USDA Natural Resources Conservation Service

Ecological site F121XY002KY
Moderately Deep Interbedded Limestone-Shale Backslopes

Accessed: 05/03/2024

General information

Approved. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 121X–Kentucky Bluegrass

The project area lies within the major land resource area (MLRA)121 as designated by the Natural Resources Conservation Service. Central Kentucky makes up 83% of the MLRA with the remaining acreage in Ohio (11%) and Indiana (6%). Total MLRA size is 10,680 square miles or 27,670 square kilometers. The majority of the MLRA is in the Lexington Plain Section of the Interior Low Plateaus Province of the Interior Plains. Elevations in MLRA 121 range from about 430 feet (on the Ohio River) to approximately 1100 feet.

This ecological site description covers sites within the Inner and Outer Bluegrass physiographic regions of Kentucky. The rolling hills of this area are caused by the weathering of limestone that has been pushed up along the crest of the Cincinnati Arch. Younger geologic units occur along the eastern and western edges of the bluegrass region and are typified by thin-bedded shale, siltstone, and limestone.

Classification relationships

Plant Communities of the Midwest, Association Descriptions: CEGL002070 White Oak-Mixed Oak Dry-Mesic Alkaline Forest.

Kentucky State Nature Preserves Commission, Calcareous Sub-xeric Forest (Evans, Hines, Yahn, 2009).

USNVV Hierachy: Quercus alba (Quercus rubra, Carya spp.) Forest Alliance.

Ecological site concept

These ecological sites are characterized by moderately-deep soils predominately influenced by parent materials of limestone and shale. Soil depths of 21 to 40 inches provide an adequate moisture and growing environment for a wide range of quality hardwood trees, including various species of oaks and hickories. Understory communities, while influenced by differences in soil depths and soil parent materials, exhibited similarities in species composition. Located on hillsides and ridges, these sites were a hardwood forest of oak-hickory or oak-hickory-sugar maple with a robust and diverse herbaceous layer. The most common summer understory species were: various species of agrimony (AGPU & AGR03), black snakeroots (SACA15 & SAOD), white snakeroot (AGALA), Virginia creeper (PAQU2), smooth Solomon's seal (POBI2), false Solomon's seal (SMRA), etc. The shrub layer usually consisted of coralberry (SYOR) and groupings of northern spicebush (LIBE3). Species such as spicebush and paw-paw often found on these sites are indicative of higher levels of available moisture compared to the shallow limestone-based ecological sites (121XY0001) that are geographically related within MLRA 121.

The state and transition model for this ecological site description highlights the various community states and phases including three reference phases and multiple successional stages including managed pastureland, minimally managed pastureland, managed native grasses, eastern red cedar communities, and honeysuckle (non-native invasive) woodlands. These stages transition predictably with external influences and through natural succession.

Table 1. Dominant plant species

Tree	(1) *Quercus alba* (2) *Carya ovata*
Shrub	(1) *Symphoricarpos orbiculatus* (2) *Lindera benzoin*
Herbaceous	(1) *Sanicula canadensis* (2) *Agrimonia*

Physiographic features

These ecological sites (ES) are found on hillsides and/or ridgetops. The best examples of these sites were found on slopes ranging from 15-45% range. Soils depth ranges from 21- 40" over interbedded limestone and shale or interbedded limestone, shale, and siltstone. The mixed geology can be seen best on road cuts where the limestone & shale or limestone, shale & siltstone layers are layered along the hillsides. Elevations of these sites generally range from 500 feet to 1000 feet. There is no influencing water table, flooding or ponding on these sites as the runoff class is medium to rapid.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Ridge (3) Knob
Flooding frequency	None
Ponding frequency	None
Elevation	137–436 m
Slope	2–50%
Water table depth	152 cm
Aspect	Aspect is not a significant factor

Climatic features

These ecological sites are located in central Kentucky and are at the northern periphery of the humid subtropical climate zone. Generally characterized by hot, humid summers and cold winter, the area has four distinct seasons. The expected annual precipitation for sites included in this ecological site description is 40 to 50 inches. The majority of precipitations falls during the freeze-free months, and thunderstorms with heavy rainfall are common during the spring and summer months. The freeze-free period averages 210 days, but varies somewhat based on localized topography and longtitude.

Table 3. Representative climatic features

Frost-free period (average)	159 days
Freeze-free period (average)	191 days
Precipitation total (average)	2,870 mm

Climate stations used

- (1) CYNTHIANA [USC00151998], Cynthiana, KY

Influencing water features

There are no influencing water features for this ESD.

Soil features

These ecological sites are found on specific landscapes dominated by Eden and Faywood soils and are influenced by interbedded geology of limestone and shale parent materials. The Eden series consists of moderately-deep, well-drained, and slowly-permeable soils formed in residuum from interbedded calcareous shale, siltstone, and limestone. These soils are found on steep hillsides and narrow ridgetops. The Faywood series consists of moderately-deep and well-drained soils formed in limestone residuum interbedded with thin layers of shale. The office site description for Eden includes slopes from 2 to 70 percent; however, for this ecological site description, sites evaluated ranged in slope from 12 to 40 percent. The official site description for Faywood includes slopes from 2 to 60 percent; however, sites evaluated for this ecological site description ranged in slope from 12 to 40 percent.

Table 4. Representative soil features

Parent material	(1) Residuum–limestone
Surface texture	(1) Flaggy silty clay loam (2) Very flaggy silt loam (3) Channery silty clay
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Very slow to moderate
Soil depth	30–122 cm
Surface fragment cover <=3"	0–25%
Surface fragment cover >3"	0–25%
Available water capacity (0-101.6cm)	4.83–8.64 cm
Calcium carbonate equivalent (0-101.6cm)	0–1%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0

Soil reaction (1:1 water) (0-101.6cm)	6.2–7.5
Subsurface fragment volume <=3" (Depth not specified)	5–20%
Subsurface fragment volume >3" (Depth not specified)	5–30%

Ecological dynamics

As diagramed in the state and transition model, these ecological sites have four distinct states and eight easily identifiable community phases. The reference state consists of three woodland phases. The first is the mature oak-hickory forest (phase 1.1) which is dominated by oak and hickory species, such as white oak, northern red oak, shagbark hickory, Shumard oak, black oak, chinkapin oak, and mockernut hickory. Sugar maple is also common, especially on more mesic sites. Other tree species found on these sites include white ash, American elm, slippery elm, eastern red cedar, bitternut hickory, and eastern redbud. The understory frequently had a shrub layer of coralberry or spicebush. On monitored plots, coralberry was denser in areas of higher shale content (Eden soils) and on drier sites. Spicebush was denser in more protected micro-climates, northern slopes, and sites mapped as Faywood soils. The herbaceous understory is robust and diverse. Most undisturbed locations had a beautiful array of native wildflowers in early spring.

Phase 1.2 is best described as an eastern red cedar woodland. This successional state is seen throughout the Inner and Outer Bluegrass physiographic regions of Kentucky, as well as southern Indiana and Ohio. Eastern red cedar is well adapted to the limestone and limestone-shale soils, highly drought tolerant, and serves as an ecological bridge between the transitional field (phase 3.1) and the oak-hickory forest (phase 1.1)and the sugar maple-white oak forest (phase 1.3).

Monitored plots within these dense stands of eastern red cedar were typified by high basal areas and slow-growing young oaks and hickory trees in the understory and midstory. These young hardwood trees will eventually overtop the cedars, and within a few decades, start to dominate the overstory. In the spring these hillsides were a mass of dark green cedars and highlighted with bright pink blooms from eastern redbud trees.

On more mesic sites, phase 1.2 plots exhibited a predominance of sugar maple, ash, and elm seedlings with a reduced oak and hickory regeneration. These sites were transitioning toward phase 1.3 and would likely required forest stand management activities, such as maple thinning or prescribed fire, to reach phase 1.1.

Phase 1.3 sites were observable on numerous locations in the study area, but the long- range composition of these sites and the long-term potential to transition to other phases is somewhat of an unknown. Ecologists, researchers, and natural resource professional interviewed for this project believed that the reduction of historic wildfire regimes have contributed to the reduction of oak-hickory forests and increased the predominance of sugar maple-oak woodlands on this (and many other) ecological sites. The density of shade-tolerant maple on these sites modifies the ground-level environment by increasing shade levels and moisture content, altering leaf litter composition, and influencing the tree regeneration. The dense shading from maples and the thick leaf litter reduces oak and hickory regeneration and increases the reproductive success of shade-tolerant tree such as sugar maple and white ash.

The pasture state (state 2.0) contains three commonly found phases: managed cool-season grasses (usually tall fescue or other non-native planted grasses), minimally-managed pastures, and a native warm-season grass habitat. Production levels vary on these sites by grass species and the management of the sites.

The transitional field (state 3.0) is a successional state between an abandoned pasture and an eastern red cedar grove. Characterized by a variety of grasses, forbs, herbs, and young trees, these sites are often wildlife friendly, pollinator beneficial, and are often maintained by landowners to maximize wildlife habitat.

Trees found on these sites are a mix depending on adjacent seed sources and how long the land was in pasture. Eastern red cedar is the early successional dominant tree; however, hardwood seedling and saplings were found scattered throughout monitored plots and included honey locust, black locust, osage orange, black walnut, hackberry, boxelder, and eastern red cedar. Multiflora rose, briars, berries and brambles were a component on all sites visited. The most common non-native herbaceous species included Queen Anne’s lace, thistles, lespedeza,

lambs quarters, horse nettle, mullein, and pigweed. The most common native herbaceous species were ironweed, common milkweed, goldenrods, yellow crownbeard, and sunflowers. This state will transition naturally to phase 1.3 the eastern red cedar grove. Landowners wishing to retain the wildlife benefits of the “old field” state would control cedar growth.

State 4 is woodland with dense bush honeysuckle (usually *Lonicera maackii*) in the understory and midstory. This non-native, invasive plant is aggressive, adaptable, persistent, and currently negatively impacting oak-hickory forests throughout Kentucky. Found on many different ecological sites, this plant fundamentally alters the natural ecological pathways and transition mechanisms due to its dense growth form and aggressive growth and reproduction capabilities. Ecological sites in state 4 require substantial and long-term management inputs, including multi-year restoration activities, to transition to another ecological state or phase.

State and transition model

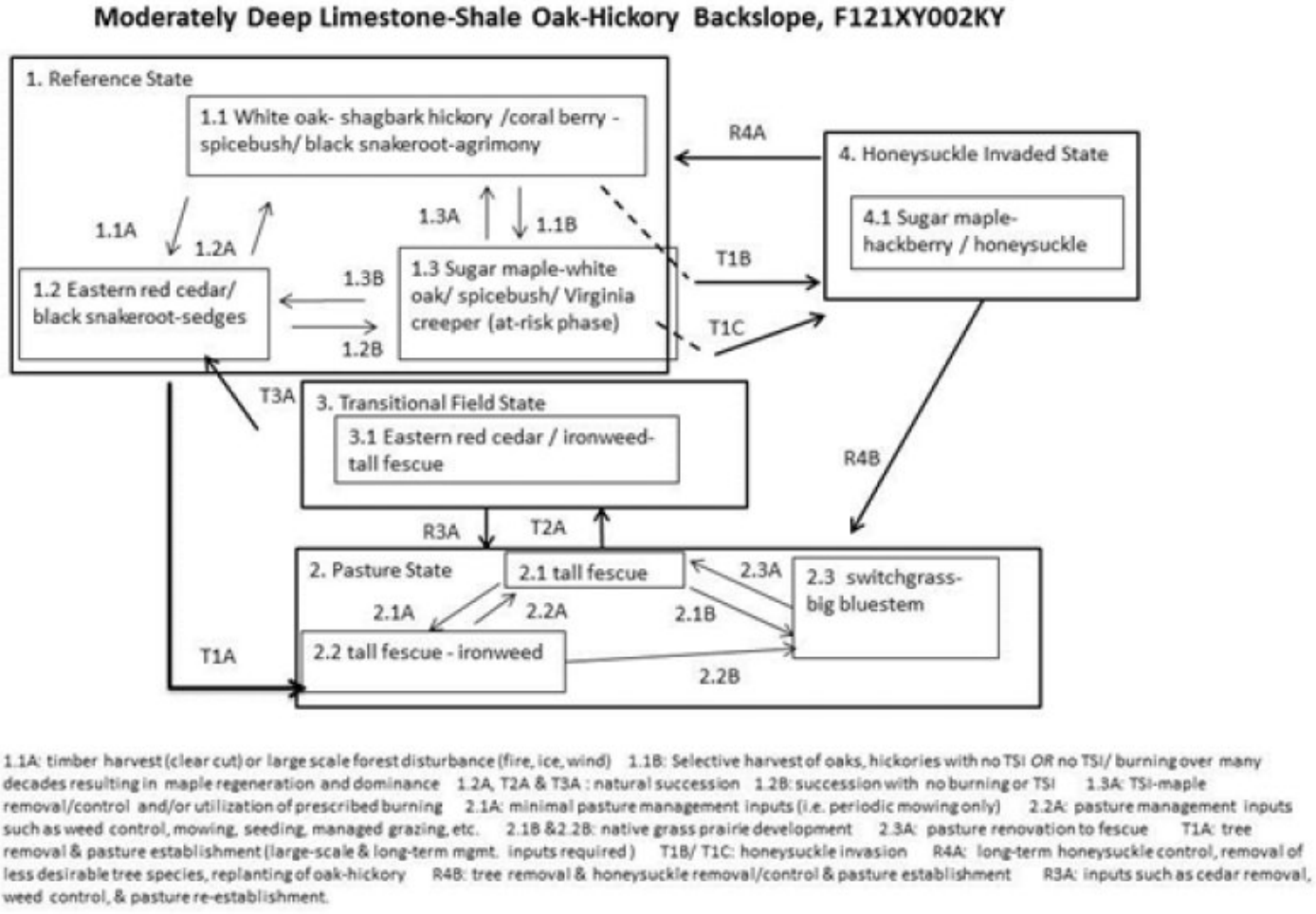

Figure 6. F121XY002KY_STM

State 1
Moderately Deep Interbedded Limestone-Shale Oak-Hickory Forest

These ecological sites generally occupied the middle to upper sideslopes and lower ridges of hills within the Inner and Outer Bluegrass physiographic regions of Kentucky. The aspect on these sites is variable as soil depth and rock content appeared to have more influence on plant growth and species density than aspect. Slopes on sites visited ranged from 15% to over 45%. Soil depth varied from 21 to 40 inches and parent material of the soils were residuum from interbedded calcareous shale, siltstone, and limestone (Eden soils) or limestone residuum interbedded with thin layers of shale (Faywood soils). Sites frequently had exposed surface rock and rock content in the soil profile. Tree canopies were generally medium in height and somewhat closed (70 to 90% shade levels) with dominant trees consisting of oak and hickory species in phase 1.1, oak and sugar maple in phase 1.3, and eastern

red cedar in phase 1.2. Understory herbaceous layers were generally dense and diverse with minor variations dependent upon soil depth, rock content, soil type, and micro-topography.

Community 1.1
Moderately Deep Limestone-Shale Oak-Hickory Backslope

Figure 7. Eden_Faywood_backslope_Outerbluegrass_KY

Figure 8. Eden_Faywood_pawpaw_grove_Outerbluegrass_KY

Figure 9. Eden_FaywoodUnderstory_GrantCo_KY

Figure 10. Eden_Faywood_PendletonCo_KY

This community phase is characterized by a a mix of oak and hickory species including white oak, northern red oak, chinkapin oak, Shumard oak, black oak, shagbark hickory, mockernut hickory, and pignut hickory. Sugar maple was common on all sites. Other tree species found on these ecological sites may included bitternut hickory, eastern redbud, hackberry, white ash, blue ash, and sassafras. Shrub and herbaceous layers varied somewhat with soil depth, topography, drainage patterns and aspect. For example, spicebush was more prevalent on the north and east aspects and on concave hillsides where soil moisture levels were higher. In more mesic microclimate areas, pawpaw trees were common. Coralberry was prevalent on Eden soils versus Faywood soils and on shallow, drier sites. Spicebush was denser on Faywood soils and on mesic sites.

Forest overstory. Sites showed variations in overstory composition based on soil depth ranging from 21-40 inches, micro-topography, and available seed sources.

Shallower sites (monitored 6 sites 21-28" depth) had more chinkapin oak and Shumard oak than deeper sites, but still exhibited the variety of overstory trees that typify this community phase. Species present included white oak, black oak, pignut hickory, shagbark hickory. Also present, but not dominate, where American elm, white ash, and sugar maple. Eastern redbud, hophornbeam, sassafras, hackberry, black walnut, black locust, and bitternut hickory were also present in monitored plots. Protected sites had the addition of northern red oaks and often a grove of pawpaw trees.

Forest understory. Understory composition of these sites ranged from shrub and herbaceous to just herbaceaous. Common shrub species included coralberry, spicebush, blackhaw, and rarely, arrow-wood. Herbaceous plants were plentiful and varied with a wide variety of spring wildflowers and summer natives.

Table 5. Soil surface cover

Tree basal cover	3-4%
Shrub/vine/liana basal cover	1%
Grass/grasslike basal cover	1%
Forb basal cover	30-70%
Non-vascular plants	0-1%
Biological crusts	0%
Litter	5-15%
Surface fragments >0.25" and <=3"	1-5%
Surface fragments >3"	1-5%
Bedrock	0-5%
Water	0%
Bare ground	1-5%

Table 6. Woody ground cover

Downed wood, fine-small (<0.40" diameter; 1-hour fuels)	1-3%
Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels)	1-2%
Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels)	1-1%
Downed wood, coarse-small (3.00-8.99" diameter; 1,000-hour fuels)	0-1%
Downed wood, coarse-large (>9.00" diameter; 10,000-hour fuels)	0-1%
Tree snags** (hard***)	–
Tree snags** (soft***)	–
Tree snag count** (hard***)	0-2 per hectare
Tree snag count** (hard***)	0-2 per hectare

*** Decomposition Classes: N - no or little integration with the soil surface; I - partial to nearly full integration with the soil surface.**

**** >10.16cm diameter at 1.3716m above ground and >1.8288m height--if less diameter OR height use applicable down wood type; for pinyon and juniper, use 0.3048m above ground.**

***** Hard - tree is dead with most or all of bark intact; Soft - most of bark has sloughed off.**

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	1-5%	1-3%	3-5%	5-15%
>0.15 <= 0.3	1-15%	1-10%	5-15%	15-30%
>0.3 <= 0.6	5-10%	1-10%	–	20-55%
>0.6 <= 1.4	5-10%	10-30%	–	1-10%
>1.4 <= 4	15-25%	1-15%	–	–
>4 <= 12	10-35%	–	–	–
>12 <= 24	30-70%	–	–	–
>24 <= 37	10-40%	–	–	–
>37	–	–	–	–

Community 1.2
Moderately-Deep Interbedded Limestone-Shale Cedar Woodland

Figure 11. ERC_successional_grove_FaywoodSoils

This successional community phase is dominated by eastern red cedar trees. Hardwood species such as white oak, chinkapin oak, Shumard oak, northern red oak, shagbark hickory, white ash, blue ash, sugar maple, and elms are in the understory and growing slowly due to the shaded environment. Within two to three decades, natural succession will result in the hardwoods starting to overtop the cedars. This process can be accelerated through forest stand management activities. This community will transition to phase 1.1 or phase 1.2 depending upon the management, available seed sources, and the fire regime of the site.

Forest overstory. Dense eastern red cedar composes the canopy of this community. A small percentage of the midstory or overstory canopy may be hardwood species. If nearby seed sources are available, oak and hickory species are likely to include white oak, chinkapin oak, Shumard oak, black oak, and northern red oak. Hickory species found on some sites included shagbark, bitternut, mockernut and black walnut. Trees with wind-blow seed distribution were common on all sites and included white ash, sugar maple, and elm species. Some sites contained blue ash and hackberry.

Forest understory. Eastern redbud is the most common midstory hardwood tree in these communities. Limited hardwood seedling and sapplings were found in the understory on monitored sites and included sugar maple, white ash, American elm, slippery elm, red oak (Shumard or northern red), chinkapin oak, hackberry, eastern redbud, Ohio buckeye, hackberry, and black locust. Two sites in the Inner Bluegrass also included blue ash (Fraxinus quadrangulata Michx.).

Table 8. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	0-1%	0-1%	1-1%	1-2%
>0.15 <= 0.3	1-2%	1-5%	1-40%	1-15%
>0.3 <= 0.6	1-5%	1-40%	1-25%	1-25%
>0.6 <= 1.4	2-10%	1-15%	0-1%	0-1%
>1.4 <= 4	30-45%	–	–	–
>4 <= 12	75-90%	–	–	–
>12 <= 24	1-10%	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 1.3
Moderately Deep Interbedded Limestone/Shale Maple Oak Forest

Figure 12. maple_midstory_EdenSoils_KincaidLakeSP

Figure 13. understory_maple_regeneration_EdenSoil_PendletonCo

This community phase still has a predominant oak-hickory overstory component; however, this phase is characterized by the dominance of sugar maple in the understory and midstory levels. These sites are typically found on protected areas or on hillsides with deeper soils (30-40 inches). Additional soils depth, north or eastern aspects, and convex micro-topography offer plants additional available water. The dense shading of the understory reduces the reproduction of oaks and hickories on these sites. High basal areas were typical due to large numbers of small DBH maples found in plots.

Forest overstory. Phase 1.2 sites had forest overstories of oak, hickory and sugar maple. Oak and hickory still made up a major component of the upper overstory; however, the understory, midstory and lower portion of the

overstory all had a noticeably high percentage of sugar maple compared to phase 1.1.

Forest understory. This phase is noticeably different from 1.1 due to the lack of oak/hickory regeneration, the higher percentage of canopy cover shading, and the higher density of the leaf litter layer. Rather than the drier, fluffier oak/hickory leaf litter, the sugar maple sites had a thick, matted layer of maple leaves. These sites also had less of an understory: fewer forbs/herb, a lighter shrub layer, and a much higher percentage of young maple trees.

Table 9. Ground cover

Tree foliar cover	1-2%
Shrub/vine/liana foliar cover	1%
Grass/grasslike foliar cover	1%
Forb foliar cover	1-2%
Non-vascular plants	1%
Biological crusts	0%
Litter	35-60%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0-5%
Bedrock	0-1%
Water	0%
Bare ground	0-1%

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	1-1%	1-1%	1-1%	1-15%
>0.15 <= 0.3	1-1%	1-2%	1-1%	5-15%
>0.3 <= 0.6	1-1%	1-5%	1-1%	5-10%
>0.6 <= 1.4	5-15%	5-10%	–	0-1%
>1.4 <= 4	5-30%	–	–	–
>4 <= 12	20-40%	–	–	–
>12 <= 24	30-80%	–	–	–
>24 <= 37	20-40%	–	–	–
>37	–	–	–	–

Pathway 1.1A
Community 1.1 to 1.2

Moderately Deep Limestone-Shale Oak-Hickory Backslope

Moderately-Deep Interbedded Limestone-Shale Cedar Woodland

Large-scale disturbance, specifically mature hardwood tree removal or destruction, will cause phase 1.1 to transition back to phase 1.2. Natural or man-made events such as clear cutting, wind, ice, or catastrophic fires will cause a community shift in this direction. Removal of the oak-hickory forest overstory will allow eastern red cedar trees to thrive and dominate the site. Phase 1.2 will then transition to either 1.1 or 1.3 depending on seed sources, fire regime, and timber stand management activities.

Conservation practices

Brush Management
Fence
Access Control
Forest Trails and Landings
Forest Stand Improvement
Forest Management Plan - Applied

Pathway 1.1B
Community 1.1 to 1.3

Moderately Deep Limestone-Shale Oak-Hickory Backslope

Moderately Deep Interbedded Limestone/Shale Maple Oak Forest

With removal of overstory oak and hickory species (for example, a selective harvest), phase 1.1 will transition to phase 1.3. Forest stand maangement is often warranted under these conditions to control sugar maple density and encourage regeneration of oak and hickory species. This pathway also reflects a growing ecological concern nationwide that oak-hickory forests are transitioning to maple-dominated woodlands due to a change in the natural fire regime (i.e. lack of wildfires). Ecological communities that were previously oak-hickory forests are converting to maple woodlands. Ten sites visited for this ecological site description had understory and midstory canopies consisting of 60 to 85 percent sugar maple. The dense shading from a maple dominant overstory retards oak and hickory reproduction and reduces the diversity of the herbaceous layer. As a shade-tolerant species, sugar maple will continue to thrive on these sites. Without management inputs or wildfires, this community will likely not transition naturally to an oak-hickory forest.

Conservation practices

Brush Management
Prescribed Burning
Fence
Access Control
Tree/Shrub Site Preparation
Tree/Shrub Establishment
Forest Stand Improvement
Forest Management Plan - Applied
Herbaceous Weed Control

Pathway 1.2A
Community 1.2 to 1.1

Moderately-Deep Interbedded Limestone-Shale Cedar Woodland

Moderately Deep Limestone-Shale Oak-Hickory Backslope

Phase 1.2, the eastern red cedar grove, will transition to the reference community given adequate seed sources and a natural fire regime. In the absense of oak and hickory seed sources or a natural fire regime, timber stand improvement activites may be needed. Activities may include planting oak and hickory trees, reducing maple populations, and controling bush honeysuckle. Maple control would allow hardwoods the additional light needed to speed growth and increase forest production rates. These ecological sites contain a variety of hardwood species in the understory and midstory level. White oak, northern red oak, black oak, chinkapin oak, Shumard oak, shagbark hickory, mockernut hickory, pignut hickory, bitternut hickory, white ash, blue ash, eastern redbud, American elm, slippery elm, and black walnut are some of the more frequent tree species.

Conservation practices

Brush Management
Fence
Access Control
Tree/Shrub Site Preparation
Tree/Shrub Establishment
Upland Wildlife Habitat Management
Forest Stand Improvement
Forest Management Plan - Applied
Herbaceous Weed Control

Pathway 1.2B
Community 1.2 to 1.3

Moderately-Deep Interbedded Limestone-Shale Cedar Woodland

Moderately Deep Interbedded Limestone/Shale Maple Oak Forest

This pathway was seen on multiple mesic sites where sugar maple was the dominant midstory and understory tree species. On multiple sites visited, sugar maple regeneration was dense but oak-hickory seedlings were scarce. Long-term pastures that have transitioned to eastern red cedar groves often do not have an adequate seed source to successfully reach the oak-hickory reference phase without management inputs (i.e. plantings). A highly shade-tolerant species, sugar maple will likely become the dominate hardwood species on such sites in the absense of managment intervention.

Conservation practices

Brush Management
Prescribed Burning
Fence
Access Control
Tree/Shrub Site Preparation
Tree/Shrub Establishment
Upland Wildlife Habitat Management
Forest Stand Improvement
Prescribed Grazing
Forest Management Plan - Applied

Herbaceous Weed Control

Pathway 1.3A
Community 1.3 to 1.1

Moderately Deep Interbedded Limestone/Shale Maple Oak Forest

Moderately Deep Limestone-Shale Oak-Hickory Backslope

This community pathway involves forest stand improvement activities to reduce maple growth in the midstory and understory. The reduction in maples will allow more light to young oak and hickory seedlings and saplings. Planting of oaks and hickories my be required depending on available seed sources, management goals, and site quality. Landowners should also be on the lookout for the invasive bush honeysuckle and take active control measures if required. Potential conservation practices include forest stand improvement, forest management plan applied, brush management, prescribed burning, and/or upland wildlife habitat management.

Conservation practices

Brush Management
Prescribed Burning
Upland Wildlife Habitat Management
Forest Stand Improvement
Forest Management Plan - Applied

Pathway 1.3B
Community 1.3 to 1.2

Moderately Deep Interbedded Limestone/Shale Maple Oak Forest

Moderately-Deep Interbedded Limestone-Shale Cedar Woodland

emoval of hardwood trees (harvesting, ice damage, wind storms, catastrophic fires) can shift a maple-oak community toward an eastern red cedar woodland. These moderately deep sites over limestone/shale parent material are excellent habitat for eastern red cedar succesional communities. Potential conservation practices include access control, fence, brush management, forest stand improvement, tree/shrub establishment, and/or upland wildlife habitat management.

Conservation practices

Brush Management
Fence
Access Control
Tree/Shrub Establishment
Upland Wildlife Habitat Management
Forest Stand Improvement
Forest Management Plan - Applied

State 2
Grasslands

The pasture state for these ecological sites is commonly one of three phases: managed pasture, minimally managed pasture, or a warm-season grass habitat. The managed and minimally managed pasture sites were predominately cool-season, introduced grass species such as tall fescue, orchard grass, brome grass, and Kentucky bluegrass.

Community 2.1
Managed Pastureland

Figure 14. Managed_Pasture_F121XY002KY

This community phase consists of managed pastureland and was found mostly on lower slope sites. The majority of these sites were planted with tall fescue and actively managed for grazing or hay production. Forb and herb species, noxious weeds, vines, and trees were kept to a minimum through herbicide treatments and mowing. This phase was found on limited sites. Since most of the sites included in this project are in excess of 15 percent slope, this phase occurred on lower slope sites.

Forest overstory. There was no forest overstory composition for this community phase.

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Table 11. Ground cover

Tree foliar cover	0-1%
Shrub/vine/liana foliar cover	1-2%
Grass/grasslike foliar cover	80-98%
Forb foliar cover	1-5%
Non-vascular plants	0%
Biological crusts	0%
Litter	0%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	0%

Table 12. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	0-1%	0-1%	5-30%	1-5%
>0.15 <= 0.3	0-1%	0-1%	25-35%	1-5%
>0.3 <= 0.6	0-1%	0-1%	40-60%	1-5%
>0.6 <= 1.4	0-1%	0-1%	15-40%	1-5%
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.2
Minimally Managed Pastureland

Figure 15. unmanaged_pasture_F121XY002KY

This phase is typified by an array of introduced grasses such as tall fescue, orchard grass, timothy, Johnson grass, orchard grass, Kentucky bluegrass, etc. Due to the reduction in management inputs (less weed treatment, less mowing, unmanaged grazing, etc.) the quality and quanity of forage was reduced compared to phase 2.1. The amount and diversity of native and introduced forbs, herbs, and vines were greater than phase 2.1. On sites with unmanaged grazing, especially those with steeper slopes, moderate to severe soil erosion was often visible.

Forest overstory. There is no Forest Overstory composition in this community phase.

Forest understory. There is no Forest Overstory composition in this community phase.

Table 13. Ground cover

Tree foliar cover	0-1%
Shrub/vine/liana foliar cover	3-5%
Grass/grasslike foliar cover	50-70%
Forb foliar cover	20-40%
Non-vascular plants	0%
Biological crusts	0%
Litter	0%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%

Bedrock	0%
Water	0%
Bare ground	0%

Table 14. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	0-1%	1-2%	1-5%	1-5%
>0.15 <= 0.3	0-1%	1-2%	5-10%	5-10%
>0.3 <= 0.6	0-1%	1-2%	10-25%	5-10%
>0.6 <= 1.4	0-1%	1-2%	20-65%	5-20%
>1.4 <= 4	–	–	10-25%	0-10%
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.3
Native Grass-Pollinator pasture

Figure 16. native_grass_pollinator_herbs_forbs_F121XY002KY

This community contains a majority of native plants but is not truly "natural" in that management inputs are required to create and maintain this phase. The community consists mainly of warm-season grasses, forbs, and herbs - the percentages of each and species are dependent upon seeding and management. Maintenance of this community may include prescribed burning to control the growth of eastern red cedar and other pioneer species of trees and shrubs. Six plots in the Bluegrass physiographic region of Kentucky were monitored and plants found are listed below. Not all species were found on all plots as species distribution was determined mainly by what seed mix was used. Landowners interested in developing a native grass prairie often have the objective of benefiting wildlife and pollinators. Seed companies have developed specific mixes targeting this market, and NRCS conservation planners can assist in developing a plan specific to a landowners location and objectives.

Forest overstory. There is no forest overstory composition for this phase.

Forest understory. There is no forest understory composition for this phase.

Table 15. Ground cover

Tree foliar cover	0-1%
Shrub/vine/liana foliar cover	1-3%

Grass/grasslike foliar cover	50-85%
Forb foliar cover	30-45%
Non-vascular plants	0%
Biological crusts	0%
Litter	0%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	0%

Table 16. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	1-1%	0-1%	5-15%	1-2%
>0.15 <= 0.3	0-1%	0-1%	10-20%	1-3%
>0.3 <= 0.6	0-1%	0-1%	35-65%	5-15%
>0.6 <= 1.4	0-1%	0-1%	25-75%	10-15%
>1.4 <= 4	0-1%	0-1%	–	0-1%
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 2.1A
Community 2.1 to 2.2

Managed Pastureland

Minimally Managed Pastureland

This pathway will occur naturally with the reduction or lack of management inputs and is generally observed on hilly locations where pasture maintenance is more difficult. With a lack of grazing, these sites had a dense cover of cool-season grasses along with a variety of introduced and native forbs, herbs, and vines. Unmanaged grazing on these sites generally resulted in an increase in undesirable species including thistles, greenbrier, ironweed, and multiflora rose. Signs of soil erosion were often present on these sites.

Conservation practices

Brush Management
Fence
Access Control
Prescribed Grazing
Grazing Management Plan - Applied
Herbaceous Weed Control

Pathway 2.1B
Community 2.1 to 2.3

Managed Pastureland

Native Grass-Pollinator pasture

Transitioning a predominately fescue field to a native grass pasture requires management inputs including herbicides, seeding, and weed control management. These areas of natural grasses are utilized as wildlife habitat, hay production, summer pastures, pollinator habitat, and/or conservation areas for native plants. Monitored sites contained a diversity of grasses, herbs, and forbs, usually dependent upon inital plantings selected by landowners and the levels of ongoing management.

Conservation practices

Brush Management
Prescribed Burning
Fence
Access Control
Water Well
Stream Crossing
Grazing Management Plan - Applied
Fish and Wildlife Habitat Plan - Applied
Pollinator Habitat Plan - Applied
Herbaceous Weed Control

Pathway 2.2A
Community 2.2 to 2.1

Minimally Managed Pastureland

Managed Pastureland

With additional management inputs, this phase can be transitioned to a high-quality pasture or hayland. Steep slopes and/or high rock content preclude mechanized management, so the better pasture sites were always found on the lower slopes.

Conservation practices

Brush Management
Forage Harvest Management
Forage and Biomass Planting
Grazing Management Plan - Written
Grazing Management Plan - Applied
Herbaceous Weed Control

Pathway 2.2B
Community 2.2 to 2.3

Minimally Managed Pastureland

Native Grass-Pollinator pasture

On sites with lower slopes and less rock content, it would be feasible to plant and maintain a native grass pasture. Two native grass prairies were visited as part of this project. The owners had installed them with NRCS assistance for wildlife benefits and pollinator conservation. Species planted would vary depending on the owners management goals. The species listed below are not all-inclusive but represent the species found in the field during site visits.

Conservation practices

Field Border
Upland Wildlife Habitat Management
Fish and Wildlife Habitat Plan - Written
Fish and Wildlife Habitat Plan - Applied
Pollinator Habitat Plan - Written
Pollinator Habitat Plan - Applied

Pathway 2.3A
Community 2.3 to 2.1

Native Grass-Pollinator pasture

Managed Pastureland

This community pathway was not observed in the field. However, it is feasible to convert a warm-season grass pasture to a managed tall fescue pasture if so desired. Inputs would include herbicide, seed, and labor. The taller native grass species, such as big blue stem and indian grass, would likely require multiple herbicide treatment for a complete die down. Tall fescue is a bunch grass with deep roots, short rhizomes, and is highly adaptable to different soils types and site conditions, so development of this phase would not be difficult on most sites. Production levels will be determined by available moisture and management.

Conservation practices

Fence
Access Control
Forage and Biomass Planting
Prescribed Grazing
Grazing Management Plan - Applied
Herbaceous Weed Control

State 3
Transitional Field

This state is characterized by encroaching eastern red cedar trees into a pastureland environment. This natural

transition occurs once pasture management inputs are reduced. Monitored sites were predominately tall fescue pastures that were in the process of naturally reverting to a eastern red cedar grove. The moderately-deep soils on these sites had minimal surface rock and with 5 to 20 percent rock fragments in the subsurface layers. Hardwood seedlings present could include white oak, chinkapin oak, red oak, black oak, shagbark hickory, mockernut hickory, and/or black walnut if an adequate seed sources were available. Seedlings of white ash, red maple, sugar maple, hackberry, black locust, honey locust, American elm, osage orange and slippery elm could also be found on these sites.

Community 3.1
Transitional Field

Figure 17. Transitional_field_F121XY002KY_2

Figure 18. Transitional_field_F121XY002KY

This phase is best described as an old field habitat with a mixture of native and introduced grasses, a variety of native herbs and forbs, a selection of non-native weedy plants such as thistles, a robust community of young eastern red cedar trees, and a few hardwood seedlings. The moderately-deep limestone soil provides adequate available moisture for a wide variety of plant species. These sites were often found on private property of landowners interested in wildlife habitat or on Kentucky wildlife management areas. The variety of plants found on these sites provides desired habitat for non-game and game species. To reduce the density of the eastern red cedar trees, many landowners chose to actively managing these properties by thinning or removal of cedar trees. This management activity halts or slows the natural transition of this community to phase 1.3. On sites that were still being grazing, the eastern red cedars were encroaching but there were very few native forbs and herbs. These sites generally had few hardwood seedlings, more weedy species, and lower pasture production levels. Common species on these sites included honey or black locust, multiflora rose, Canadian thistle, bull thistle, ironweed, greenbriers, and blackberries.

Forest overstory. The overstory composition on these sites consisted mainly of eastern red cedar. Most sites also had assorted young hardwoods (especially those species with wind-blown seeds)including sugar maple, hackberry, white ash, American elm, and eastern redbud. Other species on monitored sites included black walnut, sassafras, white oak, chinkapin oak, Shumard oak, osage orange, and winged elm.

Forest understory. The understory composition of this phase was a mix of introduced grasses and many different species of native and introduced forbs, herbs, and vines. Grass composition was dependent upon previous seeding and adjacent fields

Table 17. Ground cover

Tree foliar cover	1%
Shrub/vine/liana foliar cover	1%
Grass/grasslike foliar cover	25-65%
Forb foliar cover	5-25%
Non-vascular plants	0-1%
Biological crusts	0%
Litter	20-40%
Surface fragments >0.25" and <=3"	1-5%
Surface fragments >3"	1-5%
Bedrock	0-1%
Water	0%
Bare ground	0%

Table 18. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	1-2%	0-1%	5-20%	1-5%
>0.15 <= 0.3	1-3%	0-1%	10-35%	1-5%
>0.3 <= 0.6	1-5%	0-2%	25-50%	5-15%
>0.6 <= 1.4	1-5%	0-2%	5-15%	5-20%
>1.4 <= 4	1-10%	–	–	–
>4 <= 12	5-20%	–	–	–
>12 <= 24	0-5%	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

State 4
Honeysuckle Invaded State

This State is characterized by the dominance of bush honeysuckle, an aggressive non-native shurb. Bush honeysuckle is a common name used for many differenct species including *Lonicera maackii*, *L. tatarica*, *L. morrowii*, *L. fragrantissima*, etc. Plot monitoring for this project found Amur honeysuckle, *Lonicera maackii*, was the most common species on these sites. This plan was introduced from Asia in the 1700 and 1800s for ornamental purposes and is now an ecological epidemic in central Kentucky and surrounding states. *L. maackii* is shade tolerate plant that forms dense thickets in forests, roadsides, and pastures. Colonizing by abundant seed production and root sprouting, this plant will dominate the midstory of forest communities. The dense shade and competition from these plants destroys the native herbaceous layer and halts normal oak-hickory reproduction.

Community 4.1
Honeysuckle-Hardwood Woodland

Figure 19. HoneysuckleWoodland

This community phase is typified by dense *Lonicera maackii* in the understory and midstory, limited to no hardwood reproduction, a sparse and undiverse herbaceous layer. Often the overstory is still oak-hickory trees which pre-date the invasion of the honeysuckle. Plots on these sites show that the understory consists of 70-100% honeysuckle. Forest floor shading is 80-100% due to the dense grown pattern of this plant. Six out of ten monitored plots had no hardwood tree seedlings. The other four plots had one white oak and 6 sugar maple seedlings total. Restoration of this community to an oak-hickory woodland requires extensive and long-term inputs to remove the honeysuckle, plant desirable tree species, and maintain a multi-year control program.

Forest overstory. Forest overstory composition of these sites varied depending on age of the community when invaded by the bush honeysuckle. Overstory trees on monitored sites included sugar maple, white oak, chinkapin oak, hackberry, white ash, red oak, black oak, shagbark hickory, black locust, honey locust, and in on plot- blue ash. Older oak-hickory forests that had been invaded by honeysuckle still had an intact overstory; however, normal oak-hickory reproduction was not present due to the dense shading of the honeysuckle. Younger communities had almost no oak-hickory overstory component and were generally composed of sugar maple, hackberry, white ash, and other more shade tolerant tree species.

Forest understory. The understory composition of these sites were hugely different from reference sites. Juvenile bush honeysuckle plants were 70-95% of the recorded plants in monitored plots. Ground cover shade from the shrub layer was sometimes as high as 100%. Overall, these areas were unique in that the herbaceous layer was sparse and lacked species diversity. Most noticeable in monitored plots was the absence of oak-hickory seedling and/or saplings and the usual native forbs found on reference sites. Limited sugar maple, hackberry, and white ash seedlings were recorded on these sites; however the majority of plant reproduction was that of bush honeysuckle.

Table 19. Ground cover

Tree foliar cover	1-5%
Shrub/vine/liana foliar cover	10-30%
Grass/grasslike foliar cover	0-1%
Forb foliar cover	0-1%
Non-vascular plants	0-1%
Biological crusts	0%
Litter	20-35%
Surface fragments >0.25" and <=3"	0-1%
Surface fragments >3"	0-1%
Bedrock	0%
Water	0%
Bare ground	0-5%

Table 20. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	0-1%	0-5%	0-1%	1-2%
>0.15 <= 0.3	0-1%	5-10%	0-1%	1-2%
>0.3 <= 0.6	0-1%	5-10%	0-1%	1-2%
>0.6 <= 1.4	0-1%	10-20%	–	0-1%
>1.4 <= 4	0-1%	60-90%	–	–
>4 <= 12	5-15%	0-50%	–	–
>12 <= 24	50-70%	–	–	–
>24 <= 37	20-50%	–	–	–
>37	–	–	–	–

Transition T1B, T1C
State 1 to 4

These transitions represent the ecological impacts of a woodland phase being invaded by bush honeysuckle.

Transition T3A
State 3 to 1

Transition 3A will occur via natural succession for these ecological sites. The transitional field community will progressively develop into an eastern red cedar woodland (phase 1.2 in the state and transition model).

Restoration pathway R3A
State 3 to 2

The transitional field community, with appropriate management inputs, can be moved back to any of the pasture phases. This transition is labeled as a restoration pathway only because the transitional field phase (State 3) originally transitioned from pastureland (State 2).

Conservation practices

Brush Management
Forage and Biomass Planting
Integrated Pest Management (IPM)
Native Plant Community Restoration and Management
Invasive Plant Species Control
Integrated Pest Management Plan - Written
Integrated Pest Management Plan - Applied
Fish and Wildlife Habitat Plan - Written
Fish and Wildlife Habitat Plan - Applied

Restoration pathway R4A
State 4 to 1

Restoration of this State is a multi-year undertaking that requires extensive inputs and continual brush/invasive plant removal and treatment. Several sources indicate bush honeysuckle seeds are dispersed primarily by frugivorous birds and numerous studies have shown that a wide variety of bird species consume and spread Amur honeysuckle fruit. Seeds are viable for many years and seed production is robust. Research has shown that bush

honeysuckle plants can produce thousands of seeds annually. Herbicides are necessary to reduce sprouting after brush cutting and such treatment requires a multi-year effort. Most of the sites monitored for this project did not have adequate seed sources to naturally return to a productive oak-hickory forest, so forest planting/seeding would likely be necessary for most sites.

Conservation practices

Brush Management
Tree/Shrub Site Preparation
Tree/Shrub Establishment
Upland Wildlife Habitat Management
Forest Stand Improvement
Invasive Plant Species Control
Forest Management Plan - Written
Forest Management Plan - Applied
Fish and Wildlife Habitat Plan - Written
Fish and Wildlife Habitat Plan - Applied
Herbaceous Weed Control

Additional community tables

Table 21. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
Shumard's oak	QUSH	*Quercus shumardii*	Native	9.4–26.5	0–35	45.7–52.1	–
mockernut hickory	CATO6	*Carya tomentosa*	Native	9.1–22.9	0–30	44.5–48.3	–
northern red oak	QURU	*Quercus rubra*	Native	8.2–28.7	0–30	45.7–54.6	–
white oak	QUAL	*Quercus alba*	Native	4.9–27.4	10–30	45.7–57.2	–
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	9.1–27.1	10–30	43.2–50.8	–
sugar maple	ACSA3	*Acer saccharum*	Native	5.8–26.8	0–25	47–50.8	–
shagbark hickory	CAOV2	*Carya ovata*	Native	8.2–25.6	5–20	40.6–48.3	–

Table 22. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
sedge	CAREX	*Carex*	Native	0–0.2	1–5
Forb/Herb					
white snakeroot	AGALA	*Ageratina altissima var. altissima*	Native	0.2–0.6	10–50
cutleaf toothwort	CACO26	*Cardamine concatenata*	Native	0.1–0.2	5–40
dwarf larkspur	DETR	*Delphinium tricorne*	Native	0.1–0.2	5–40
Virginia springbeauty	CLVI3	*Claytonia virginica*	Native	0–0.2	5–35
spring blue-eyed Mary	COVE2	*Collinsia verna*	Native	0–0.2	10–20

spring blue eyed Mary	COVE2	*Collinsia verna*	Native	0–0.2	10–20
Canadian blacksnakeroot	SACA15	*Sanicula canadensis*	Native	0.1–0.4	1–20
clustered blacksnakeroot	SAOD	*Sanicula odorata*	Native	0.1–0.5	1–10
celandine poppy	STDI3	*Stylophorum diphyllum*	Native	0.1–0.4	0–10
American hogpeanut	AMBR2	*Amphicarpaea bracteata*	Native	0–0.2	1–10
wild blue phlox	PHDI5	*Phlox divaricata*	Native	0.1–0.3	1–10
harbinger of spring	ERBU	*Erigenia bulbosa*	Native	0.1–0.2	3–10
white avens	GECA7	*Geum canadense*	Native	0–0.3	0–5
spring avens	GEVE	*Geum vernum*	Native	0.1–0.6	0–5
beaked agrimony	AGRO3	*Agrimonia rostellata*	Native	0.1–0.4	1–5
soft agrimony	AGPU	*Agrimonia pubescens*	Native	0.1–0.3	1–5
Virginia snakeroot	ARSE3	*Aristolochia serpentaria*	Native	0.1–0.4	0–5
toadshade	TRSE2	*Trillium sessile*	Native	0.1–0.2	1–5
bellwort	UVULA	*Uvularia*	Native	0.1–0.3	1–5
mayapple	POPE	*Podophyllum peltatum*	Native	0.2–0.4	1–5
goldenseal	HYCA	*Hydrastis canadensis*	Native	0.1–0.2	0–5
yellow fumewort	COFL3	*Corydalis flavula*	Native	0.1–0.4	0–3
crinkleroot	CADI10	*Cardamine diphylla*	Native	0.1–0.2	0–3
cream avens	GEVI4	*Geum virginianum*	Native	0.1–0.6	0–2
wild comfrey	CYVI	*Cynoglossum virginianum*	Native	0.1–0.6	0–2
rue anemone	THTH2	*Thalictrum thalictroides*	Native	0.1–0.2	0–2
common selfheal	PRVU	*Prunella vulgaris*	Native	0–0.2	0–2
Carolina elephantsfoot	ELCA3	*Elephantopus carolinianus*	Native	0.1–0.7	0–1
Canadian white violet	VICA4	*Viola canadensis*	Native	0.1–0.2	0–1
yellow giant hyssop	AGNE2	*Agastache nepetoides*	Native	0.1–0.9	0–1
perfoliate bellwort	UVPE	*Uvularia perfoliata*	Native	0.1–0.2	0–1
common blue wood aster	SYCO4	*Symphyotrichum cordifolium*	Native	0.1–0.4	0–1
eastern poison ivy	TORA2	*Toxicodendron radicans*	Native	0.1–0.2	0–1
smooth Solomon's seal	POBI2	*Polygonatum biflorum*	Native	0.1–0.5	0–1
early meadow-rue	THDI	*Thalictrum dioicum*	Native	0.1–0.2	0–1
twinleaf	JEDI	*Jeffersonia diphylla*	Native	0.1–0.3	0–1
spring forget-me-not	MYVE	*Myosotis verna*	Native	0.1–0.2	0–1
longstyle sweetroot	OSLO	*Osmorhiza longistylis*	Native	0.1–0.4	0–1
Clayton's sweetroot	OSCL	*Osmorhiza claytonii*	Native	0.1–0.5	0–1
licorice bedstraw	GACI2	*Galium circaezans*	Native	0.1–0.4	0–1
shining bedstraw	GACO3	*Galium concinnum*	Native	0.1–0.5	0–1
jumpseed	POVI2	*Polygonum virginianum*	Native	0.1–0.5	0–1
bloodroot	SACA13	*Sanguinaria canadensis*	Native	0.1–0.2	0–1
hairy alumroot	HEVI2	*Heuchera villosa*	Native	0.1–0.2	0–1
Jack in the pulpit	ARTR	*Arisaema triphyllum*	Native	0.2–0.3	0–1
violet woodsorrel	OXVI	*Oxalis violacea*	Native	0.1–0.2	0–1
blisterwort	RARE2	*Ranunculus recurvatus*	Native	0.1–0.3	0–1
limestone wild petunia	RUST2	*Ruellia strepens*	Native	0.1–0.2	0–1
rattlesnakeroot	PRENA	*Prenanthes*	Native	0.2–1	0–1

roundleaf ragwort	PAOB6	*Packera obovata*	Native	0.1–0.4	0–1
eastern false rue anemone	ENBI	*Enemion biternatum*	Native	0.1–0.2	0–1
American stoneseed	LILA2	*Lithospermum latifolium*	Native	0.1–0.4	0–1
green dragon	ARDR3	*Arisaema dracontium*	Native	0.3–0.4	0–1
common yellow oxalis	OXST	*Oxalis stricta*	Native	0.1–0.2	0–1
panicledleaf ticktrefoil	DEPA6	*Desmodium paniculatum*	Native	0.1–0.5	0–1
nakedflower ticktrefoil	DENU4	*Desmodium nudiflorum*	Native	0.1–0.5	0–1
sharplobe hepatica	HENOA	*Hepatica nobilis var. acuta*	Native	0.1–0.2	0–1
fourleaf yam	DIQU	*Dioscorea quaternata*	Native	0.1–0.5	0–1
richweed	COCA4	*Collinsonia canadensis*	Native	0.2–0.8	0–1
Maryland senna	SEMA11	*Senna marilandica*	Native	0.2–1	0–1
Virginia strawberry	FRVI	*Fragaria virginiana*	Native	0–0.2	0–1
stickywilly	GAAP2	*Galium aparine*	Native	0.1–0.4	0–1
dutchman's breeches	DICU	*Dicentra cucullaria*	Native	0.1–0.4	0–1
smallspike false nettle	BOCY	*Boehmeria cylindrica*	Native	0.2–0.5	0–1
downy rattlesnake plantain	GOPU	*Goodyera pubescens*	Native	0–0.1	–
Fern/fern ally					
ebony spleenwort	ASPL	*Asplenium platyneuron*	Native	0–0.3	0–2
Christmas fern	POAC4	*Polystichum acrostichoides*	Native	0.1–0.4	0–2
northern maidenhair	ADPE	*Adiantum pedatum*	Native	0.1–0.2	0–1
rattlesnake fern	BOVI	*Botrychium virginianum*	Native	0.1–0.2	0–1
Shrub/Subshrub					
coralberry	SYOR	*Symphoricarpos orbiculatus*	Native	0.1–0.8	1–30
northern spicebush	LIBE3	*Lindera benzoin*	Native	0.2–1.1	0–25
rusty blackhaw	VIRU	*Viburnum rufidulum*	Native	0.1–1	0–1
blackhaw	VIPR	*Viburnum prunifolium*	Native	0.2–4.6	0–1
Indianhemp	APCA	*Apocynum cannabinum*	Native	0.1–0.4	0–1
Tree					
eastern redbud	CECA4	*Cercis canadensis*	Native	1–3	0–10
white oak	QUAL	*Quercus alba*	Native	1–1.7	0–5
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	0.5–1.1	0–5
bitternut hickory	CACO15	*Carya cordiformis*	Native	1.8–	0–5
bitternut hickory	CACO15	*Carya cordiformis*	Native	0.9–1.6	0–5
white oak	QUAL	*Quercus alba*	Native	2.1–3.7	0–3
shagbark hickory	CAOV2	*Carya ovata*	Native	0.4–0.6	0–2
white oak	QUAL	*Quercus alba*	Native	0.2–0.5	1–2
hophornbeam	OSVI	*Ostrya virginiana*	Native	0.1–0.3	0–1
shagbark hickory	CAOV2	*Carya ovata*	Native	0.1–0.2	0–1
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	0.2–0.3	0–1
black oak	QUVE	*Quercus velutina*	Native	0.3–0.4	0–1
Shumard's oak	QUSH	*Quercus shumardii*	Native	0.2–0.3	0–1
eastern redcedar	JUVI	*Juniperus virginiana*	Native	0.1–0.2	0–1
flowering dogwood	COFL2	*Cornus florida*	Native	0.6–2.1	0–1
sassafras	SAAL5	*Sassafras albidum*	Native	0.1–0.2	0–1

sassafras	SAAL5	*Sassafras albidum*	Native	1.2–2.4	0–1
white ash	FRAM2	*Fraxinus americana*	Native	0.1–0.2	0–1
white ash	FRAM2	*Fraxinus americana*	Native	0.3–0.5	0–1
white ash	FRAM2	*Fraxinus americana*	Native	2.1–3.3	0–1
sugar maple	ACSA3	*Acer saccharum*	Native	0.7–1.8	0–1
sugar maple	ACSA3	*Acer saccharum*	Native	0.2–0.3	0–1
boxelder	ACNE2	*Acer negundo*	Native	0.9–1.6	0–1
common hackberry	CEOC	*Celtis occidentalis*	Native	0.4–2.1	0–1
eastern redbud	CECA4	*Cercis canadensis*	Native	0.1–0.3	0–1
Vine/Liana					
Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	Native	0.2–5.5	2–15
frost grape	VIVU	*Vitis vulpina*	Native	0.2–4.9	0–1
roundleaf greenbrier	SMRO	*Smilax rotundifolia*	Native	0–1.5	0–1
summer grape	VIAE	*Vitis aestivalis*	Native	0.1–0.2	0–1
crossvine	BICA	*Bignonia capreolata*	Native	0–0.8	0–1
summer grape	VIAE	*Vitis aestivalis*	Native	1.3–6.4	0–1
common moonseed	MECA3	*Menispermum canadense*	Native	0–0.4	0–1

Table 23. Community 1.2 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
eastern redcedar	JUVI	*Juniperus virginiana*	Native	1.6–10.7	60–90	16.5–21.6	–
white oak	QUAL	*Quercus alba*	Native	4.3–9.1	15–35	15.2–22.9	–
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	3.4–8.2	5–25	7.6–12.7	–

Table 24. Community 1.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
tall fescue	SCAR7	*Schedonorus arundinaceus*	Native	0–0.4	5–65
tall fescue	SCAR7	*Schedonorus arundinaceus*	Introduced	0–0.4	1–15
Forb/Herb					
white snakeroot	AGALA	*Ageratina altissima var. altissima*	Native	0.2–0.4	1–2
sedge	CAREX	*Carex*	Native	0–0.2	1–2
Canadian blacksnakeroot	SACA15	*Sanicula canadensis*	Native	0.1–0.3	0–1
stickywilly	GAAP2	*Galium aparine*	Native	0.1–0.2	0–1
Fern/fern ally					
ebony spleenwort	ASPL	*Asplenium platyneuron*	Native	0.1–0.3	1
Tree					
eastern redcedar	JUVI	*Juniperus virginiana*	Native	0.1–0.4	0–5
eastern redbud	CECA4	*Cercis canadensis*	Native	1.3–3	1–5
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	1.1–3	0–3
white oak	QUAL	*Quercus alba*	Native	1.4–4	1–2
blue ash	FRQU	*Fraxinus quadrangulata*	Native	1.5–4	0–2
common hackberry	CEOC	*Celtis occidentalis*	Native	0.2–0.4	0–1
American elm	ULAM	*Ulmus americana*	Native	0.1–0.3	0–1
slippery elm	ULRU	*Ulmus rubra*	Native	1.5–3.1	0–1
Shumard's oak	QUSH	*Quercus shumardii*	Native	0.1–0.2	0–1
eastern redbud	CECA4	*Cercis canadensis*	Native	0.2–0.3	1
sugar maple	ACSA3	*Acer saccharum*	Native	0.1–0.3	1
sugar maple	ACSA3	*Acer saccharum*	Native	1.1–2.7	1
white ash	FRAM2	*Fraxinus americana*	Native	0.1–0.2	0–1

Table 25. Community 1.3 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
sugar maple	ACSA3	*Acer saccharum*	Native	8.2–28	25–50	45.7–55.9	–
white oak	QUAL	*Quercus alba*	Native	11.6–30.5	10–30	45.7–58.4	–
northern red oak	QURU	*Quercus rubra*	Native	8.5–27.4	0–20	53.3	–
shagbark hickory	CAOV2	*Carya ovata*	Native	9.4–28.7	0–20	43.2–50.8	–
Shumard's oak	QUSH	*Quercus shumardii*	Native	11–29.9	0–15	45.7–50.8	–
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	9.4–28	1–15	43.2–48.3	–

Table 26. Community 1.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
sedge	CAREX	*Carex*	Native	0–0.2	1–2
Forb/Herb					

spring blue eyed Mary	COVE2	*Collinsia verna*	Native	0–0.1	5–20
dwarf larkspur	DETR	*Delphinium tricorne*	Native	0.1–0.2	5–20
Virginia springbeauty	CLVI3	*Claytonia virginica*	Native	0–0.2	5–15
cutleaf toothwort	CACO26	*Cardamine concatenata*	Native	0.1–0.2	1–10
clustered blacksnakeroot	SAOD	*Sanicula odorata*	Native	0.1–0.4	3–10
harbinger of spring	ERBU	*Erigenia bulbosa*	Native	0–0.2	2–10
Canadian blacksnakeroot	SACA15	*Sanicula canadensis*	Native	0.1–0.3	1–5
spring avens	GEVE	*Geum vernum*	Native	0.1–0.5	0–3
rue anemone	THTH2	*Thalictrum thalictroides*	Native	0.1–0.2	0–2
celandine poppy	STDI3	*Stylophorum diphyllum*	Native	0.1–0.3	1–2
American hogpeanut	AMBR2	*Amphicarpaea bracteata*	Native	0.1–0.2	1–2
zigzag spiderwort	TRSU2	*Tradescantia subaspera*	Native	0–0.5	0–1
eastern false rue anemone	ENBI	*Enemion biternatum*	Native	0.1–0.2	0–1
smooth Solomon's seal	POBI2	*Polygonatum biflorum*	Native	0.1–0.3	0–1
narrowleaf knotweed	POBE	*Polygonum bellardii*	Native	–	0–1
early meadow-rue	THDI	*Thalictrum dioicum*	Native	0.2–0.4	0–1
twinleaf	JEDI	*Jeffersonia diphylla*	Native	–	0–1
Canadian woodnettle	LACA3	*Laportea canadensis*	Native	0.1–0.6	0–1
spring forget-me-not	MYVE	*Myosotis verna*	Native	0–0.2	0–1
dutchman's breeches	DICU	*Dicentra cucullaria*	Native	0.1–0.3	0–1
stickywilly	GAAP2	*Galium aparine*	Native	0–0.2	0–1
licorice bedstraw	GACI2	*Galium circaezans*	Native	0–0.2	0–1
toadshade	TRSE2	*Trillium sessile*	Native	0.1–0.2	0–1
Canadian wildginger	ASCA	*Asarum canadense*	Native	0.1–0.2	0–1
cream avens	GEVI4	*Geum virginianum*	Native	0.1–0.5	0–1
goldenseal	HYCA	*Hydrastis canadensis*	Native	0.1–0.2	0–1
white avens	GECA7	*Geum canadense*	Native	0–0.2	0–1
shining bedstraw	GACO3	*Galium concinnum*	Native	0–0.3	0–1
Fern/fern ally					
ebony spleenwort	ASPL	*Asplenium platyneuron*	Native	0–0.3	0–1
rattlesnake fern	BOVI	*Botrychium virginianum*	Native	0.1–0.2	0–1
Christmas fern	POAC4	*Polystichum acrostichoides*	Native	0.1–0.3	0–1
Shrub/Subshrub					
northern spicebush	LIBE3	*Lindera benzoin*	Native	0.2–0.9	0–10
coralberry	SYOR	*Symphoricarpos orbiculatus*	Native	0.2–0.6	1–5
Tree					
sugar maple	ACSA3	*Acer saccharum*	Native	1.7–4	10–60
sugar maple	ACSA3	*Acer saccharum*	Native	1.2–2.9	15–35
sugar maple	ACSA3	*Acer saccharum*	Native	0.1–0.5	5–25
white ash	FRAM2	*Fraxinus americana*	Native	0.1–0.4	0–2
white ash	FRAM2	*Fraxinus americana*	Native	1.9–4	0–1
white oak	QUAL	*Quercus alba*	Native	0.1–0.2	0–1
white ash	FRAM2	*Fraxinus americana*	Native	1.2–1.7	0–1
Vine/Liana					

Vine/Liana					
Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	Native	0.2–0.4	0–10
eastern poison ivy	TORA2	*Toxicodendron radicans*	Native	0.1–0.3	0–1

Table 27. Community 2.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
tall fescue	SCAR7	*Schedonorus arundinaceus*	Introduced	0–0.6	80–95
orchardgrass	DAGL	*Dactylis glomerata*	Introduced	0.1–0.7	0–10
Johnsongrass	SOHA	*Sorghum halepense*	Introduced	0.2–0.8	0–5
Kentucky bluegrass	POPR	*Poa pratensis*	Introduced	0.1–0.6	1–5
Forb/Herb					
red clover	TRPR2	*Trifolium pratense*	Introduced	0.2–0.6	0–5
white clover	TRRE3	*Trifolium repens*	Introduced	0.1–0.2	1–5
Vine/Liana					
field bindweed	COAR4	*Convolvulus arvensis*	Introduced	0.2–0.5	0–1

Table 28. Community 2.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
tall fescue	SCAR7	*Schedonorus arundinaceus*	Introduced	0–0.7	35–80
orchardgrass	DAGL	*Dactylis glomerata*	Introduced	0.1–0.9	1–10
timothy	PHPR3	*Phleum pratense*	Introduced	0.1–0.9	1–10
Kentucky bluegrass	POPR	*Poa pratensis*	Introduced	0–0.8	2–10
Johnsongrass	SOHA	*Sorghum halepense*	Introduced	0.2–1.4	0–5
Forb/Herb					
giant ironweed	VEGI	*Vernonia gigantea*	Native	0.2–1	1–5
aster	SYMPH4	*Symphyotrichum*	Native	0.2–0.8	1–3
goldenrod	SOLID	*Solidago*	Native	0.2–0.8	1–3
common milkweed	ASSY	*Asclepias syriaca*	Native	0.2–0.6	1–2
yarrow	ACHIL	*Achillea*	Native	0.1–0.5	0–2
buttercup	RANUN	*Ranunculus*	Native	0.1–0.5	1–2
Joseph's-coat	AMTR2	*Amaranthus tricolor*	Native	0.2–0.9	0–2
yellow crownbeard	VEOC	*Verbesina occidentalis*	Native	0.2–1	0–2
wild garlic	ALVI	*Allium vineale*	Introduced	0.1–0.3	0–1
Queen Anne's lace	DACA6	*Daucus carota*	Introduced	0.1–0.9	0–1
lambsquarters	CHAL7	*Chenopodium album*	Introduced	0.2–0.6	0–1
field thistle	CIDI	*Cirsium discolor*	Introduced	0.1–0.6	0–1
devil's beggartick	BIFR	*Bidens frondosa*	Native	0.1–0.6	0–1
eastern daisy fleabane	ERAN	*Erigeron annuus*	Introduced	0.1–0.7	0–1
curly dock	RUCR	*Rumex crispus*	Introduced	0–0.9	0–1
stickywilly	GAAP2	*Galium aparine*	Introduced	0–0.4	0–1
burdock	ARCTI	*Arctium*	Introduced	0.1–0.9	0–1
annual ragweed	AMAR2	*Ambrosia artemisiifolia*	Introduced	0.2–0.9	0–1
yellowrocket	BARBA	*Barbarea*	Native	0.1–0.6	0–1
chicory	CIIN	*Cichorium intybus*	Introduced	0.2–0.7	0–1
bull thistle	CIVU	*Cirsium vulgare*	Introduced	0.1–0.9	0–1
sericea lespedeza	LECU	*Lespedeza cuneata*	Introduced	0.1–0.6	0–1
wild parsnip	PASA2	*Pastinaca sativa*	Introduced	0.1–1.1	0–1
American pokeweed	PHAM4	*Phytolacca americana*	Native	0.5–1.1	0–1
common sneezeweed	HEAU	*Helenium autumnale*	Introduced	0.1–0.6	0–1
common chickweed	STME2	*Stellaria media*	Introduced	0.1–0.4	0–1

Table 29. Community 2.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
big bluestem	ANGE	*Andropogon gerardii*	Native	0.1–1.6	35–55
Indiangrass	SONU2	*Sorghastrum nutans*	Native	0.1–1.7	20–40
switchgrass	PAVI2	*Panicum virgatum*	Native	0.1–1.7	20–40
little bluestem	SCSC	*Schizachyrium scoparium*	Native	0.1–1.1	10–40
Virginia wildrye	ELVI3	*Elymus virginicus*	Native	0.1–0.7	0–20
sideoats grama	BOCU	*Bouteloua curtipendula*	Native	0.1–0.4	0–15
tall fescue	SCAR7	*Schedonorus arundinaceus*	Introduced	0.1–0.6	2–10
Kentucky bluegrass	POPRP2	*Poa pratensis ssp. pratensis*	Introduced	0.2–0.5	0–5
sedge	CAREX	*Carex*	Native	0–0.3	0–1
Forb/Herb					
blackeyed Susan	RUHI2	*Rudbeckia hirta*	Native	0.1–0.9	1–10
eastern purple coneflower	ECPU	*Echinacea purpurea*	Native	0.1–1	1–3
purpletop tridens	TRFL2	*Tridens flavus*	Native	0–1.3	0–3
wild bergamot	MOFI	*Monarda fistulosa*	Native	0.2–0.9	1–2
pinnate prairie coneflower	RAPI	*Ratibida pinnata*	Native	0.2–0.8	0–2
foxglove beardtongue	PEDI	*Penstemon digitalis*	Native	0.1–0.9	0–1
common milkweed	ASSY	*Asclepias syriaca*	Native	0.1–0.9	0–1
dense blazing star	LISP	*Liatris spicata*	Native	0.1–0.8	0–1
wild bergamot	MOFI	*Monarda fistulosa*	Native	0.1–0.9	0–1
Canada goldenrod	SOCA6	*Solidago canadensis*	Native	0.1–1.4	0–1
sweetscented joe pye weed	EUPU21	*Eutrochium purpureum*	Native	0.8–1.4	0–1
Illinois bundleflower	DEIL	*Desmanthus illinoensis*	Native	0.2–0.5	0–1
partridge pea	CHFAF	*Chamaecrista fasciculata var. fasciculata*	Native	0.1–0.7	0–1
common yarrow	ACMI2	*Achillea millefolium*	Native	0.1–0.6	0–1
butterfly milkweed	ASTU	*Asclepias tuberosa*	Native	0.1–0.8	0–1
partridge pea	CHFAF	*Chamaecrista fasciculata var. fasciculata*	Native	0.1–0.9	0–1
eastern purple coneflower	ECPU	*Echinacea purpurea*	Native	0.1–1.2	0–1
smooth oxeye	HEHE5	*Heliopsis helianthoides*	Native	0.1–1.7	0–1
lanceleaf tickseed	COLA5	*Coreopsis lanceolata*	Native	0–1	0–1
wingstem	VEAL	*Verbesina alternifolia*	Native	0.3–1.4	0–1
giant ironweed	VEGI	*Vernonia gigantea*	Native	0.9–1.5	0–1
bluejacket	TROH	*Tradescantia ohiensis*	Native	0.2–0.6	0–1
New England aster	SYNO2	*Symphyotrichum novae-angliae*	Native	0.1–0.9	0–1
blackeyed Susan	RUHI2	*Rudbeckia hirta*	Native	0.1–0.9	0–1
Shrub/Subshrub					
Carolina rose	ROCA4	*Rosa carolina*	Native	0.1–0.9	0–1
Vine/Liana					
greenbrier	SMILA2	*Smilax*	Native	0.1–0.9	0–1
blackberry	RUBUS	*Rubus*	Native	0.2–1.1	0–1

Table 30. Community 3.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
eastern redcedar	JUVI	*Juniperus virginiana*	Native	0.5–12.2	10–50	14–22.9	–

Table 31. Community 3.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
tall fescue	SCAR7	*Schedonorus arundinaceus*	Introduced	0.1–0.4	40–75
timothy	PHPR3	*Phleum pratense*	Introduced	0–0.5	0–15
Johnsongrass	SOHA	*Sorghum halepense*	Introduced	0–1.2	1–15
orchardgrass	DAGL	*Dactylis glomerata*	Introduced	0–0.5	1–5
perennial ryegrass	LOPE	*Lolium perenne*	Native	0–0.7	0–3
Kentucky bluegrass	POPRP2	*Poa pratensis ssp. pratensis*	Introduced	0.1–0.3	0–3
Virginia wildrye	ELVI3	*Elymus virginicus*	Native	0.1–0.7	0–2
Forb/Herb					
common mallow	MANE	*Malva neglecta*	Introduced	0.1–0.2	0–1
red clover	TRPR2	*Trifolium pratense*	Introduced	0.1–0.3	0–1
curly dock	RUCR	*Rumex crispus*	Introduced	0–0.9	0–1
eastern daisy fleabane	ERAN	*Erigeron annuus*	Native	0.1–0.9	0–1
Indian-tobacco	LOIN	*Lobelia inflata*	Native	0.2–0.5	0–1
American pokeweed	PHAM4	*Phytolacca americana*	Native	0.3–1.6	0–1
common yarrow	ACMI2	*Achillea millefolium*	Native	0.1–0.6	0–1
common milkweed	ASSY	*Asclepias syriaca*	Native	0.1–0.6	0–1
butterfly milkweed	ASTU	*Asclepias tuberosa*	Native	0.1–0.6	0–1
crownvetch	CORON	*Coronilla*	Introduced	0.1–0.2	0–1
Canadian horseweed	COCA5	*Conyza canadensis*	Native	0.1–0.8	0–1
blackeyed Susan	RUHI2	*Rudbeckia hirta*	Native	0.2–0.7	0–1
Canada goldenrod	SOAL6	*Solidago altissima*	Native	0.2–0.8	0–1
Jerusalem artichoke	HETU	*Helianthus tuberosus*	Native	0.2–1.3	0–1
trumpetweed	EUFI14	*Eutrochium fistulosum*	Native	0.2–1.4	0–1
common chickweed	STME2	*Stellaria media*	Introduced	0–0.2	0–1
buttercup	RANUN	*Ranunculus*	Introduced	0.1–0.4	0–1
lambsquarters	CHAL7	*Chenopodium album*	Introduced	0.1–0.9	0–1
Carolina horsenettle	SOCA3	*Solanum carolinense*	Introduced	0–0.2	0–1
pigweed	AMARA	*Amaranthus*	Introduced	0.1–0.9	0–1
burdock	ARCTI	*Arctium*	Native	0.1–1	0–1
Canada thistle	CIAR4	*Cirsium arvense*	Introduced	0–1.1	0–1
Queen Anne's lace	DACA6	*Daucus carota*	Introduced	0.1–1.1	0–1
sweetscented joe pye weed	EUPU21	*Eutrochium purpureum*	Native	0.1–1.3	0–1
Jerusalem artichoke	HETU	*Helianthus tuberosus*	Native	0.1–0.9	0–1
blackeyed Susan	RUHI2	*Rudbeckia hirta*	Native	0.1–0.9	0–1
giant ironweed	VEGI	*Vernonia gigantea*	Native	0.1–1.3	0–1
winter vetch	VIVI	*Vicia villosa*	Introduced	0–0.5	0–1

winter vetch	VIVI	*Vicia villosa*	Introduced	0–0.9	0–1
wild bergamot	MOFI	*Monarda fistulosa*	Native	0.2–0.9	0–1
nodding plumeless thistle	CANU4	*Carduus nutans*	Introduced	0.1–0.8	0–1
chicory	CIIN	*Cichorium intybus*	Introduced	0.2–1	0–1
Shrub/Subshrub					
smooth sumac	RHGL	*Rhus glabra*	Native	0.6–2.7	0–5
winged sumac	RHCO	*Rhus copallinum*	Native	0.6–3.1	0–3
fragrant sumac	RHAR4	*Rhus aromatica*	Native	0.1–0.8	0–1
Carolina rose	ROCA4	*Rosa carolina*	Introduced	0.1–0.9	0–1
Tree					
eastern redcedar	JUVI	*Juniperus virginiana*	Native	0.2–1.4	5–30
eastern redcedar	JUVI	*Juniperus virginiana*	Native	0.5–3.1	0–25
eastern redcedar	JUVI	*Juniperus virginiana*	Native	0–0.5	1–5
American elm	ULAM	*Ulmus americana*	Native	0.9–2.3	0–5
black locust	ROPS	*Robinia pseudoacacia*	Native	1.1–2.4	0–5
Osage-orange	MAPO	*Maclura pomifera*	Native	0.1–2.6	0–3
honeylocust	GLTR	*Gleditsia triacanthos*	Native	1.5–2.5	0–2
white oak	QUAL	*Quercus alba*	Native	0.2–0.6	0–2
white oak	QUAL	*Quercus alba*	Native	1.4–3.1	0–2
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	1.2–3.5	0–2
Shumard's oak	QUSH	*Quercus shumardii*	Native	0.2–0.9	0–2
Shumard's oak	QUSH	*Quercus shumardii*	Native	0.1–0.5	0–1
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	0.1–0.4	0–1
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	0.7–1.7	0–1
common hackberry	CEOC	*Celtis occidentalis*	Native	0.2–0.4	0–1
black walnut	JUNI	*Juglans nigra*	Native	0.2–1.2	0–1
black locust	ROPS	*Robinia pseudoacacia*	Native	0.2–0.5	0–1
honeylocust	GLTR	*Gleditsia triacanthos*	Native	0.2–0.7	0–1
sassafras	SAAL5	*Sassafras albidum*	Native	0.2–0.7	0–1
winged elm	ULAL	*Ulmus alata*	Native	1–2.4	0–1
black cherry	PRSE2	*Prunus serotina*	Native	0–0.2	0–1
boxelder	ACNE2	*Acer negundo*	Native	0.2–0.4	0–1
sugar maple	ACSA3	*Acer saccharum*	Native	0.1–0.4	0–1
Vine/Liana					
blackberry	RUBUS	*Rubus*	Native	0.1–1.4	0–1
greenbrier	SMILA2	*Smilax*	Native	0.1–1.2	0–1
field bindweed	COAR4	*Convolvulus arvensis*	Introduced	0.2–0.6	0–1

Table 32. Community 4.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
white oak	QUAL	*Quercus alba*	Native	13.1–26.5	20–40	35.6–53.3	–
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	7.9–25	0–25	33–45.7	–
common hackberry	CEOC	*Celtis occidentalis*	Native	8.5–24.1	5–20	33–38.1	–
white ash	FRAM2	*Fraxinus americana*	Native	5.5–23.5	5–15	38.1–45.7	–
northern red oak	QURU	*Quercus rubra*	Native	7.6–25.3	0–15	20.3–49.5	–
sugar maple	ACSA3	*Acer saccharum*	Native	4.9–14.6	1–15	27.9–45.7	–
black walnut	JUNI	*Juglans nigra*	Native	4.6–21.6	0–10	17.8–30.5	–

Table 33. Community 4.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
tall fescue	SCAR7	*Schedonorus arundinaceus*	Introduced	0.1–0.5	1–8
Kentucky bluegrass	POPR	*Poa pratensis*	Introduced	0.1–0.4	0–5
sedge	CAREX	*Carex*	Native	0–0.3	0–1
Nepalese browntop	MIVI	*Microstegium vimineum*	Introduced	0.1–0.4	0–1
Forb/Herb					
winter creeper	EUFO5	*Euonymus fortunei*	Introduced	0–0.2	0–1
Canadian blacksnakeroot	SACA15	*Sanicula canadensis*	Native	0.2–0.6	0–1
stickywilly	GAAP2	*Galium aparine*	Native	0.1–0.2	0–1
clustered blacksnakeroot	SAOD	*Sanicula odorata*	Native	0.1–0.4	0–1
avens	GEUM	*Geum*	Native	0.1–0.2	0–1
eastern poison ivy	TORA2	*Toxicodendron radicans*	Native	0.1–0.3	0–1
Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	Native	0.1–0.2	0–1
dwarf larkspur	DETR	*Delphinium tricorne*	Native	0.1–0.2	0–1
Virginia springbeauty	CLVI3	*Claytonia virginica*	Native	0.1–0.2	0–1
harbinger of spring	ERBU	*Erigenia bulbosa*	Native	0.1–0.2	0–1
Fern/fern ally					
ebony spleenwort	ASPL	*Asplenium platyneuron*	Native	0.1–0.4	0–1
Shrub/Subshrub					
Amur honeysuckle	LOMA6	*Lonicera maackii*	Introduced	1.2–4	35–90
Amur honeysuckle	LOMA6	*Lonicera maackii*	Introduced	0.7–2.1	20–65
Amur honeysuckle	LOMA6	*Lonicera maackii*	Introduced	0.2–0.6	10–15
Amur honeysuckle	LOMA6	*Lonicera maackii*	Introduced	0.1–0.2	5–10
multiflora rose	ROMU	*Rosa multiflora*	Introduced	0.1–2	0–5
lespedeza	LESPE	*Lespedeza*	Introduced	0.1–1.5	0–1
Tree					
eastern redbud	CECA4	*Cercis canadensis*	Native	0.2–0.4	0–1
American elm	ULAM	*Ulmus americana*	Native	0.1–0.3	0–1
white oak	QUAL	*Quercus alba*	Native	0.1–0.3	0–1
sugar maple	ACSA3	*Acer saccharum*	Native	0.2–0.5	0–1
white ash	FRAM2	*Fraxinus americana*	Native	0.2–0.3	0–1
common hackberry	CEOC	*Celtis occidentalis*	Native	0.1–0.4	0–1
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	–	0–1
Vine/Liana					
Japanese honeysuckle	LOJA	*Lonicera japonica*	Introduced	0.2–0.9	0–2
bristly greenbrier	SMTA2	*Smilax tamnoides*	Native	0.1–1	0–1
Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	Native	1.2–5.5	0–1

Animal community

The ecological sites included in this project have three main forested phases; mixed oak-hickory forest, oak-sugar maple forest, and eastern red cedar woodland. Oak species on these ecological sites are predominately white, chinkapin, Shumard, black, and northern red. Shagbark, pignut, and mockernut were the common hickory species. Other hardwoods on these sites include white ash, blue ash, American elm, slippery elm, sugar maple, eastern

redbud, and Ohio buckeye.

The mixed oak-hickory forested phase provides critical habitat and ecosystem functions for a multitude of wildlife species. Research has documented that ninety-six species of birds and mammals consume acorns, especially during the fall and winter months (Martin et al. 1961). In many ecosystems, oaks are a community foundation and their production of acorns influences wildlife population and community dynamics. (Ellison et al. 2005). Valuable as an energy-rich food available to wildlife, acorn production is a key element of quality wildlife habitat.

The noted ecologist E.L. Braun believed that at the time of European settlement, the most widespread and common mast-producing trees were oaks, beech, hickory and chestnut. With the loss of the American chestnut and the reduction in many areas of American beech (due to introduced pathogens), the importance of oaks to wildlife populations has increased. Although hickories are present on these ecological sites as well, the hard, thick shell of many Carya species relegates them to being utilized more as a food source for rodents (Martin et. al. 1961) while acorns are an abundant and accessible wildlife food source.

Wildlife researchers have documented that acorn production in mature oak forests impacts wildlife behavior, habitat uses, population numbers, and reproductive successes in a variety of species ranging from deer to mice (McShea and Schwede 1993, Ostfeld et al. 1996). In eastern forests, no other genus of trees provides the same wildlife habitat functional role as mature oak-dominated forests. (McShea and Healy 2002).

The age of a forest stand is an important consideration for wildlife. Plantings of young trees, along with a shrub layer and herbaceous cover, are of greatest value to early-successional wildlife. These include cottontail rabbits, songbirds, deer, and Although oak trees typically do not produce a significant amount of mast until 20 years of age or more, young tree plantings can serve as important resting and foraging areas for migrating songbirds.

Old field or transitional field habitat is the stage of plant successional between the pasture phases and the forested phases. This ecological state is characteried primarily by grasses, forbs, brambles and shurbs pioneering into a previous pasture or field. Common wildlife psecies that use early successional habitat include wild turkey, northern bobwhite, deer, boblink, eastern meadowlark, Henslow's sparrow, sedge wren, and northern harriers. A key component of early successional habitat for many widlife species is the dominance of native warm-season grasses such as little bluestem, big bluestem, switchgrass, indiangrass, eastern gamagrass, etc. Unlike cool-season, non-native grasses like fescue, the warm-season grasses grow best during the warm months of the year, typically June, July, and August in Kentucky. There structural growth is that of a bunch grass, so that ground-feeding birds can move easily through the habitat. These grasses are also taller than fescue and provide cover for white-tail deer.

The transitional field habitat has two distinct successional stages: the early stage which consists mainly of grass, forbs, herbs, vines, small shrubs, and a few young trees. As succession progresses, the pasture will increasingly become dominated by shrubs and trees.

Many groups of animals dependent on invertebrates (especially butterflies and moths) are often dependent on specific hosts or forage plants that are found only in early successional plant communities. Monarch butterflies are an example of a species whose populations has decreased greatly and depends on specific plant species found in transitional field habitats. Although terrestrial vertebrates tend to be generalists with regards to habitat needs, over 50 species of native wildlife use early successional habitat. Within these early successional communities, annual plants produce an abundance of seeds that are eaten by granivorous birds and many small mammals. Herbivores and browsers, like the white-tailed deer, depend on nutritious forbs, legumes, and shrubs found on these sites. Additionally, this lower height herbaceous vegetation provides key cover for small mammals and birds that prefer open habitats. Without the shade of a tree canopy, light and heat are allowed to penetrate the ground, an essential habitat feature for reptiles that depend on heat sources outside their body for temperature regulation. Maintaining and creating early successional habitat has become a priority for many landowners and natural resource agencies.

Using the Natural Resources Conservation Service (NRCS) planning and programs to establish or maintain an early successional habitat project will ensure that landowners can protect, conserve, and enhance their natural resources including the many species of wildlife that depend on these sites.

Recreational uses

Multiple state-owned wildlife management areas in central Kentucky contain large areas of Eden and Faywood soils

with these ecological sites present. Recreational benefits include hiking, bird-watching, native plant identification, photography, and hunting.

Wood products

Many of these ecological sites would be suitable for timber production and would benefit from active forest management such as brush control and timber stand improvement activities. The large majority of privately-owned forested sites visited were second or third growth unmanaged forests of lower quality. Many were in the invaded honeysuckle state with undesirable tree species present.

Field work conducted as part of this project and a review of USDA-NRCS Soil Surveys show that these ecological sites are well-suited for timber production with upland oak site indices ranging from 55 to 70 depending on site-specific characteristics such as soil depth, rock content, micro-topography, and of course, long-term forest management. Oak species well-suited to these sites include white, chinkapin, Shumard, and on more mesic locations, northern red oak and black oak. Shagbark hickory was frequently found on monitored sites.

Eastern red cedar production site indices on these sites generally range from 35 to 50, and as a pioneer species, cedar is very well-adapted to these shale and limestone sites.

Other products

Most sites included in this ecological site description are above 15 percent slope and generally not ideal for cropland or hay production. However, there were sites visited that had slopes of less than 15 percent were being utilized for hay production and pastureland. Generally these fields had been seeded to tall fescue and were being maintained with moderate to high levels of management. Although predominately tall fescue, most fields also contained one or more of the following: alfalfa, timothy, Kentucky bluegrass, orchardgrass, Johnson grass, ryegrass, and bromegrass.

Alternative forest products that may offer private landowners an alternative revenue opportunity on these ecological sites, as most are suitable for alternative forest products. For example, Shiitake mushroom may provide landowners with an economic return on small diameter woodlands that would otherwise be damaged by unmanaged grazing, utilized as firewood, or simply ignored. Hardwood oak, hickory, and maple logs 3 to 8 inches in diameter are ideal for growing Shiitake mushrooms. Private landowners in this region are growing this crop successfully and production details should be investigated based on site-specific characteristics.

Another non-timber woodland product that could be considered is ginseng. Kentucky is a leading exporter of wild ginseng (5 to 8 million dollars annually) and private landowner production is increasing in this region. This medicinal herb requires the cooler north or east-facing slopes of shaded woodlands. The forest understory should be open to allow for good air circulation and slopes of 20 to 40 percent are often recommended in literature. The woodland should be protected and the soil productive enough to include native understory plants such as Solomon’s seal, mayapples, and trilliums.

Landowners interested in investigating alternative agro-forestry products should contact their state extension service or local university for assistance.

Other information

Many landowners of these ecological sites protect and appreciate the woodlands for the variety of spring and summer native woodland flower that bloom annually. The limestone slopes of these sites are ideal for a diverse population of native forbs, herbs, and vines including an array of native wildflowers that are outstanding in their beauty. A list of wildflowers typically found on these sites, if protected, is included in the understory plants list, community phase 1.1, of this document.

Inventory data references

Ecological states and phases and the plant species lists were developed utilizing low-intensity reconnaissance

followed by selective medium or high-intensity monitoring. Medium and high intensity monitoring was conducted on 20 x 20 meter plots.

Low intensity data collection included: verification of soil mapping, ocular estimates of cover, development of plant lists for species on site, landscape and individual plant photos, and the development of draft ecological site concepts based on these field observations. Additional data collection on higher-quality sites included: verification of soils (soil profile description), spatial coordinates, expanded plant identification lists, additional field notes, and evaluations of plant communities on similarly mapped soils. Photos of individual plants, transect lines within the plots, and landscape views were recorded.

Species lists were developed with assistance of Kentucky State Nature Preserves Commission botanists.

Successional community phases were documented on private lands and on Kentucky Department of Fish and Wildlife Resources wildlife management areas. These sites included a known history. and in some cases, photo documentation of landscape changes over multiple years.

Nature Conservancy sites and Kentucky State Nature Preserves Commission lands provided high-quality older-growth sites with protected understories. Management history was also usually available for these sites.

Kentucky state parks, private wildlife sanctuaries, and other public recreation areas provided examples of communities impacted by invasive vegetation, recreational uses, soil erosion and compaction, timber harvesting, and road and trail development.

Private lands visited provided a range of community states and phases depending on the landowner's purpose for owning the land. One reference site was located on private land and was of the high quality. Most private lands visited for this project were in a successional state, versus a reference state, as the property had been repeatedly logged or grazed.

Tree identification and production data on plots were developed with the assistance of a private-lands forester with the Kentucky Division of Forestry.

Type locality

Location 1: Owen County, KY	
Latitude	84° 46′ 16″
Longitude	38° 21′ 47″
General legal description	This site is located in a State wildlife management area. The property is predominately second and third growth oak-hickory forest. Access to the site is only by foot. Soils are mapped Eden silty clay loam, 12 to 20 percent slope.
Location 2: Nicholas County, KY	
Latitude	83° 53′ 14″
Longitude	38° 20′ 44″
General legal description	This site is within a Kentucky wildlife mangement area and is mapped as Eden flaggy silty clay, 20 to 30 percent slope. The majority of the wildlife management area, including this site, is oak-hickory forest. Access to the site is by foot only.
Location 3: Spencer County, KY	
Latitude	85° 16′ 5″
Longitude	38° 1′ 52″
General legal description	This oak-hickory forest site is located in a Kentucky state park. Soils are Eden flaggy silty clay, 20 to 30 percent slope. Soil mapunits adjacent to the site are Eden silty clay loam, 6- to 20 percent slope, eroded. Access is by foot only.
Location 4: Pendleton County, KY	
Latitude	84° 24′ 40″

Longitude	38° 37′ 57″
General legal description	This privately owned and protected property is a high-quality oak-hickory forest and an excellent representative for this ecological site. The monitored plot was on Eden flaggy silty clay, 20 to 30 percent slope

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

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2. **Presence of water flow patterns:**

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3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

14. **Average percent litter cover (%) and depth (in):**

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
