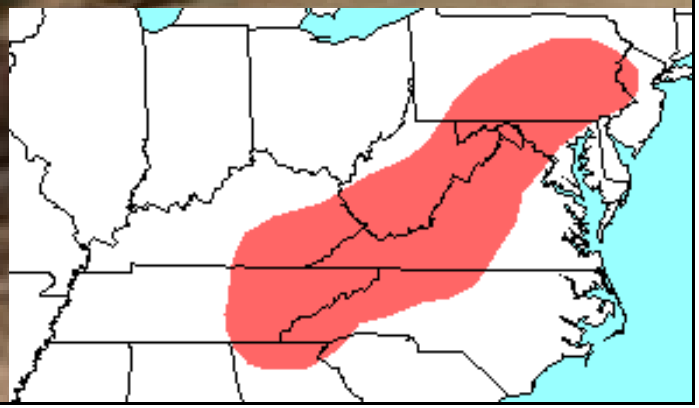
The recent threat to bat populations from White-Nose Syndrome (WNS) will probably lead to great declines, especially among smaller species (including Little Brown Bat, Indiana Bat and Northern Long-eared Bat). It is likely the fungus was brought to North America by human activities. The potential for micromanagement remains uncertain. Wildlife agancies have promoted a general reduction in human visitation to cave, and an increase in disinfection where appropriate (Hines & Armstrong 2014). It has also been suggested that infected sections of roosts in caves could be screened off from healthy sections. Cryan et al. (2014) have provided a little hope: "Although part of a mostly tragic story has continued to unfold as new areas are affected, anecdotal signs are emerging that all may not be lost when it comes to hibernating bats and WNS. Amid the continued large-scale population declines of certain species, we have yet to see mass mortality in some of the more westerly areas where the fungus was detected two winters ago… Also, recently disease without obvious mortality was diagnosed in Gray Bats—an endangered species thought by many two years ago to be at high risk of extinction from WNS." The Gray Bat, Rafinesque's Big-eared Bat and Virginia Bat have yet to suffer measurable declines. The disease does not lead to the same mass mortality in European bats as it does in North America. Indeed, native European bats seem to have a resistance resulting from coevolution with the fungal pathogen.



Range is poorly documented in western Kentucky. Compare maps here to left (from Janet Wright of "TeamWoodrat" at dickinson.edu in PA) and right (from Smithsonian NHM and NatureServe.org).

[Photo at http://www.nature.org/cs/groups/webcontent/@web/@indiana/documents/media/prd_006472.jpg]

Allegheny Woodrat (up to 18 inches long)

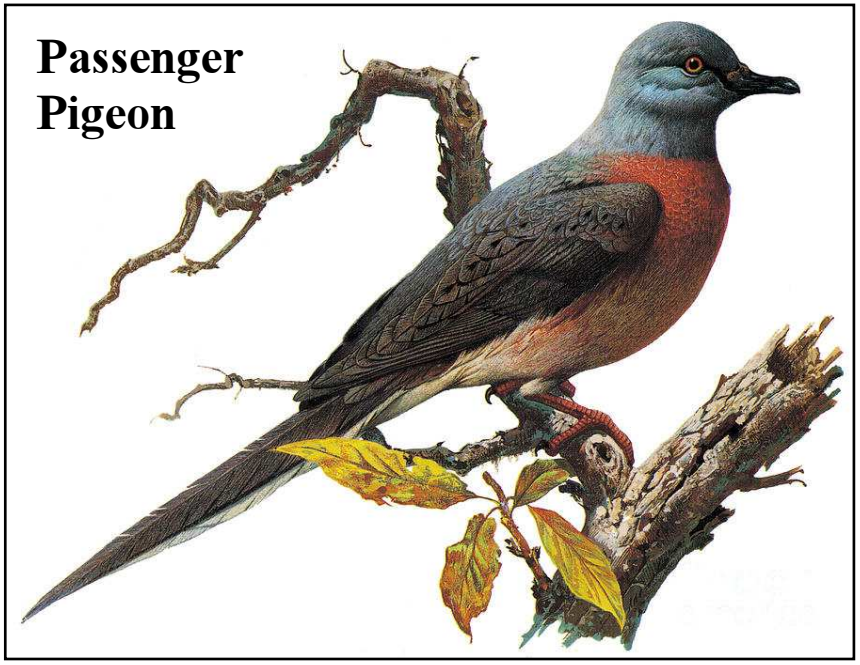


Little Brown Bats with White-Nose Syndrome in New York; their bodies about 3 inches long.
http://www.wildlife.state.nh.us/wildlife/images/white-nose-al-hicks-nydec.jpg

LARGER BIRDS: extinct, recovered and promoted

At least two bird species of eastern North America have become globally extinct—the Passenger Pigeon and Carolina Parakeet. Both of these species occurred in the Bluegrass region, and may have had significant ecological effects. In the ultimate micromanagement, it has been proposed to reconstitute DNA from museum specimens of Passenger Pigeons (Biello 2014), but then would it be possible to allow sufficient habitat and protection for recovery?

Wildlife agencies have had considerable success in recovering species of game bird (Galliformes) that have had great declines during some periods after settlement. These species can be raised in captivity and then released to suitable habitats. The primary example in this region is the Wild Turkey, which had largely disappeared from Kentucky by 1950 (Dickson 1992). The program's leader was George Wright (Stewart & Frawley 2005): "He supervised modern-day turkey restoration efforts in Kentucky, which lasted from 1978 to 1998, and watched the Kentucky turkey population grow from almost none to 230,000 birds. George used turkeys trapped in Mississippi and turkeys obtained from Missouri through a river otter trade to build his own supply source, transplanting them into prime locations with good natural habitat and with landowners who promised to protect them. The transplants took root and soon he and other KDFWR employees were trapping turkeys in state and transplanting them all over Kentucky. After restoration efforts were essentially complete, George concentrated his efforts on understanding the impacts of spring harvest on gobblers. George used his great turkey trapping skills to catch and put radio transmitters on almost 600 gobblers over the course of 5 years in and around Caldwell County..." There is also much continuing effort to restore Bobwhite Quail in the region, although this species was probably rare in the Central Bluegrass before clearance of the woods. The species was often known as "partridge" during 1790 to 1820, when it increased rapidly into farmland (Barker 1795, Ashe 1808, Ranck 1872).


Passenger
Pigeon

Carolina Parakeet

Wild Turkey

Bobwhite Quail

REPTILES & AMPHIBIANS: shut out, shunned or slipping away?

Several species have declined greatly within the Bluegrass region due to loss of suitable habitat, especially breeding sites. But amphibians are generally more sensitive to additional factors such as competition, predation, polluton and global warming. There is evidence that heavy metals and agricultural chemicals have reduced populations of some species.

Perhaps the primary example of a declining amphibian in this region is the Northern Leopard Frog (KDFWR 2013): "...populations have declined dramatically throughout large Comment sections of the range, but the species does seem to be holding its own at least in some areas. The available data indicates that northern leopard frogs are declining here and have become scarce or extirpated in many Bluegrass counties in Kentucky. Although new sites are being found with some degree of regularity, most of these have not been monitored long enough to generate any long-term data. Recent records (1984-2004) exist for northern leopard frogs in only 10 Kentucky counties; all others (12 counties) are considered historical. The northern leopard frog was a common species in rural Jessamine County through most of the 1970's but disappeared abruptly in 1980 (J.R. MacGregor data); it was also common during the 1960's in Mason County, when a number of specimens were collected and deposited at the University of Kentucky, but many years have passed since a live individual has been seen there as well." Within the Central Bluegrass, they survive locally in Scott, Bourbon and Harrison Counties (including Griffith Woods).

Northern Leopard Frogs have been studied much in the laboratory, partly to investigate effects of pollutants (e.g., Shenoy et al. 2009), and they can be raised for recovery in the wild. This species could become a useful 'ecological monitor' for the overall 'health' of our landscape. Experimental releases at selected sites would provide much environmental insight.

Photo by Bill Sutton [http://www.marshall.edu/herp/toads_frogs/Pics/Leopard_Frog_1.jpg]

LOCALLY EXTINCT FISHES?

Although the Kentucky River has been fundamentally damaged by locks-and-dams, the free-flowing South Fork of Licking River presents much potential for diverse native fish species. Two or three rare species may be expected to recover by themselves in the South Fork: the Northern Madtom, Spotted Darter and Eastern Sand Darter; latter is a globally rare species of sandy bottoms in the Lower Licking River, but there are no records from the South Fork.

Two much larger species, American Paddlefish (a filter-feeder up to 5 ft long) and Alligator Gar (a predator up to 10 ft long), were formerly widespread in larger streams such as the Kentucky River, but perhaps not in the South Fork of Licking. Although these species are secure in some sections of their ranges, there have been large declines in northern sections, partly due to excessive harvest—for food in the paddlefish but for removal as "trash fish" in the case of gar. The paddlefish can be rasied for restocking and for food—they are highly valued for their black eggs (roe) processed into caviar and for its boneless, firm, white meat. In 2000, fire destroyed a seven-story Wild Turkey warehouse in Anderson County, causing a spill into the Kentucky River that left hundreds of thousands of fish dead for 66 miles. Wild Turkey paid $256,000 to the state: "Fisheries personnel with the Kentucky Department of Fish and Wildlife Resources (KDFWR) will be restocking 700-800 paddlefish in pools 3 and 4 of the Kentucky River on Tuesday and Thursday, March 27 and 29. About 350-400 seven-to-eight pound fish will be released each day, to help reestablish the paddlefish population that was wiped out during last year's whiskey spill. On Tuesday, fish will be re-stocked in pool 3 at Still Branch off Hwy. 127 North in Franklin County. Thursday's release will be in pool 4 at the ramp behind the public library in downtown Frankfort. Fish will be brought in from a private supplier in Mayfield, Kentucky to the Frankfort Fish Hatchery, tagged, and then released later in the day." [https://www.outdoors.net/outdoors/News/News/2215]

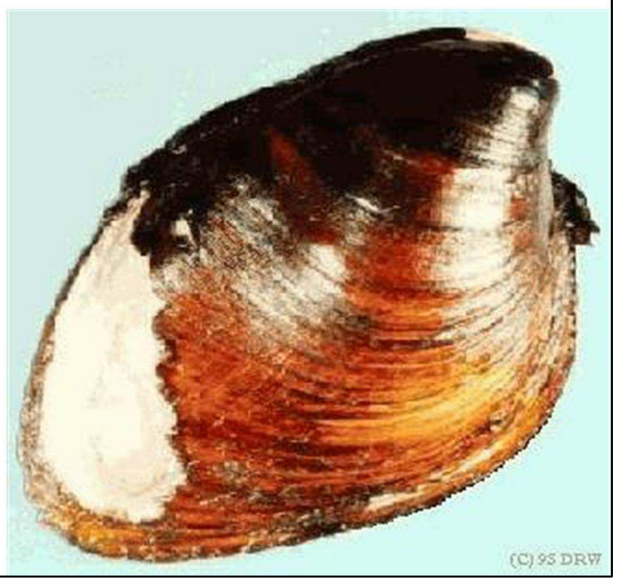
American Paddlefish. It has a sister species in Yangtze River, which is critically endangered. Fossil records of this family date back over 300 million years. They are related to surgeons.
[Photo at http://mdc.mo.gov/sites/default/files/media/images/2013/03/paddlefish_swimming_3-13-13.jpg]

LOCALLY EXTINCT MUSSELS!

Several species have virtually disappeared from Kentucky River and S. Fork of Licking.
Alasmidonta marginata (Elktoe): G4 S2: few scattered still in South Fork.
Cyprogenia stegaria (Fanshell): G1 S1; perhaps occasional in S. Fk., still in Lower Licking.
Epioblasma torulosa rangiana (Tubercled Blossom): G2 S1; was in Ky. Rv.; unknown S. Fk.
Epioblasma triquetra (Snuffbox): G3 S1; remains in Lower Licking; unknown elsewhere?
Fusconaia subrotunda subrotunda (Longsolid): G3 S3: occasional in South Fork.
Obovaria retusa (Ring Pink): G1 S1; formerly in Kentucky River; unknown from South Fork.
Pleurobema clava (Clubshell): G1G2 S1; probably disappeared from both streams.
Pleurobema rubrum (Pyramid Pigtoe): G2 S1: disappeared from both streams.
Plethobasus cyphyus (Sheepnose): G3 S1; remains in Lower Licking; unknown elsewhere?
Quadrula cylindrica cylindrica (Rabbitsfoot): G3 S2: disappeared from both streams.
Simpsonias ambigua (Salamander Mussel): G3 S2S3: perhaps occasional in South Fork.
Villosa fabalis (Rayed Bean): G1G2 S1; disappeared from both streams.

Some of these species could become targets for artificial rearing and releasing. We now have a good institutional basis for such efforts (McGregor 2013): "The Center for Mollusk Conservation was founded in 2002 by the KDFWR. Its mission is to restore and recover rare and imperiled freshwater mollusks in Kentucky... We have worked with over 70 species of freshwater mussels, 75 species of fishes, 12 species of snails, and dozens of algae species. Our primary focus is the conservation, restoration, culture and propagation of freshwater mussels... The Center has released propagated individuals of several species, such as the fatmucket, black sandshell, slippershell, snuffbox, pink mucket, Cumberland elktoe, and Cumberland bean along with translocations of the northern riffleshell, fanshell, rough pigtoe, oyster mussel, dromedary pearlymussel, and spectaclecase. These populations are being monitored for success."

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.



SELECTED INSECTS?—Monarch Butterflies?—Bees?—Beetles?

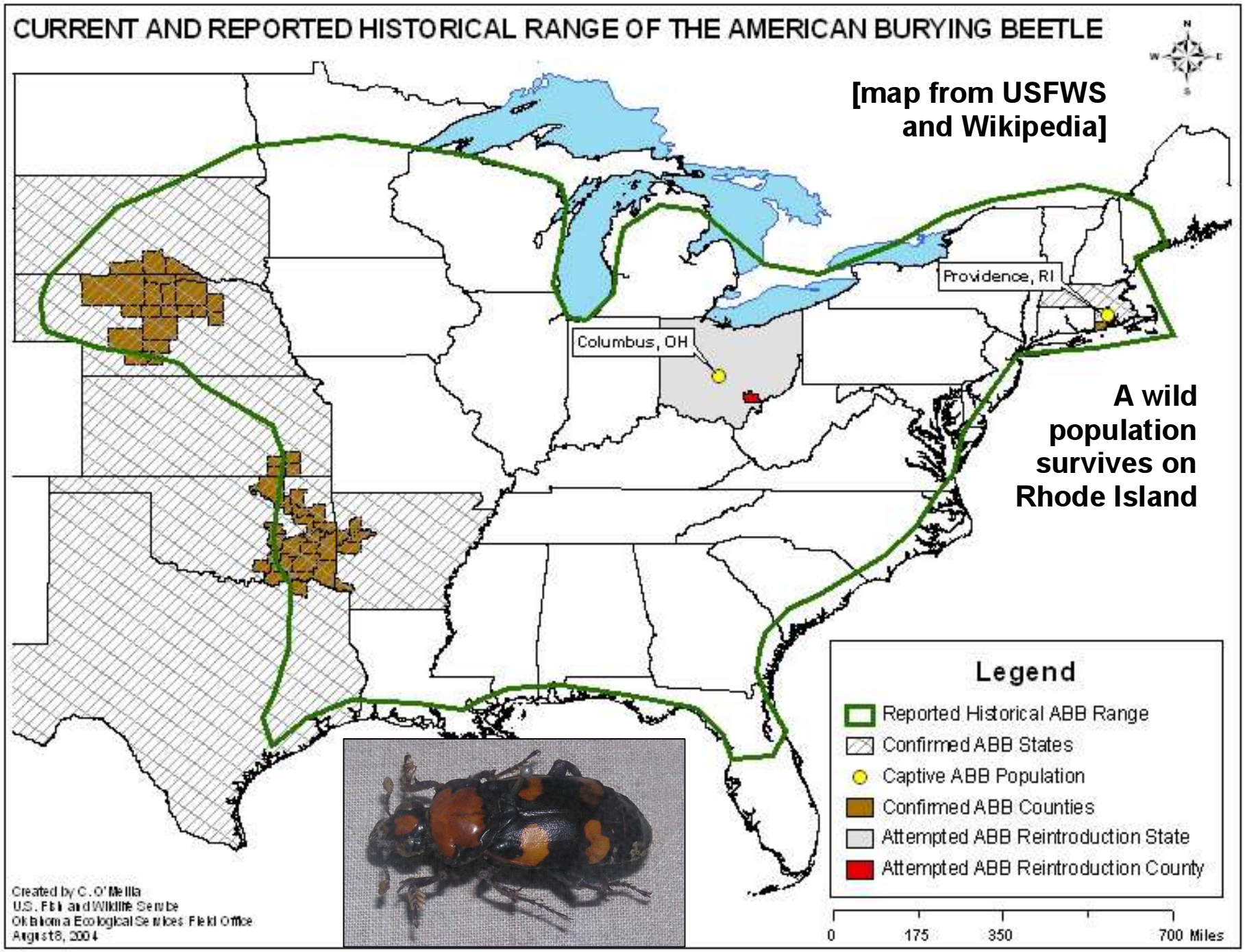
It is generally considered futile to expend public funds on direct raising and releasing of imperiled insects, since the primary factors in their declines usually involve losses of habitat or impacts of pollution. However, in a few selected cases, there has been considerable public interest in more charismatic species, such as the Monarch Butterfly. Wikipedia: “After a ten-fold drop in the population of the eastern monarch butterfly population over the last decade, a 2016 study predicted an 11%-57% probability that this population will go extinct over the next 20 years... The monarch butterfly is not currently listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) or protected specifically under U.S. domestic laws. On 14 August 2014, the Center for Biological Diversity and the Center for Food Safety filed a legal petition requesting Endangered Species Act protection for the monarch and its habitat. The U.S. Fish and Wildlife Service initiated a Status Review of the Monarch Butterfly under the Endangered Species Act with a due date for information submission of 3 March 2015... In February 2015, the U.S. Fish and Wildlife Service provided a statistic showing that nearly a billion monarchs have vanished since 1990. One of the main reasons cited was the herbicides used by farmers and homeowners on milkweed, a plant used as a food source, a home and a nursery by the monarchs. A 2016 study also attributed the last decade's ten-fold decline in the eastern monarch population to the loss of breeding habitat, namely the many species of milkweed (Asclepias spp.) that developing larvae require for food. Declines in milkweed abundance are highly correlated with the adoption of herbicide-tolerant genetically modified corn and soybeans, which now constitute 89% and 94% of these crops, respectively, in the U.S. ... Chip Taylor, director of Monarch Watch at the University of Kansas, said the Midwest milkweed habitat "is virtually gone" with 120–150 million acres lost.” Monarch Watch distributes kits with caterpillars and instructions for rasing them on milkweeds.

Monarchs depend on common milkweed, growing in rich soil along roads and around fields.

Bees? There has been much interest in declining bee populations across North America, but can any effective micromanagement be developed—or should the focus be on increasing habitat and reducing pollution? Artificial rearing of natives has been tried several times, but it appears to be difficult (Dicks et al. 2016). KSNPC states: "It is widely known that both native bees and honey bees are declining worldwide. Yet Kentucky's native bee species are poorly known. The Commission has increased its ability to track pollinators by training a biologist at the native bee course of the American Museum of Natural History. We believe he [Ellis Lowdermilk] is the only biologist in the state to complete this training." There may be at least two globally imperiled species in the state [http://www.xerces.org/pollinator-redlist/]: Rusty-patched Bumble Bee (*Bombus affinis*) and Yellow-banded Bumble Bee (*Bombus terricola*).

Beetles? The American Burying Beetle is about 3-4 cm long and feeds on carrion. It was formerly widespread across eastern North America, with Kentucky at the center of its range. It is one of the few species of beetle to exhibit parental care. Its decline has been attributed to habitat loss, alteration, and degradation, and it now occur over less than 10% of their historic range. This species appears to occur in many types of habitat, with a slight preference for grasslands and open oak-hickory woodlands. But they must have carrion the size of a dove or a chipmunk in order to reproduce. Carrion availability may be the greatest factor determining where the species can survive. Lack of small carcasses to bury would prevent the species from reproducing, and changes in land use has reduced the quantity of small- to medium-sized birds and mammals that it prefer*s*. Extinction of the once ubiquitous passenger pigeon may have had an effect. The dramatic disappearance of this beetle from many areas took place before widespread use of agricultural chemicals. Biologists have attempted to establish populations by releasing laboratory-raised American burying beetles on two islands of Massachusetts and in southeastern Ohio [Wikipedia]. Could this be tried in some Wildlife Management Areas of Ky.?

Above: Rusty-patched Bumble Bee (*Bombus affinis*) [https://beespotter.org/topics/bio/Bombus/Images/affinis.jpg]
Right: Yellow-banded Bumble Bee (*Bombus terricola*); [http://bugguide.net/node/view/52384]


CURRENT AND REPORTED HISTORICAL RANGE OF THE AMERICAN BURYING BEETLE
[map from USFWS and Wikipedia]
Providence, RI
Columbus, OH
A wild population survives on Rhode Island
Legend
Reported Historical ABB Range
Confirmed ABB States
Captive ABB Population
Confirmed ABB Counties
Attempted ABB Reintroduction State
Attempted ABB Reintroduction County
0
175
350
700 Miles
Created by C. O'Melia
U.S. Fish and Wildlife Service
Oklahoma Ecological Services Field Office
August 8, 2004

PLANTS

TREES DEVASTATED BY PESTS OR PATHOGENS

In addition to their general loss of habitat, a few tree species have declined much more than others due to alien pests and pathogens that have invaded North America during the past 50-100 years. More than one organism is often involved in these diseases, and the origins of these organisms are sometimes obscure. Declines in some trees have prompted various efforts to save seed, to select for resistance and to propagate massive numbers of new seedlings for recovery. The first major problem of this type was the loss of almost all chestnut due to fungal blight, but that tree did not occur within the Bluegrass region. Currently, hemlock is being devastated, but it is also concentrated in Appalachian regions and absent from the Bluegrass. Species affected within this region are as follows.

Red mulberry (*Morus rubra*). Although still common in woodlands and fencerows away from town, this species is rarely more than 12 inches in diameter; yet trees up to 24-30 or more inches can occur in less disturbed or remoter woods. Cankers and other diseases appear to limit the longevity of trees (Kirk et al. 2010), especially *Fusarium lateritium*—a globally widespread fungus that may be reduced by cow urine! (Gotora et al. 2014). Other special problems are competition from the alien white mulberry (*Morus alba*), hybridization or confusion of these two species by the Kentucky Division of Forestry (Campbell 2014). Despite these problems, propagation from seed is easy, if one can keep off the birds and squirrels, and with leadership in this region we could plant a lot more of this important fruit-producer.

Butternut or white walnut (*Juglans cinerea*). This species used to be locally frequent, at least on more acid soils in hills around the Bluegrass, but it has virtually disappeared here since 1950 due to an alien canker (*Sirococcus clavigignenti-juglandacearum*). There are some resistant trees, and there is an active effort to select material from these trees for propagation a new

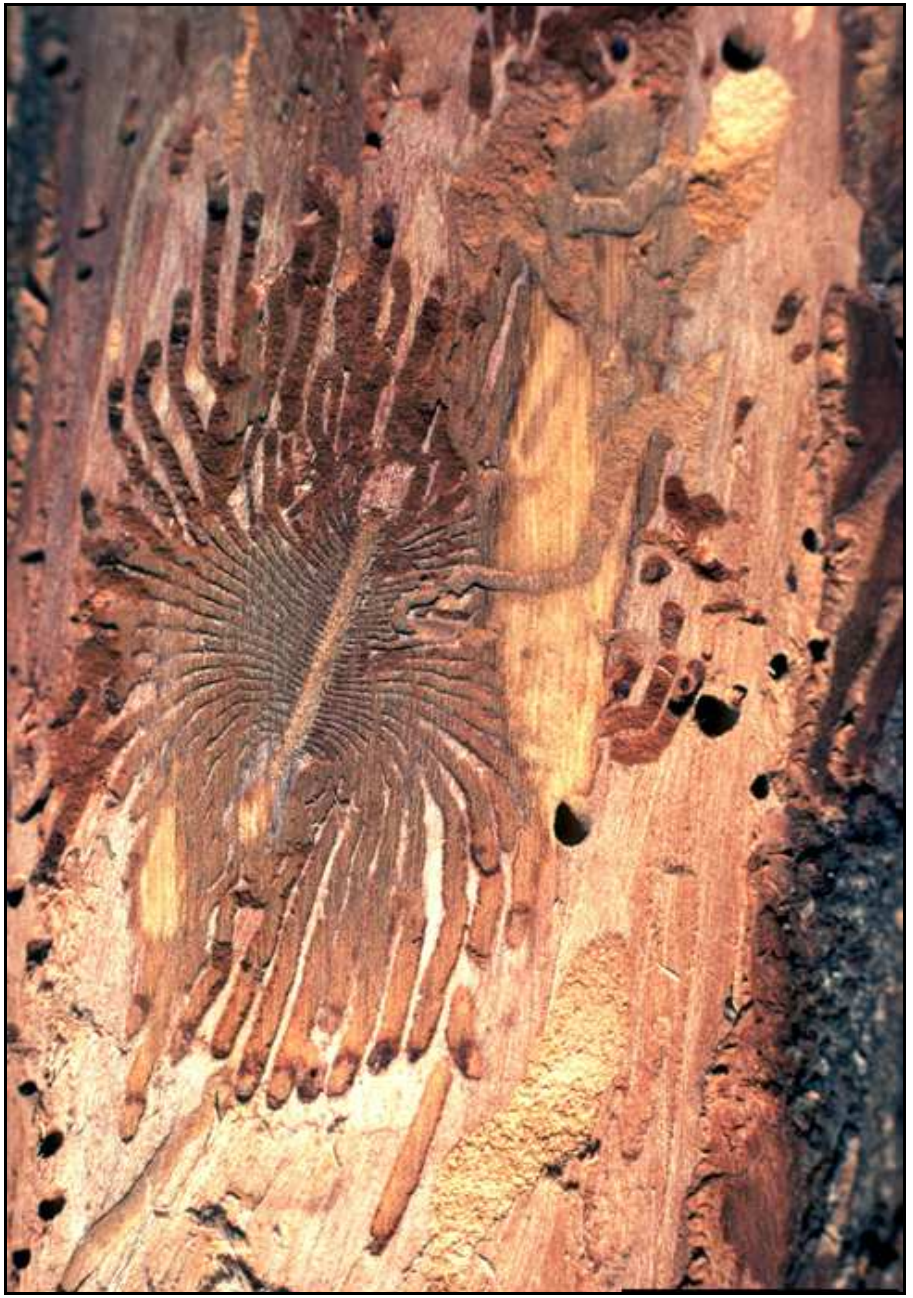
generation in nurseries (Farlee et al. 2010). Recently, black walnut (*J. nlgra*) has also become locally infested by 'thousand cankers disease' in several eastern states (Grant et al. 2011, Wiggins et al. 2014). Those cankers combine damage from walnut bark beetle (*Pityophthorus juglandis*) with a fungus (*Geosmithia morbida*); both organisms are probably alien to eastern North America. So far, that disease appears to be largely associated with stressed trees in urban areas, and there is no evidence of spread into the Bluegrass region (D. Leonard, pers. comm.).

American elm or white elm (*Ulmus americana*). This species has declined much since 1970 due to Dutch Elm Disease—caused by alien fungi (*Ophiostoma* spp.) in association with native and alien bark beetles. Other elms (*U. alata*, *U. thomasii* and especially *U. rubra*) have been affected much less in Kentucky, but they can carry the disease. Trees with smaller vessels in their wood tend to be more resistant (Karnosky & Mikler 2012). Artificial selections and hybrids with some resistance have been promoted but there may also be considerable resistance within wild populations, as indicated by scattered large trees in this region.

Green ashes (*Fraxinus pennsylvanica* sensu lato) and white ashes (*F. americana* sensu lato). These trees have recently become devastated by an East Asian beetle, Emerald Ash Borer (*Agrilus planipennnis*), across the Mid-west, but blue ash (*F. quadrangulata*) has been affected much less (Tanis & McCullough 2012). Although almost all trees are being killed, saplings less than half-an-inch in diameter generally escape. There is much interest in surveying the 1-3% of trees that have survived where the pest first appeared in Michigan and adjacent states. It is hoped that some genetic resistance may exist. There is also an extensive effort to collect and store seed.

Other trees may be threatened but problems have not been as severe as initially feared: these include some oaks, beech, flowering dogwood and fringetree (Hartman et al. 2016).

[http://newfs.s3.amazonaws.com/taxon-images-1000s1000/Juglandaceae/juglans-cinerea-ba-atal-c.jpg]
[http://fgca.net/wp/wp-content/uploads/2011/10/butternut_canker_mature.jpg]



[http://www.fcps.edu/islandcreekes/ecology/Plants/American%20Elm/wulam--br12246.jpg]
[http://www.extension.umn.edu/garden/yard-garden/trees-shrubs/dutch-elm-disease/img/DED7.jpg]

EAB Adult

EAB Larva

Emergence hole
(photos from UK)

Feeding
gallery

GENERAL CONCEPT OF GRADIENTS IN HYDROLOGY AND VEGETATION A-G: indicate the listed groups of species		G2: XERIC WOODS, OPEN CLIFFTOPS
F: MOST MESIC ROCKY WOODS	G1: SUBXERIC ROCKY WOODS	E2: XERIC-TEND-ING OPENINGS
C: DEEPER MESIC-SUBMESIC WOODS	D: INTERMEDIATE SUBMESIC WOODS	E1: TYPICAL OPENINGS +CANE
A2: RIPARIAN WOODS (alluvial soil)	B3: SUBHYDRIC WOODS (varied soil)	B4: HYDRIC-TEND-ING OPENINGS
A1: THIN RIPARIAN WOODS +SHRUBS	B1: THIN HYDRIC WOODS +SHRUBS	B2: STAGNANT WATER +AQUATICS

Explanation for lists of species that are estimated to have declined by at least 99%; see also http://www.bluegrasswoodland.com/uploads/Central_Bluegrass_Species_List.xls

HAB = habitat classes A to G; see coded chart on preceding page.

DIS = disturbance gradient; from species typical of deep shade to full sun with no competition: 1 = deep shade; 2 = average woods; 3 = young woods, thickets, woodland paths; 4 = brushy edges, old fields; 5 = grasslands, pastures; 6 = bare ground, water or rock. In additiion, responses to browsing/grazing are ranked as follows for woody species (herbaceous species remain incomplete): a = browsing sensitive; b = neutral/unknown; c = browsing tolerant

GLO = Global rarity (10 point g-scale) for rare species in state. This coding is an elaboration of the traditional "G-ranks" maintained by NatureServe (www.natureserve.org/ explorer/ ranking.htm); that 5-point scale is converted here into an 10-point scale. This conversion allows more precision for comparing species within east-central North America. It is still a provisional approximation, probably accurate to ± one unit in most cases, pending compilation of more data by J.T. Kartesz (in prep.), FNA (1993-2013), and others. For taxa with inadequate information, question marks indicate more speculative ranks, possibly off by ± two units.

STA = State rarity (10 point s-scale). This coding is parallel to the global ranks outlined above, being an elaboration of the traditional "S-ranks" maintained by State Heritage Programs, which underlie the "endangered" (mostly S1), "threatened" (mostly S2) and "special concern" (mostly S3) categories (e.g., KSNPC 2000); that 5-point scale is converted here into an 10-point scale.

LOC = Local rarity (5 point scale). This is a provisional ranking of abundance within the Central Bluegrass; it deserves more refinement, with conversion to 10-point scale.

CHA = Change estimated since settlement (5 point scale). This combines coding for alien status plus some estimate of increase-versus-decrease for native species after settlement in the 1770s.

SPECIES OF DEEPER WOODS: mostly mesic to submesic

The lists of species below include only those that have declined greatly (probably 99% or more). Following are typical of less disturbed woods with relatively deep fertile soil on uplands or on high terraces; they would probably have been widespread in the Central Bluegrass.

SCIENTIFIC NAME	COMMON NAME	HAB	DIS	GLO	STA	LOC	CHA
TREES AND SHRUBS							
Acer nigrum	**black maple**	**C**	**1a**			**3**	**4**
Aesculus glabra	**stinking (Ohio) buckeye**	**C**	**2c**			**2**	**4**
Ulmus rubra	**red elm**	**C**	**2a**			**3**	**4**
Carpinus caroliniana	**hornbeam**	**C**	**1c**			**3**	**4**
Lindera benzoin	**spicebush**	**C**	**1c**			**4**	**4**
FERNS AND ALLIES							
Cystopteris protrusa	**common fragile fern**	**C**	**1b?**			**3**	**4**
Dryopteris carthusiana	**spinulose woodfern**	**C**	**1b?**	**g10**	**s6?**	**4**	**4**
HERBS							
Asarum canadense **[sensu lato]**	**wildginger**	**C**	**1b?**			**3**	**4**
Blephilia hirsuta	**white wood-mint**	**C**	**2a?**			**5**	**4**
Circaea canadensis	**enchanter's nightshade**	**C**	**2a**			**3**	**4**
Collinsia verna	**blue-eyed-Mary**	**C**	**2b?**	**g8**	**s7**	**4**	**4**
Delphinium tricorne	**wood larkspur**	**C**	**1b?**			**3**	**4**
Dicentra cucullaria	**dutchman's breeches**	**C**	**1c**			**3**	**4**
Hydrophyllum appendiculatum	**blue waterleaf**	**C**	**1a?**			**4**	**4**
Hydrophyllum canadense	**lowland waterleaf**	**C**	**1a?**			**5**	**4**
Impatiens pallida	**yellow jewelweed**	**C**	**1a**			**3**	**4**
Jeffersonia diphylla	**twinleaf**	**C**	**1b?**			**4**	**4**
Mertensia virginica	**bluebells**	**C**	**1a?**			**4**	**4**

Osmorhiza claytonii	**hairy sweet-cicely**	**C**	**2a?**			**3**	**4**
Phlox divaricata	**eastern wood phlox**	**C**	**1a?**			**3**	**4**
Podophyllum peltatum	**mayapple**	**C**	**2c**			**3**	**4**
Ranunculus hispidus	**common wood-buttercup**	**C**	**2b?**			**4**	**4**
Sanguinaria canadensis	**bloodroot**	**C**	**1c**			**4**	**4**
Sanicula odorata	**walnut-wood sanicle**	**C**	**2b?**			**3**	**4**
Stellaria corei	**greater wood-chickweed**	**C**	**1a?**			**4**	**4**
Thaspium trifoliatum	**ternate wood-parsnip**	**C**	**2a?**			**4**	**4**
Urtica chamaedryoides	**lesser nettle**	**C**	**2b?**			**3**	**4**
Valeriana pauciflora	**valerian**	**C**	**1b?**	**g7**	**s7**	**4**	**4**
Viola pensylvanica	**smooth yellow stemmed-violet**	**C**	**1a?**			**4**	**4**
Dicentra canadensis	**squirrel corn**	**C**	**1c**			**4**	**5**
Enemion biternatum	**deep-lobed rue anemone**	**C**	**1b?**			**3**	**5**
Erigenia bulbosa	**harbinger-of-spring**	**C**	**1b?**			**4**	**5**
Laportea canadensis	**wood nettle**	**C**	**1a**			**4**	**5**
Floerkea proserpinacoides	**mermaidweed**	**C**	**1b?**	**g8**	**s5**	**X**	**5**
LEGUMES							
Hylodesmum pauciflorum	**pale wood tick-trefoil**	**C**	**2a?**			**3**	**4**
COMPOSITES							
Solidago flexicaulis	**common zig-zag goldenrod**	**C**	**1b?**			**4**	**4**
MONOCOTS							
Camassia scilloides	**wild hyacinth**	**C**	**1a**			**5**	**4**
Erythronium albidum	**white trout-lily**	**C**	**1b?**			**4**	**4**
Tradescantia subaspera	**broad-leaved spiderwort**	**C**	**1a?**			**3**	**4**
Erythronium americanum	**yellow trout-lily**	**C**	**1b?**			**4**	**5**
Galearis spectabilis	**showy orchid**	**C**	**1a?**			**X**	**5**
GRAMINOIDS							
Carex oligocarpa	**lesser wrinkled-sedge**	**C**	**2b?**			**3**	**4**

Wild Hyacinth in restored woods behind house of author

SPECIES OF INTERMEDIATE WOODS: mostly submesic

Following are typical of this habitat, on relatively deep soils and moderately disturbed.

SCIENTIFIC NAME	COMMON NAME	HAB	DIS	GLO	STA	LOC	CHA
TREES AND SHRUBS							
Carya laciniosa	**shellbark hickory**	**D**	**2c**			**3**	**4**
Carya ovata	**shagbark hickory**	**D**	**2c**			**3**	**4**
Juglans cinerea	**white walnut (butternut)**	**D**	**3b**	**g7**	**s6?**	**5**	**5**
Arundinaria gigantea	**cane**	**D**	**4a**			**4**	**5**
Asimina triloba	**pawpaw**	**D**	**2c**			**3**	**4**
HERBS							
Galium triflorum	**moist wood bedstraw**	**D**	**2b?**			**2**	**4**
Iodanthus pinnatifidus	**purple-rocket**	**D**	**2b?**			**3**	**4**
Osmorhiza longistylis	**smooth sweet-cicely**	**D**	**3a?**			**3**	**4**
Phacelia purshii	**blue "Miami" mist**	**D**	**3b?**			**2**	**4**
Ranunculus recurvatus	**lobed wood-buttercup**	**D**	**4b?**			**3**	**4**
Amphicarpaea bracteata	**common hogpeanut**	**D**	**4a**			**4**	**4**
Trifolium stoloniferum	**running buffalo clover**	**D**	**3b?**	**g4**	**s4**	**5**	**5**
Nabalus crepidineus	**giant wood-lettuce**	**D**	**3a?**	**g7?**	**s5?**	**5**	**5**
MONOCOTS							
Arisaema dracontium	**green dragon**	**D**	**3b**			**5**	**4**
Lilium michiganense	**western lily**	**D**	**3a?**	**g8**	**s6**	**5**	**5**
Polygonatum commutatum	**greater Solomon's seal**	**D**	**3a?**			**3**	**4**
Smilax lasioneura	**hairy pale carrionflower**	**D**	**3a?**			**4**	**4**
Carex normalis	**rich-wood scale-sedge**	**D**	**3b?**			**3**	**4**
Festuca subverticillata	**wood fescue**	**D**	**2a**			**3**	**4**
Poa sylvestris	**common wood bluegrass**	**D**	**2a?**			**3**	**4**
Sphenopholis intermedia	**lowland wedge-grass**	**D**	**3a?**			**4**	**4**

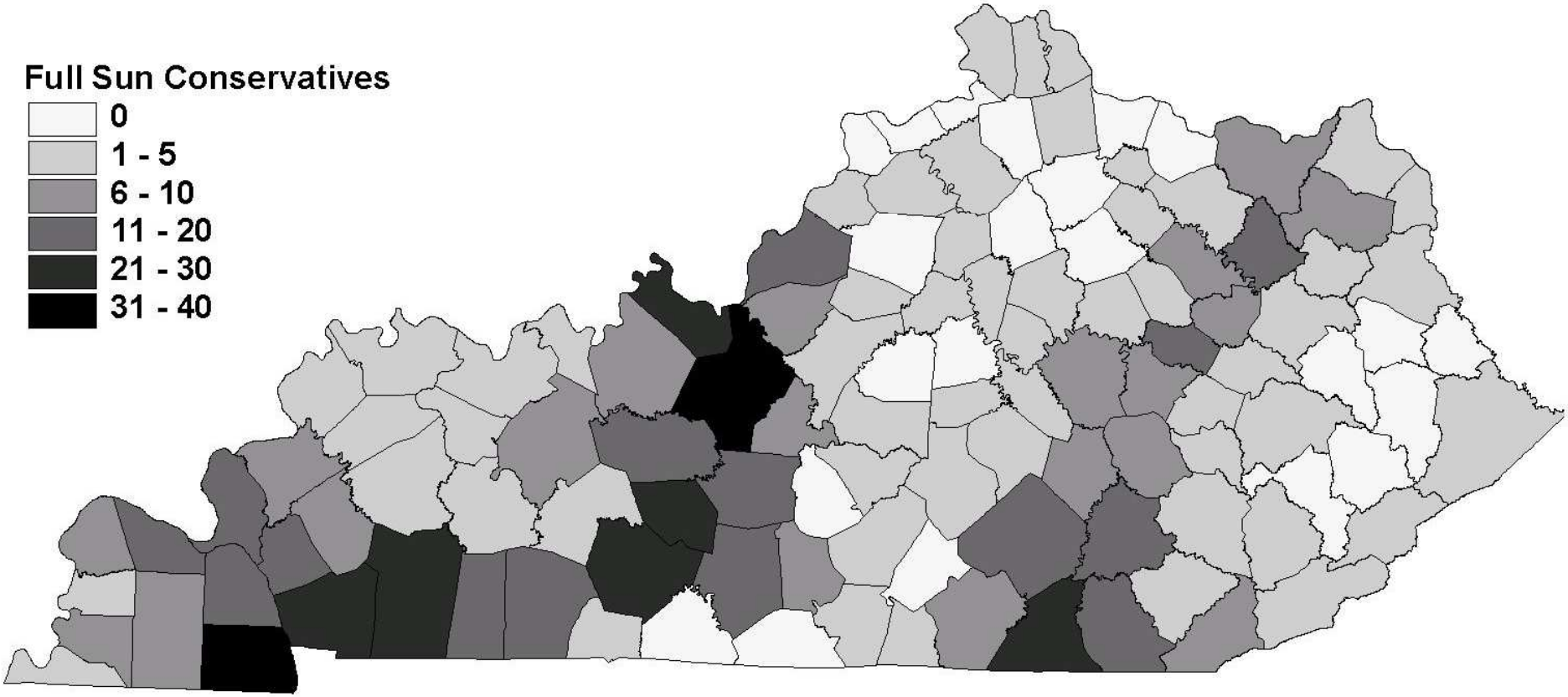
Running Buffalo Cover in protected
propagation bed behind house of author

SPECIES OF OPENINGS: mostly submesic to subxeric

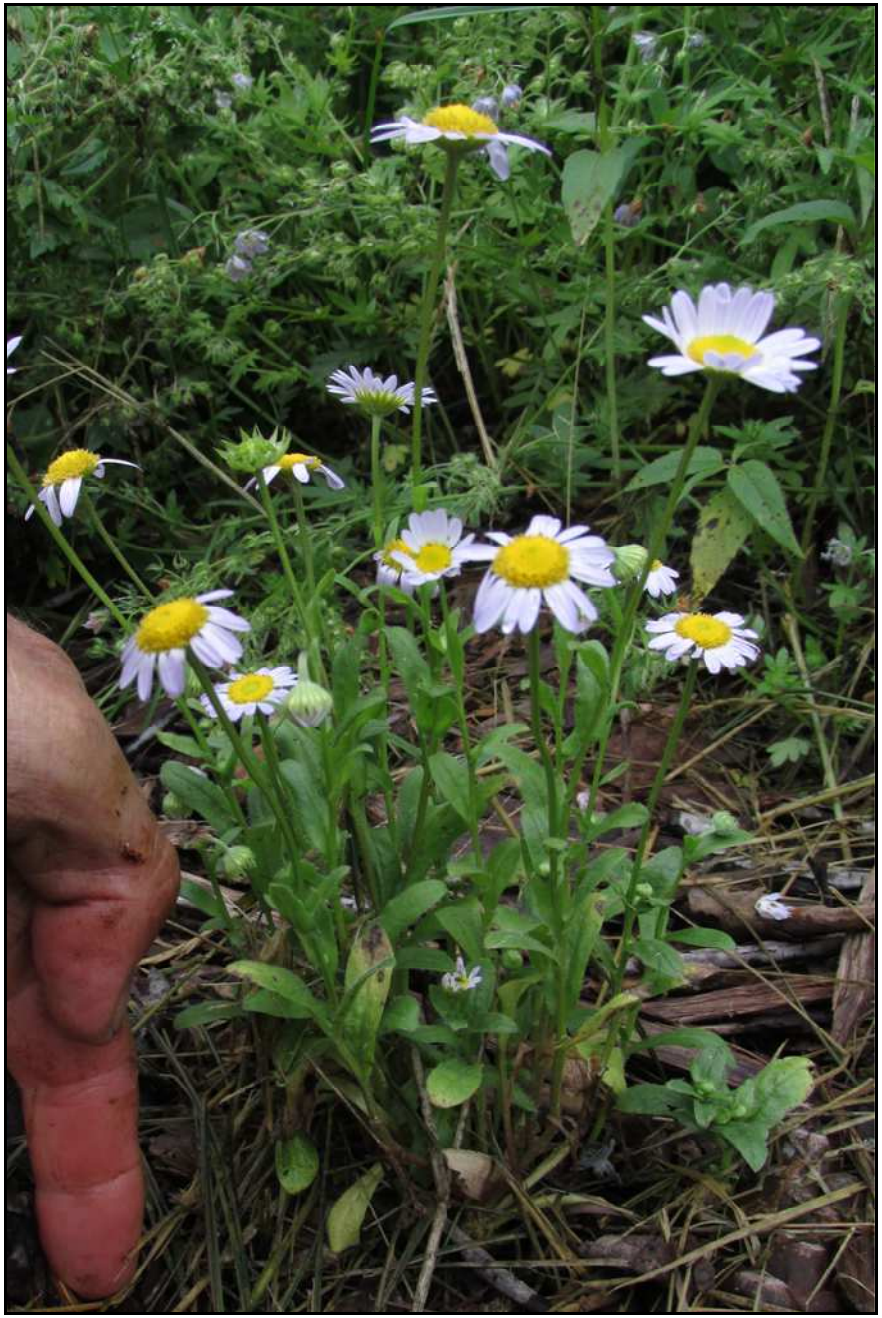
SCIENTIFIC NAME	COMMON NAME	HAB	DIS	GLO	STA	LOC	CHA
Zanthoxylum americanum	pricklyash	E2	4c			4	4
Asclepias verticillata	whorled milkweed	E2	5b			5	4
Cynoglossum officinale	hound's-tongue	E2	3			5	4
Gaura biennis	greater gaura	E1	5a?			4	4
Glandularia canadensis	rose mock-vervain	E2	5			5	4
Lithospermum canescens	orange puccoon	E2	5			5	4
Malvastrum hispidum	glade mallow	E2	6	g6?	s4	5	5
Oenothera triloba	stemless evening-primrose	E2	6	g8	s5	5	4
Onosmodium hispidissimum	eastern gromwell	E2	5c	g7?	s3	5	5
Opuntia cespitosa	midwestern prickly pear	E2	5c			4	4
Penstemon calycosus [sensu lato]	felty open beardtongue	E2	4a?			3	4
Scutellaria parvula	eastern lesser skullcap	E2	6			5	4
Veronicastrum virginicum	Culver's root	E2	4b?	g9	s7?	5	5
Desmanthus illinoensis	prairie mimosa	E1	4a?			4	4
Orbexilum onobrychis	broad-leaved scurfpea	E2	4a?	g7	s5	5	5
Astranthium integrifolium	western daisy	E1	5a?	g7	s7	4	4
Brickellia eupatorioides	alternate boneset	E2	5b			3	4
Echinacea purpurea	broad-leaved purple coneflower	E2	4a?	g8	s7	5	4
Helianthus grosseserratus	midwestern slender sunflower	E2	5a?	g9	s7	4	4
Helianthus hirsutus	common glade sunflower	E2	5a?			5	4
Ratibida pinnata	prairie coneflower	E2	5b?			4	4
Solidago shortii	buffalop-trace goldenrod	E2	5b	g3	s3	5	5
Symphyotrichum juniperinum ?	lime little-white-aster	E2	5			3	4
Carex meadii	grassland lime-sedge	E2	5	g9	s7	5	4
Spiranthes magnicamporum	lime ladies'-tresses	E2	5	g8	s2	5	5
Dichanthelium scribnerianum	small barrens panic-grass	E2	5			5	5

Map showing concentrations of conservative species in openings on uplands

Number per county of “conservative” vascular plant species that are typical of full sun on deep well drained soils. These are rare non-weedy species with slow dispersal into new openings (state-rank S1-S3S4). Excluded are species that occur mostly on distinctly xeric, rocky soils, or on distinctly hydric soils. Note concentration on or near the Big Barrens region and the western margin of the Appalachian Plateaus (especially in the south). Note also general absence within the intervening zone from Bluegrass to Cumberland-Green River Hills, and within the Appalachian Rugged Hills (coal-fields).



Species that used to depend on seasonal grazing or similar disturbances, but which now largely depend upon the helping hand of mankind.



Left: *Astranthium integrifolium*, western daisy. Right: *Ratibida pinnata*, grayheaded coneflower

SPECIES OF WETLANDS: subrheic, hydric, subhydric, hydroxeric

Following are divided into four groups, corresponding to the habitat classes outlined above. This division is tentative, and many species are wide-ranging without strong concentrations. But they are all estimated to have declined by at least 99% here based on general knowledge.

SCIENTIFIC NAME	COMMON NAME	HAB	DIS	GLO	STA	LOC	CHA
THIN HYDRIC WOODS & TRANSITIONS TO STREAMS / SWAMPS							
Cephalanthus occidentalis	buttonbush	B1	4c			4	4
Cornus amomum	broad-leaved silky dogwood	B1	4a			4	4
Lycopus rubellus	swamp water-horehound	B1	3			5	4
Nuphar advena	yellow water-lily	B1	5			4	4
Saururus cernuus	lizard's tail	B1	3c			3	4
Carex crus-corvi	swamp fox-sedge	B1	5			4	4
Carex hyalinolepis	greater rich-swamp-sedge	B1	4			5	4
Elodea canadensis	northern waterweed	B1	6	g9	s5?	5	5
Elodea nuttallii	western waterweed	B1	6	g8	s3?	5	5
Ranunculus ambigens	northern spearwort	B1	5	g8	s5?	5	5
STAGNANT WATER; LOCALLY DOMINATED BY AQUATICS							
Ammannia coccinea	greater pond-purslane	B2	6			5	4
Hibiscus moscheutos	broad-leaved rosemallow	B2	4b?			2	4
Ludwigia palustris	water-purslane	B2	6a?			3	4
Persicaria coccinea	broad-leaved water smartweed	B2	6b?			5	5
Persicaria hydropiperoides	water smartweed	B2	6b			4	4
Rumex verticillatus	swamp dock	B2	5			5	4
Heteranthera reniformis	broad-leaved mudplantain	B2	6a?			5	4
Najas guadalupensis	southern water-nymph	B2	6a?			4	4
Sagittaria calycina	spongy arrowhead	B2	6			5	5

SUBHYDRIC WOODS WITH SMALL SWAMPY OPENINGS							
Cardamine bulbosa	**bulbous bittercress**	**B3**	**3b**			**4**	**4**
Chelone glabra	**white turtlehead**	**B3**	**3b?**			**5**	**4**
Cicuta maculata	**spotted cowbane**	**B3**	**4**			**5**	**4**
Lobelia cardinalis	**cardinal-flower**	**B3**	**3**			**3**	**4**
Ranunculus caricetorum	**northern swamp buttercup**	**B3**	**3c+?**			**4**	**4**
Carex lupuliformis	**western greater hop-sedge**	**B3**	**4b**	**g8**	**s7**	**4**	**4**
Carex squarrosa	**fat head-sedge**	**B3**	**2b?**			**5**	**4**
Cinna arundinacea	**wood reedgrass**	**B3**	**3**			**3**	**4**
Apios americana	**potato bean**	**B3**	**4**			**5**	**5**
HYDRIC-TENDING / HYDROXERIC WOODS / MARSHY OPENINGS							
Quercus bicolor	**swamp white oak**	**B4**	**4b**			**5**	**5**
Quercus lyrata	**overcup oak**	**B4**	**4b**			**5**	**4**
Anemone canadensis	**meadow anemone**	**B4**	**5c**	**g10**	**s0**	**X**	**5**
Caltha palustris	**marsh marigold**	**B4**	**5c**	**g10**	**s0**	**X**	**5**
Lysimachia hybrida	**swamp loosestrife**	**B4**	**5a?**	**g8?**	**s3?**	**5**	**5**
Mentha canadensis	**wild mint**	**B4**	**5c**	**g10**	**s6**	**5**	**5**
Rudbeckia speciosa	**northern coneflower**	**B4**	**5b?**	**g6?**	**s2?**	**5**	**5**
Penstemon digitalis	**smooth open penstemon**	**B4**	**4a?**			**4**	**5**
Spiranthes odorata	**marsh ladies' tresses**	**B4**	**4**	**g8**	**s2**	**5**	**5**
Stenanthium gramineum	**featherbells**	**B4**	**5b?**	**g8**	**s5**	**X**	**5**
Carex lupulina	**greater hop-sedge**	**B4**	**5b?**			**3**	**4**
Carex shortiana	**lime-swale-sedge**	**B4**	**4b?**			**3**	**4**
Eleocharis compressa	**flat-stemmed spike-rush**	**B4**	**5**	**g9**	**s5?**	**5**	**4**

Note the large proportion of state-rare species in latter (B4); this habitat appears to have been most intensively damaged by agricultural influences, especially excessive effects of livestock.

Marsh Marigold planted in
remnant of spring-fed wetland at
end of Allendale Drive in Lexington

SPECIES OF RIPARIAN ZONES: rheic (A1), subrheic (A2)

SCIENTIFIC NAME	COMMON NAME	HAB	DIS	GLO	STA	LOC	CHA
Amorpha fruticosa	indigo-bush	A1	4a			4	4
Amaranthus tuberculatus	eastern sand amaranth	A1	6			5	4
Hypericum sphaerocarpum	shoreline St. Johnswort	A1	5b	g8	s7	4	4
Rorippa sessiliflora	sessile yellow-cress	A1	6			5	4
Panicum virgatum	switch-grass	A1	5	g10	s7	4	4
Physostegia virginiana	lowland obedient plant	A1	5	g10	s7	5	5
Ranunculus longirostris	stream crowfoot	A1	6a?	g9?	s4	5	5
Spermacoce glabra	greater buttonweed	A1	6			5	5
Baptisia australis	blue wild indigo	A1	5	g8	s7	5	5
Humulus americanus	wild hops	A2	4b			5	4
Acalypha deamii	lowland mercury	A2	2b	g7?	s7?	5	4
Lysimachia ciliata	riparian loosestrife	A2	4a?			4	4
Monarda serotina sp. nov.	lowland bergamot	A2	2a?	g7?	s7?	5	4
Stachys tenuifolia	smooth woundwort	A2	3a?			3	4
Thalictrum pubescens	lowland meadow-rue	A2	3b?			4	5
Urtica gracilis	greater nettle	A2	3a?			5	5
Zizia aurea	lowland alexanders	A2	4b?			4	4
Arnoglossum reniforme	dark Indian plaintain	A2	3			5	4
Rudbeckia laciniata	cutleaf coneflower	A2	3b?			3	4
Silphium perfoliatum	cupleaf rosinweed	A2	4a?			3	4
Solidago gigantea	lowland old-field goldenrod	A2	4b			4	4
Symphyotrichum prenanthoides	streamside blue-aster	A2	2a?			3	4
Allium canadense	wild onion	A2	2a			3	4
Dioscorea villosa	lowland wild yam	A2	2b?			4	4
Carex grayi	basic rounded hop-sedge	A2	3			5	4

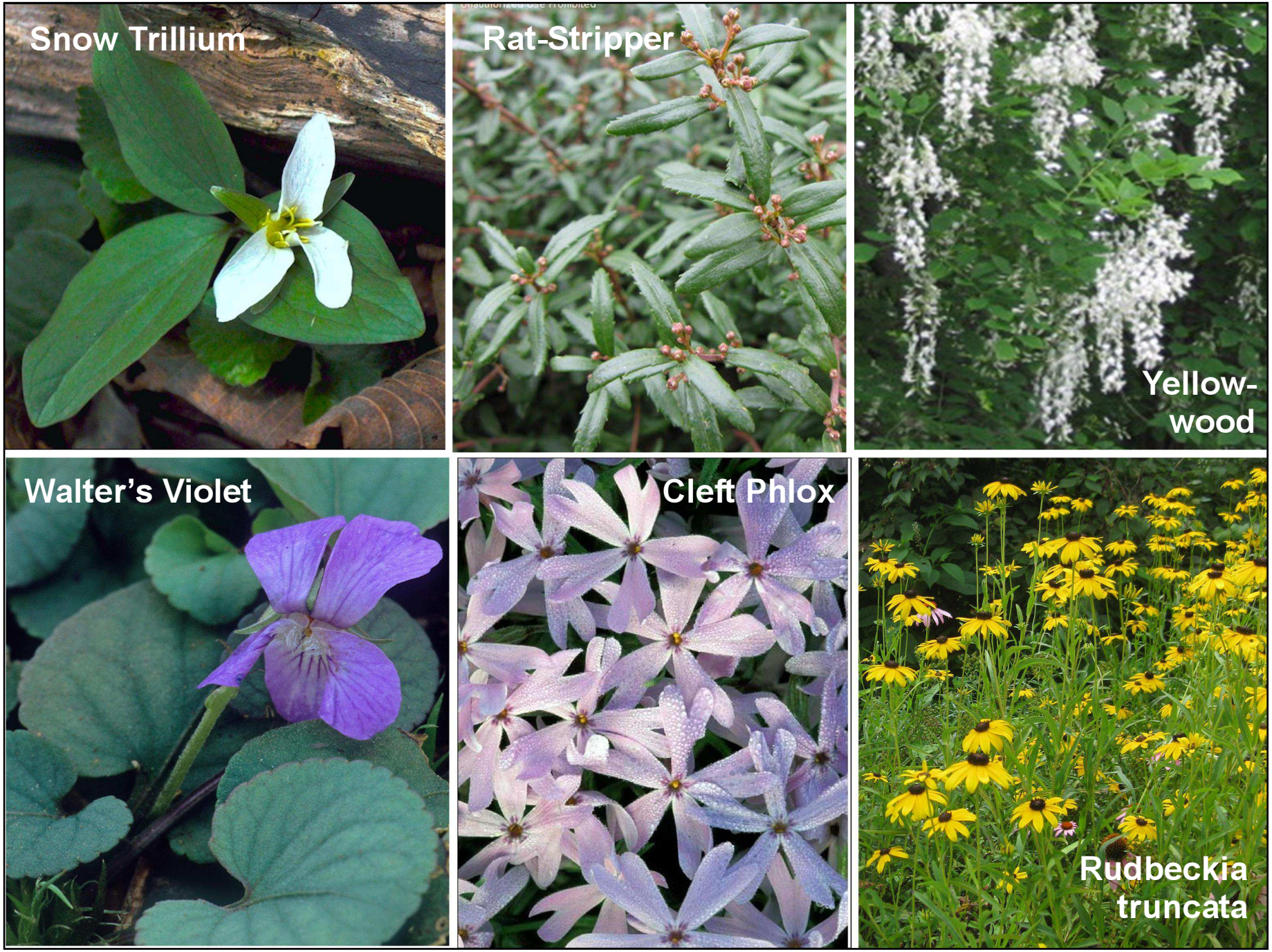
Blue Indigo (*Baptisia austalis*) cultivated at Mount Cuba Center, Delaware. Only one wild plant of this formerly widespread species is known to remain in the Kentucky River watershed. [http://www.mtcubacenter.org/images/plant-trials/b_australis_big_ben_1.jpg]

SPECIES OF ROCKY RAVINES: mesic/F, subxeric/G1, xeric/G2

Following are divided into three groups, corresponding with the habitat classes outlined above. These species have probably declined more than others associated with rocky ravines, but this is a subjective estimation based on very few clues in most cases.

SCIENTIFIC NAME	COMMON NAME	HAB	DIS	GLO	STA	LOC	CHA
Aplectrum hyemale	puttyroot orchid	F	2a?			5	4
Caulophyllum thalictroides	blue cohosh	F	1b?			5	4
Collinsonia canadensis	horse-balm	F	2			4	4
Phlox amplifolia	broad-leaved phlox	F	1	g7	s6?	5	4
Allium tricoccum	broad wild leek	F	1a			4	4
Corallorrhiza odontorhiza	autumn coralroot	F	1b?			4	4
Corallorrhiza wisteriana	spring coralroot	F	1b?			4	4
Galium concinnum	needle-leaved bedstraw	F	2b?			4	4
Helianthus decapetalus	large wood sunflower	F	1a?			4	4
Hylodesmum glutinosum	rich wood tick-trefoil	F	1a			4	4
Celastrus scandens	American bittersweet	G1	4a			4	4
Dasistoma macrophylla	mullein foxglove	G1	3b?			4	4
Desmodium cuspidatum	large-bracted tick-trefoil	G1	4a?	g8?	s7	5	4
Tragia cordata	broad-leaved noseburn	G1	3c?	g9	s7	5	4
Hydrastis canadensis	goldenseal	G1	1c?			5	5
Trifolium kentuckiense	Kentucky clover	G1	3	g2?	s2?	5	5
Scutellaria leonardii [+ S. parvula?]	midwestern lesser skullcap	G2	6	g10	s7	5	4
Clinopodium glabellum	glade basil	G2	4c+?	g6	s5	4	4
Quercus stellata Wangenh.	post oak	G2	4c			4	4
Ranunculus fascicularis	rocky wood-buttercup	G2	3	g9?	s5?	5	4
Paysonia globosa	bladder-pod	G2	4b?	g3	s2	5	5
Perideridia americana	eastern yampah	G2	3a?	g6	s4	5	5

Several common species of mesic ravines can be easily spread onto wooded slopes in town. And some rarer species of drier cliffs may be suitable for rock-gardens here; see next page.


Snow Trillium
Rat-Stripper
Yellow-wood
Walter's Violet
Cleft Phlox
Rudbeckia truncata

Yampah (*Perideridia americana*), cultivated in garden of the author, an edible endangered species that used to occur in thin dry woods on ridges near the Kentucky River

SPECIES OF MORE ACID SOILS: mesic/F, subxeric/G1, xeric/G2

These are species associated with more shaley hills and older river terraces, where soils tend to be more acid or less fertile. They are divided into three groups, corresponding with the habitats outlined above. These listed species have probably declined more than others associated with rocky ravines, but this is a subjective estimation based on very few clues in most cases.

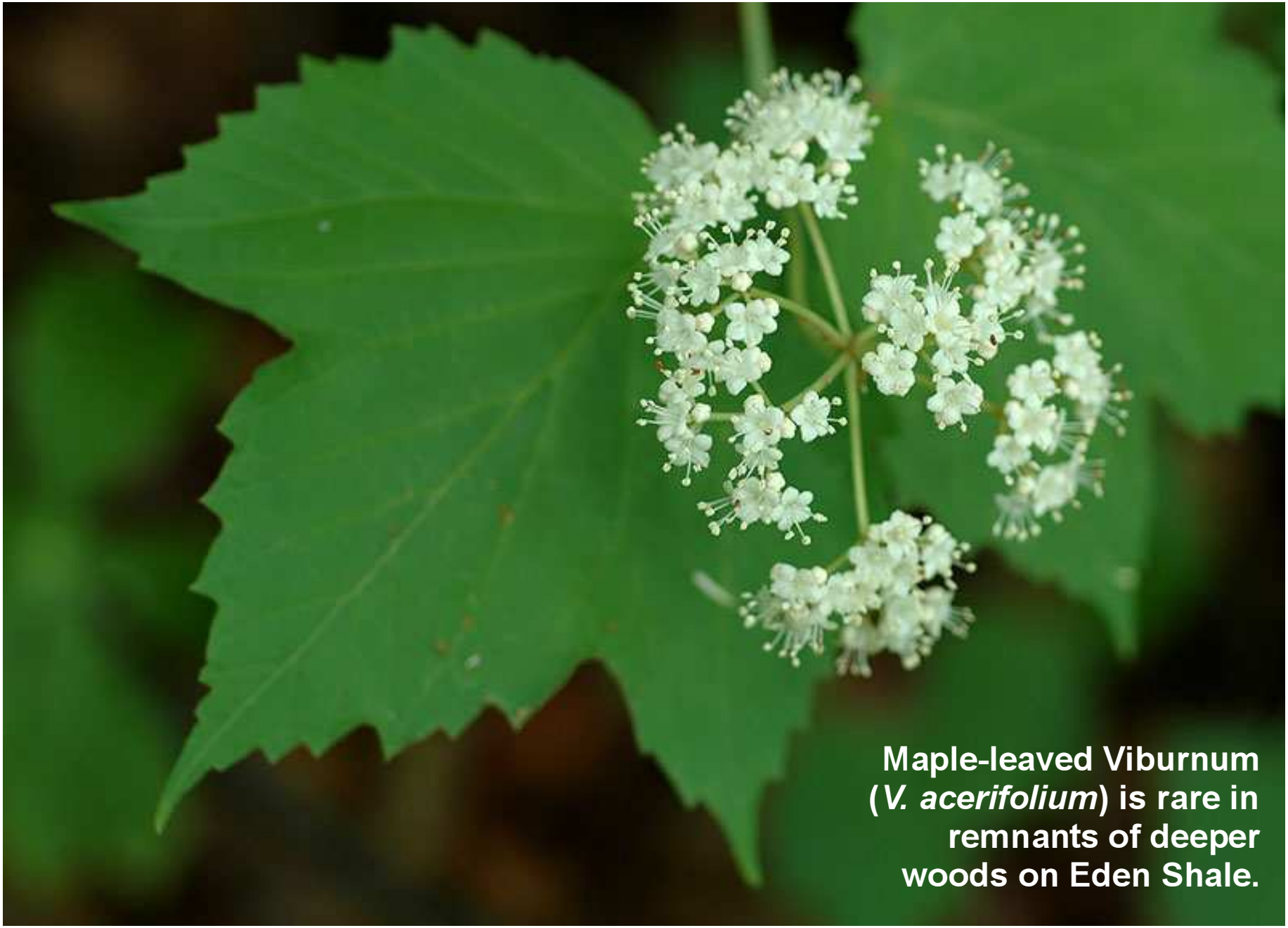
SCIENTIFIC NAME	COMMON NAME	HAB	DIS	GLO	STA	LOC	CHA
Aruncus dioicus	goat's-beard	xF	1			5	4
Brachyelytrum erectum	beech-grass	xF	1a			4	4
Cimicifuga racemosa	common bugbane	xF	1b?			5	4
Iris cristata	common dwarf iris	xF	1			5	4
Magnolia acuminata	cucumber magnolia	xF	2b			X?	4
Astilbe biternata	dull goat's beard	xF	1			X?	5
Panax quinquefolius	ginseng	xF	1b	g8	s7	5	5
Viola rostrata	long-spurred spreading-violet	xF	1			5	5
Antennaria parlinii	smooth pussytoes	xG1	3			5	4
Aureolaria virginica	downy yellow foxglove	xG1	3			5	4
Carex striatula	exert lax-sedge	xG1	4			4	4
Carya tomentosa	mockernut hickory	xG1	2c			4	4
Chimaphila maculata	striped wintergreen	xG1	3			4	4
Crataegus intricata	lobed hawthorn	xG1	4c	g9	s7?	5	4
Eupatorium sessilifolium	wood boneset	xG1	3			4	4
Gaultheria procumbens	teaberry	xG1	2			5	4
Gillenia stipulata	Indian physic	xG1	3			5	4
Goodyera pubescens	rattlesnake plantain	xG1	3			5	4
Helianthus divaricatus	sessile wood sunflower	xG1	3			4	4

Hylodesmum nudiflorum	**common wood tick-trefoil**	**xG1**	**2**			**4**	**4**
Krigia biflora	**common orange dandelion**	**xG1**	**3**			**5**	**4**
Luzula echinata	**common woodrush**	**xG1**	**3**			**5**	**4**
Lysimachia quadrifolia	**wood loosestrife**	**xG1**	**3**			**5**	**4**
Mitchella repens	**partridgeberry**	**xG1**	**1**			**5**	**4**
Monotropa uniflora	**Indianpipe**	**xG1**	**1**			**5**	**4**
Obolaria virginica	**pennywort**	**xG1**	**2**			**4**	**4**
Orobanche uniflora	**wood broomrape**	**xG1**	**2**			**5**	**4**
Pedicularis canadensis	**common lousewort**	**xG1**	**3**			**4**	**4**
Uvularia perfoliata	**lesser bellwort**	**xG1**	**2**			**4**	**4**
Viburnum acerifolium	**mapleleaf arrow-wood**	**xG1**	**2c**			**5**	**4**
Hexalectris spicata	**crested coralroot**	**xG1**	**3**	**g8**	**s7**	**5**	**5**
Phaseolus polystachios	**thicket bean**	**xG1**	**4a?**	**g9**	**s7**	**5**	**5**
Lithospermum latifolium	**broad-leaved puccoon**	**xG2**	**3**			**5**	**4**
Comandra umbellata	**bastard toadflax**	**xG2**	**5**			**4**	**4**
Packera paupercula [pseudotomenosa]	**balsam ragwort**	**xG2**	**6**	**g8?**	**s2?**	**X**	**5**

Other groups of acidophilous species occur on deeper or wetter soils, including more open habitats, but mostly outside the Central Bluegrass. A more comprehensive treatment of the region's flora would provide details; see Excel file currently posted at bluegrasswood.com [http://www.bluegrasswoodland.com/uploads/Central_Bluegrass_Species_List.xls].

Species of more open or disturbed habitats, especially (D, E1, E2), deserve more attention, since they could be used in plantings of 'quasi-native' grassland in the Eden Shale Hills. Such species include *Astragalus canadensis,Ceanothus americanus, Gentiana alba, Gentianella quinquefolia, Liatris squarrosa, Lysimachia lanceolata, Malus coronaria, Pycnanthemum tenuifolium, Ruellia caroliniensis, Sabatia angularis* and *Silphium trifoliatum*.

[https://s-media-cache-ak0.pinimg.com/564x/f1/bf/2f/f1bf2ffcd6bd920af3189dcc9d9c768e.jpg]



[http://www.delawarewildflowers.org/images/viburnum_acerifolium_2.jpg]

Ginseng (*Panax quinuefolius*) used to be common in hills around the Central Bluegrass but it has largely disappeared due to harvesting for its value as a medicinal herb; it can be cultivated.

SUMMARY OF ALL CONSERVATION TARGETS

The following items could be crafted into programmatic goals for conservation in the region.

1. Landscape level. As outlined in Part 2, it is important to focus on three large 'megasites'.
1a. Palisades of Kentucky River: extensive wooded corridor but river itself highly degraded.
1b. South Fork, Licking River: river restorable in long term; Griffith Woods on uplands.
1c. Bluegrass Army Depot: degraded but large potential restoration for clover, other species.

2. Habitat level. As outlined in Part 3, some habitat classes deserve more effort to restore.
2a. Stream corridors (1): especially larger streams with rocky banks, gravel bars and riffles.
2b. Mesic-subxeric acid woods (5a): formerly on high river terraces and in Eden Shale Hills.
2c. Xeric flatrocks and thin woodland/grassland (12, drier 10): especially uplands near Ky. Rv.
2d. Wetlands in general (2, 6, 9): especially better oxbow remnants, and a few ponded uplands.
2e. Rolling upland woods in general (7, 8, 10): widespread but degraded; focus on Griffith W.

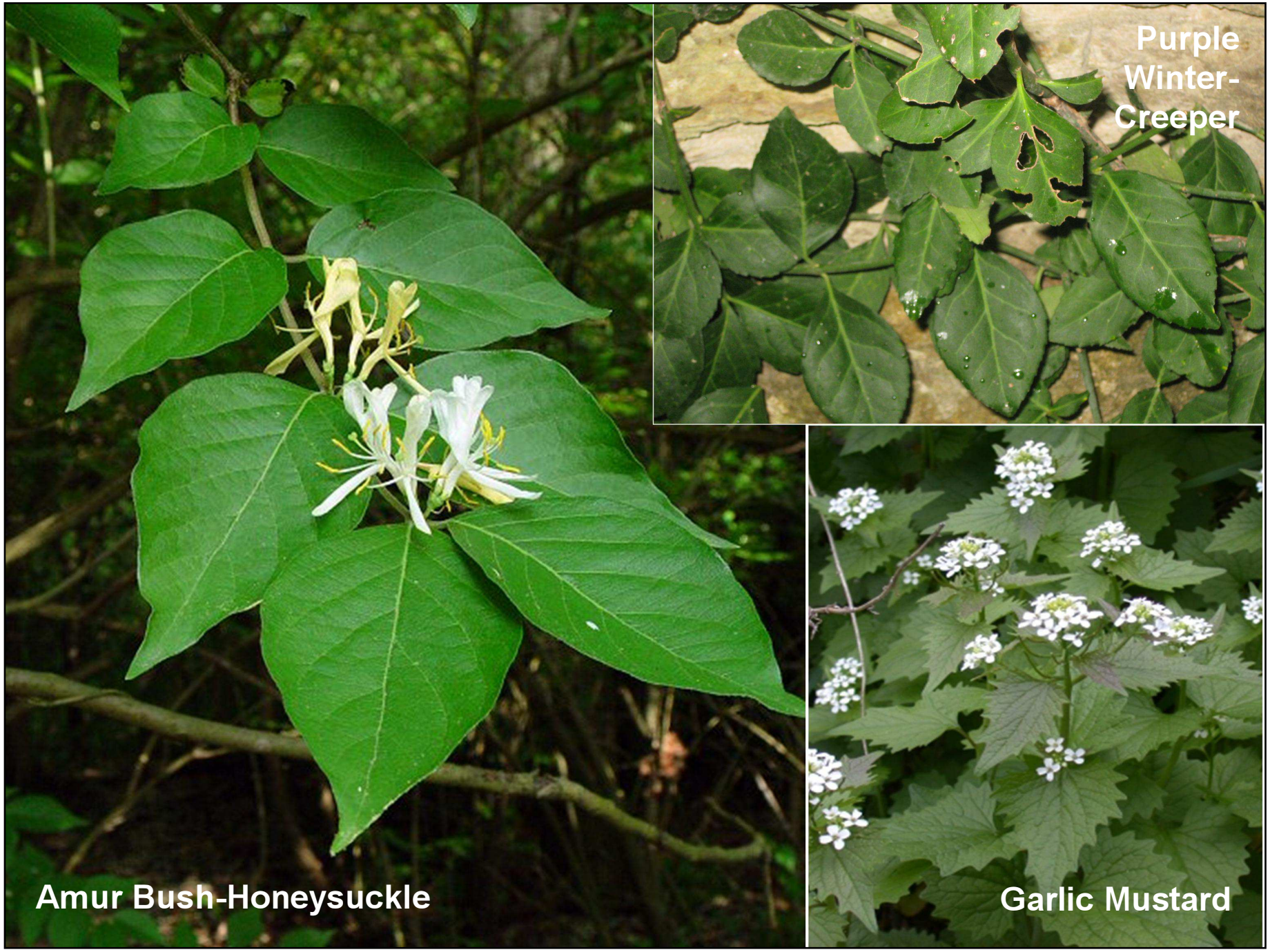
3. Species level. As outlined in Part 4, some declined species deserve more micromanagement.
3a. Species of stream corridors (A): especially propagation for use in restored systems.
3b. Species of mesic-subxeric acid woods (xF, xG): propagation for use in restored woods.
3c. Species of xeric flatrocks and grassy transitions (G2, E2): propagation for recovery.
3d. Species of wetlands in general (B1, B2, B3, B4): propagation for use in restored systems.
3e. Species of rolling upland woods in general (C, D, E1): propagation for use in restoration.
3f. Tree species devastated by alien pests or pathogens: selection of resistant trees for recovery.
3g. Larger herbivores: without native species, focus on experimental use of livestock in restoration of woodland; determine if appropriate seasonal browsing can reduce invasive aliens.
3h. Species of mussel that have disappeared from South Fork of Licking: given long-term potential for restoration of river, determine which mussel species should be raised and released.

NEGATIVE TARGETS—INVASIVE ALIEN SPECIES

A more comprehensive account should also detail the problems due to invasive alien species, and how to control them if at all. Major problems can be outlined as follows.

Plants: these are often obvious problems; some are controlable, others probably not.
a. Aquatics (*Myriophyllum spicatum, Naias minor, Potamogeton nodosus*): hard to control.
b. Japanese Grass (*Microstegium vimineum*): spreads into browsed woods on more acid soil.
c. Drier pastures (*Festuca arundinacea, Melilotus* spp., *Centaurea maculata*, etc.)
d. Wetland species (*Lysimachia nummularia, Lythrum salicaria, Mentha* spp., etc.)
e. Upland woods (*Euonymus, Lonicera, Alliaria, Duschenea, Glechoma, Stellaria*, etc.)
f. Trees (widespread *Morus alba,* local *Ailanthus altissima,* new *Pyrus calleryana*).

Animals: these are potential problems, but effects are often unclear.
a. Mammals: domestic/feral cats & dogs. Cats appear to have significant effects on some birds, at least in urban areas (Loss et al. 2013); but cats tend to be reduced by coyotes in rural areas.
b. Birds: especially starlings and house sparrows. Starlings have much economic impact, and may reduce some native bird populations through competition, but the evidence is not strong (Koenig 2003, Linz et al. 2007).
c. Fishes? Silver Carp probably cause problems but may be restricted to the Kentucky River.
d. Aquatic gastropods: Japanese clam is widespread; zebra mussel is in larger rivers & lakes. Both species may reduce some native mussels, but more evidence is needed (Bouchet 2015).
e. Bees? Although abundant, alien Honey Bees may not cause large problems. Competition with native pollinators probably does occur, but effects are hard to show (Goulson 2004).
f. Earthworms? The most common species in this region are aliens, which have contributed to declines in native species, even in some woodland remnants (Kalisz & Wood 1995).


Purple
Winter-
Creeper
Amur Bush-Honeysuckle
Garlic Mustard

CONCLUSION: Why should we integrate the three levels?

This approach to Natural History and Conservation Planning is based on the fundamental concept that three general levels of organization are useful: landscape / watershed, habitat and species-group. Rather than beginning with taxonomic details for the vast numbers of species, which is the traditional approach in much Natural History, it is important that students and the general public first learn to appreciate the distinctive landscape of their region. And then can be explained the local patterns of variation in habitats, largely related to geology and soils but with disturbance regimes also overlayed. Upon this foundation can be laid the deeper study of ecological interactions in diverse species. Such study can include the deep search for understanding how species diverge and maintain themselves over different landscapes and habitats—a basic theme of evolutionary biology. It can also lead to effective modern conservation, linked with well-planned programs of research and education in this region.

A problem with the current culture of conservation here is that Natural History no longer presents significant interest as a focus for schools and colleges. This is understandable, partly because for many decades academic approaches tended to be divorced from practical matters in conservation. Plant species were 'studied to death' in many cases with no effort to protect habitat or even save seed. In much Conservation Planning today, there is now insufficient local knowledge of Natural History, and the natural inclination of leadership in conservation is to focus on the larger areas of landscape or watersheds for expenditures of funds. Larger areas tend to be more easily supported by the tax-paying public and by non-profit donors, compared to good restoration of degraded habitat patches or intensive action to save imperiled species. Yet the latter are essential for more comprehensive conservation—if planned and implemented with clear goals and continual reassessment. Unless we generate 'kids with clipboards' who pay attention to the details of our immediate biological environment, there is no hope.

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