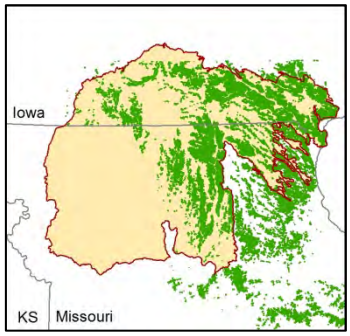
Ecological Site Description

Till Protected Backslope Forest

Major Land Resource Area 109
Iowa and Missouri Heavy Till Plain



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Cover photos:

Center photo (from Missouri Department of Conservation) is a protected till backslope forest found on northerly and easterly aspects of steep, dissected slopes in MLRA 109.

Center bottom photo (from Natural Resources Conservation Service) is a bloodroot (*Sanguinaria Canadensis)*, a perennial, herbaceous flowering plant native to eastern North America. In bloodroot, the juice is red and poisonous.

Top right photo (Photo provided by Terry Sohl) is a Scarlet Tanager (*Piranga olivacea*) commonly found in mature forests. Their breeding habitat is large stretches of deciduous forest, especially with oaks, across eastern North America.

Bottom left photo (from Natural Resources Conservation Service) is a bellwort *(Uvularia grandiflora,* an early-blooming native shade adapted plant found on steep slopes and ravines of a till forest.

Bottom Right photo (from Missouri Department of Conservation) is a spotted salamander (*Ambystoma maculatum*). They are nocturnal and come out at night to hunt for food.

Top right map is the distribution map for Till Protected Backslope Forest (see page 5 for more detail).

This publication is a multi-agency effort with input from a wide range of natural resource specialists. NRCS and the Missouri Department of Conservation are leading this effort along with the University of Missouri, Missouri Department of Natural Resources, USDA Forest Service, and U.S. Fish and Wildlife Service. Ecological site information is available via the NRCS Web Soil Survey, USDA Ecological Site Information System website, and the Missouri Field Office Technical Guide. The information in this publication was developed using historical data, professional experience, field reviews, and scientific studies. The information is representative of complex communities. Key indicator plants, animals and ecological processes are described to help guide land management decisions.

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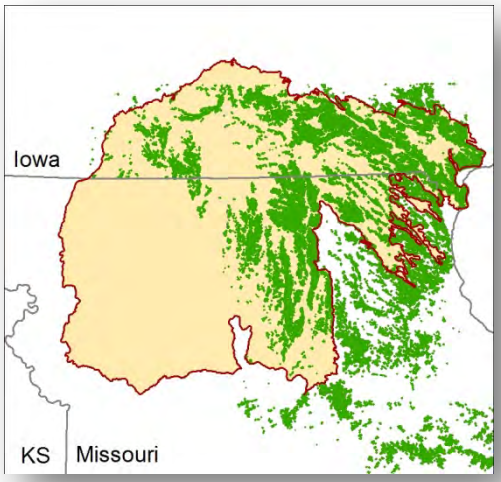
Section I: Ecological Site Characteristics

Ecological Site Identification

- *Site common name:* Till Protected Backslope Forest
- *Site biotic name*: white oak – northern red oak/eastern hophornbeam – Ohio buckeye/harbinger of spring – May apple
- *Site ID*: F109XY009MO
- *Major land resource area (MLRA):* 109 – Iowa and Missouri Heavy Till Plain

Introduction

The Iowa and Missouri Heavy Till Plain (area outlined in red on the map) is an area of rolling hills interspersed with interfluve divides and alluvial valleys. Elevation ranges from about 660 feet along the lower reaches of rivers, to about 980 feet on stable interfluve summits in southern Iowa. Relief is about 80 to 160 feet between major streams and adjacent interfluve summits. Most of the till plain drains south to the Missouri River via the Grand and Chariton River systems, but the northeastern portion drains southeast to the Mississippi River. Loess caps the pre-Illinoisan aged till on interfluves, whereas the till is exposed on side slopes. Mississippian aged limestone and Pennsylvanian aged sandstone and shale crop out on lower slopes in some areas.

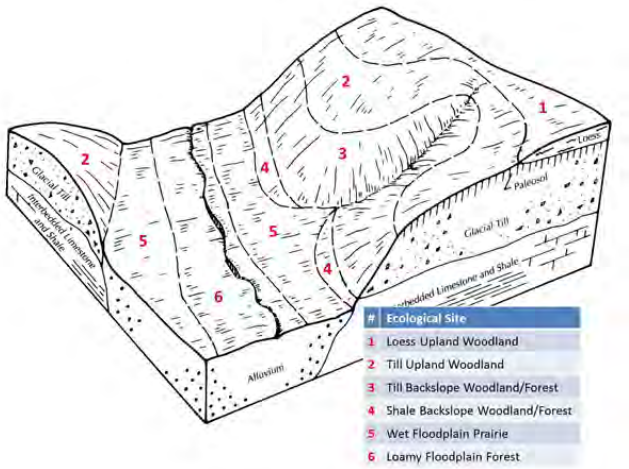


Ecological Site Concept

Till Protected Backslope Forests (within the green areas on the map) occupy the northerly and easterly aspects of steep, dissected slopes, and are mapped in complex with the Till Exposed Backslope Woodland ecological site. These ecological sites occur primarily in the eastern and southeastern portion of the Till Plain. They are typically downslope from Loess Upland Woodland or Till Upland Woodland ecological sites, and generally occupy the mid to lowest portion of the hillslope. In a few places, a narrow band of Shale Protected Backslope ecological site is downslope. Soils are very deep, with dense till subsoils that are mainly clay loam. The reference plant community is forest dominated by white and northern red oaks, with a well-developed understory and a rich herbaceous ground flora.

Physiographic Features

This site is on upland backslopes, with slopes of 14 to 45 percent. It is on protected aspects (north and east), which receive significantly less solar radiation than the exposed aspects. The site receives runoff from upslope summit and shoulder sites, and generates runoff to adjacent, downslope ecological sites. This site does not flood.



The adjacent figure (adapted from Festervand, 1994) shows the typical landscape position of this ecological site, and landscape relationships among the major ecological sites in the uplands and adjacent floodplains. The site is within the area labeled "3", and is typically downslope from Till Upland Woodland ecological sites. In areas where the local drainageways have not dissected into the underlying residuum, Upland Drainageway or Floodplain ecological sites are directly downslope.

Landforms: (1) Hill

	Minimum	Maximum
Slope (percent):	14	35
Water table depth (inches):	24	72
Flooding Frequency:	None	None
Ponding Frequency:	None	None
Runoff class:	High	Very high
Aspect:	North, Northeast, and East	

Climatic Features

The Iowa and Missouri Heavy Till Plain MLRA has a continental type of climate marked by strong seasonality. In winter, dry-cold air masses, unchallenged by any topographic barriers, periodically swing south from the northern plains and Canada. If they invade reasonably humid air, snowfall and rainfall result. In summer, moist, warm air masses, equally unchallenged by topographic barriers, swing north from the Gulf of Mexico and can produce abundant amounts of rain, either by fronts or by convectional processes. In some summers, high pressure stagnates over the region, creating extended droughty periods. Spring and fall are transitional seasons when abrupt changes in temperature and precipitation may occur due to successive, fast-moving fronts separating contrasting air masses.

This MLRA experiences small regional differences in climates that grade inconspicuously into each other. The basic gradient for most climatic characteristics is along a line from north to south. Both mean annual temperature and precipitation exhibit fairly minor gradients along this line. Mean January minimum temperature follows the north-to-south gradient. However, mean July maximum temperature shows hardly any geographic variation in the region. Mean July maximum temperatures have a range of only two to three degrees across the region. Mean annual precipitation varies along the same gradient as temperature – lower annual precipitation in the north, higher in the south. Seasonality in precipitation is very pronounced due to strong continental influences. June precipitation, for example, averages four to five times greater than January precipitation. During years when precipitation is normal, moisture is stored in the soil profile during the winter and early spring, when evaporation and transpiration are low. During the summer months the loss of water by evaporation and transpiration is high, and if rainfall fails to occur at frequent intervals, drought will result. Drought directly influences ecological communities by limiting water supplies, especially at times of high temperatures and high evaporation rates. Drought indirectly affects ecological communities by increasing plant and animal susceptibility to the probability and severity of fire. Frequent fires encourage the development of grass/forb dominated communities and understories.

Superimposed upon the basic MLRA climatic patterns are local topographic influences that create topo-climatic, or microclimatic variations. For example, air drainage at nighttime may produce temperatures several degrees lower in valley bottoms than on side slopes. At critical times during the year, this phenomenon may produce later spring or earlier fall freezes in valley bottoms. Slope orientation is an important topographic influence on climate. Summits and south-and-west-facing slopes are regularly warmer and drier, supporting more grass dominated communities than adjacent north- and-east-facing slopes that are cooler and moister that support more woody dominated communities. Finally, the climate within a canopied forest ecological site is measurably different from the climate of the more open grassland or savanna ecological sites.

Source: University of Missouri Climate Center - http://climate.missouri.edu/climate.php; Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin, United States Department of Agriculture Handbook 296 - http://soils.usda.gov/survey/geography/mlra/

The following tables are a summary from the following Climate Stations:
(1) KEOSAUQUA [USC00134389], Van Buren County IA 52565. Period of record 1981-2010
(2) OSCEOLA [USC00136316], Clarke County IA 50213. Period of record 1981-2010
(3) CHILLICOTHE 2S [USC00231580], Livingston County MO 64601. Period of record 1981-2010
(4) UNIONVILLE [USC00238523], Putnam County MO 63565. Period of record 1981-2010

	Averaged
Frost-free period (days):	156
Freeze-free period (days):	183
Mean annual precipitation (inches):	21.37

Monthly Precipitation (Inches):

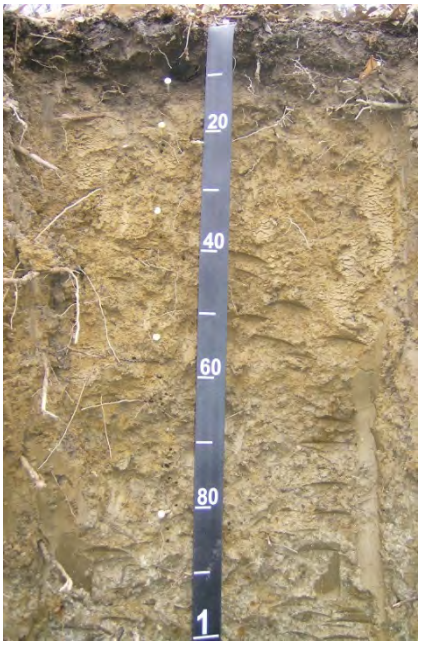
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	1.80	2.03	3.58	4.78	6.16	6.33	6.65	5.56	5.46	4.40	3.29	2.38
Medium	1.02	1.35	2.35	3.65	4.71	4.54	4.37	3.69	3.25	2.73	2.29	1.62
Low	0.62	0.85	1.52	2.72	3.38	3.27	2.71	2.26	2.18	1.61	1.36	0.93

Monthly Temperature (°F):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	34.2	39.3	51.8	64.1	73.9	82.8	87.5	86.0	78.0	65.9	51.1	37.3
Low	14.5	18.4	29.0	39.8	50.8	60.7	65.4	63.3	53.4	41.6	30.1	18.4

Influencing Water Features
This ecological site is not influenced by wetland or riparian water features.

Representative Soil Features
These soils have no major rooting restriction. The soils were formed under woodland vegetation, and have thin, light-colored surface horizons. Parent material is till. They have loam surface layers, with dense subsoils that are mainly clay loam. These soils are not affected by seasonal wetness. Soils in this protected aspect ecological site typically have thicker surface horizons relative to similar soils on exposed aspects (Steele, 2011). Soil series associated with this site include Brevator, Keswick, Lindley, and Winnegan.



The accompanying picture of the Winnegan series shows a thin surface horizon overlying the brown clayey till. Threads and filaments of calcium carbonate are below about 70 cm in this profile, and are typical in soils of this ecological site. Picture courtesy of Amber Steele; scale is in centimeters.

Parent materials
Kind: Till

Surface texture: (1) Clayey
(2) Clay loam
(3) Silt loam

Subsurface texture group: Clayey

	Minimum	Maximum
Surface fragments <=3" (% cover):	0	4
Surface fragments >3" (% cover):	0	1
Subsurface fragments <=3" (% volume):	1	10
Subsurface fragments >3" (% volume):	0	4

Drainage class: Moderately well drained to well drained
Permeability class: Slow

	Minimum	Maximum
Depth (inches):	72	
Available water capacity (inches):	5.00	6.00
Electrical conductivity (mmhos/cm):	0	2
Sodium adsorption ratio:	0	0
Calcium carbonate equivalent (percent):	0	0
Soil reaction (1:1 water):	4.5	6.5

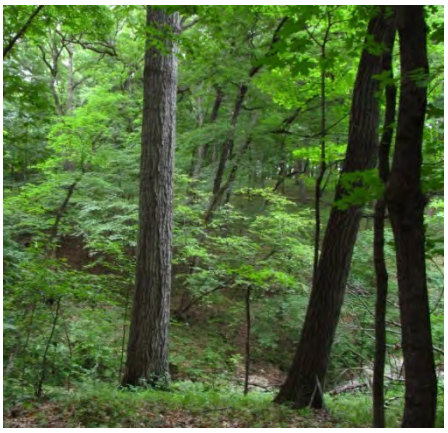
Ecological Site Dynamics
Information contained in this section was developed using historical data, professional experience, field reviews, and scientific studies. The information is representative of very complex vegetational communities. Not all scenarios or plants are included or discussed. Key indicator plants, animals and ecological processes are described to help guide land management decisions. Plant communities will differ across the MLRA because of the naturally occurring variability in weather, soils, and aspect. The Reference Plant Community is not necessarily the management goal. The biological processes on this site are complex. Therefore, representative values are presented in a land management context. The species lists are representative and are not botanical descriptions of all species occurring, or potentially occurring, on this site. They are not intended to cover every situation or the full range of conditions, species, and responses for the site.

Till Protected Backslope Forests historically occurred in the most protected landscape positions on lower, steep slopes in the deeper valleys furthest from the prairie uplands. The reference plant community is a forest dominated (see photo on right) by white (*Quercus alba*) and northern red oaks *(Quercus rubra*) and characterized by a tall (70 to 90 feet), closed canopy (80 to 100 percent) with a well-developed understory of white ash (*Fraxinus americana*), eastern hop hornbeam (*Ostrya virginiana*), Ohio buckeye (*Aesculus glabra*) and haws (*Viburnum sp*.), providing woody structural diversity not found in many adjacent woodland communities. The ground flora has many spring ephemerals and other shade loving herbaceous plant species (MDC, 2006; Nelson, 2010).

While the upland prairies and savannas in the area may have had a fire frequency of 1 to 3 years, Till Protected Backslope Forests would have burned less frequently (10 to 20 years) and with lower intensity (Frost 1996). In addition to periodic fire, these ecological sites were subjected to occasional disturbances from wind and ice, as well as grazing by native large herbivores. Wind and ice periodically opened the canopy up by knocking over trees or breaking substantial branches off canopy trees. Grazing by native large herbivores effectively kept understory conditions more open, creating conditions more favorable to oak reproduction.

Today, these ecological sites have been cleared and converted to pasture or have undergone repeated timber harvest and domestic grazing. Most existing forested ecological sites have a younger (50 to 80 years) canopy layer whose species composition and quality has been altered by timber harvesting practices. An increase in maple (*Acer sp*.) and hickories (*Carya sp*.) over historic conditions is not uncommon. On protected slopes, the absence of periodic fire has allowed more shade tolerant tree species, such as sugar maple (*Acer saccharum*), white ash, and hickories to increase along with a more fully developed understory layer (Steele et al. 2013).

Uncontrolled domestic grazing has also impacted these communities, further diminishing the diversity of native plants and introducing species that are tolerant of grazing, such as buckbrush (*Symphoricarpos orbiculatus*), gooseberry (*Ribes sp*.), and Virginia creeper (*Parthenocissus quinquefolia*). Grazed sites also have a more open understory. In addition, soil compaction and soil erosion related to grazing can be a problem and lower site productivity.

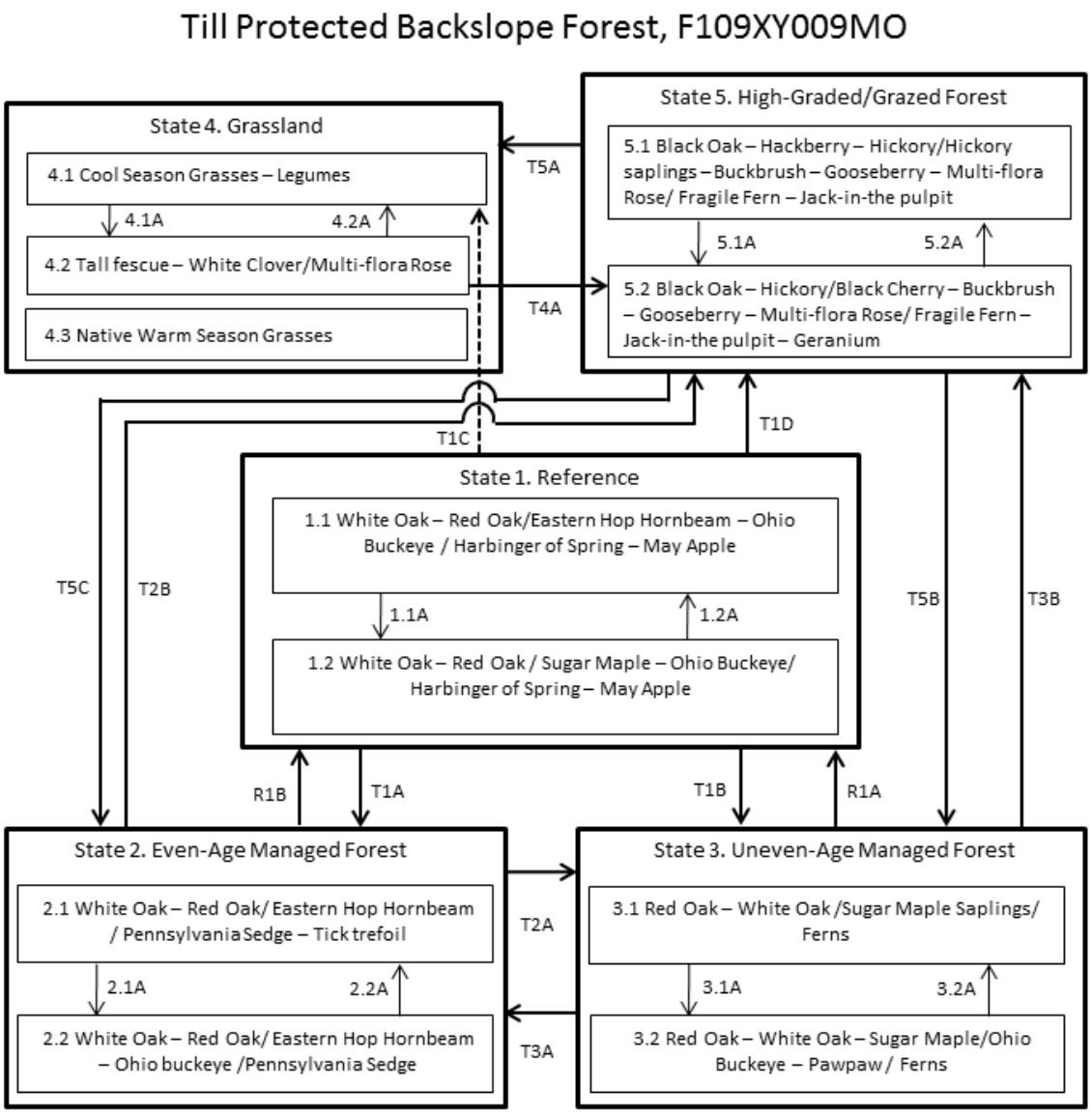


These ecological sites are some of the most productive sites in the region. Oak regeneration is typically problematic. Sugar maple, red elm (*Ulmus rubra*), ironwood, hickories, pawpaw (*Asimina triloba*) and spicebush are often dominant competitors in the understory (photo on right). Maintenance of the oak component will require disturbances that will encourage more sun adapted species and reduce shading effects. Single tree selection timber harvests are common in this region and often results in removal of the most productive trees (high grading) in the stand leading to poorer quality timber and a shift in species composition away from more valuable oak species. Better planned single tree selection or the creation of group openings can help regenerate and maintain more desirable oak species and increase vigor on the residual trees. Clearcutting also occurs and results in dense, even-aged stands dominated by oak. This may be most beneficial for existing stands whose composition has been highly altered by past management practices. However, without some thinning of the dense stands, the ground flora diversity can be shaded out and diversity of the stand may suffer.

Finally, on some forested sites in the northern part of the MLRA, invasive non-native species of earthworms (suborder *Lumbricina*) are beginning to have broad effects on the nutrient cycles in temperate forests. These earthworms increase the cycling and leaching of nutrients by breaking up decaying organic matter and spreading it into the soil. Temperate forests rely on thick layers of decaying organic matter for growth and nutrition. The invasive earthworm presence and activity is diminishing the diversity of native plants in these environments. This change in the plant diversity directly affects the other organisms of the environment and often leads to increased invasions of exotic species as well as overall forest decline. Restoration to a reference state under these conditions will be more difficult if not dramatically reduced or impossible (Hendrix et al. 2006; Nuzzo et al. 2009).

A State and Transition Diagram model follows. Detailed descriptions of each state, transition, plant community, and pathway follow the model. This model is based on available experimental research, field observations, professional consensus, and interpretations. It is likely to change as knowledge increases. The following diagram suggests some pathways that the vegetation on this site might take. There may be other states not shown on the diagram. This information is intended to show what might happen in a given set of circumstances. It does not mean that this would happen the same way in every instance. Local professional guidance should always be sought before pursuing a treatment scenario.

State and Transition Diagram (STD)



Code	Event/Process/Activity
T1A	Harvesting; even-aged forest management
T1B	Harvesting; uneven-age forest management
T1C, T5A	Clearing; forage planting; grassland management
T1D, T2B, T3B	High-grade harvesting; uncontrolled grazing
T2A	Uneven-age forest management; thinning
T3A	Even-age forest management; thinning
T4A	Long-term succession; no grazing
T5B	Uneven-age management; thinning; no grazing
T5C	Even-age management; thinning; no grazing

Code	Event/Process/Activity
R1A, R1B	Extended rotations; long term succession; thinning

Code	Event/Process/Activity
1.1A	No disturbance (20+ years)
1.2A	Disturbance (fire, wind, ice) < 20 years
2.1A	No activity (20+ years)
2.2A	Harvesting; forest stand improvement
3.1A	No activity (20+ years)
3.2A	Harvesting; forest stand improvement
4.1A	Over grazing; no fertilization
4.2A	Brush management; grassland seeding; grassland management
5.1A	No activity (20+ years)
5.2A	Logging; grazing

Ecological States and Community Phases

State 1: Reference
The reference state was dominated by white oak associated with red oak and other mixed hardwoods. Maximum tree age was likely 150 to 300 years. Periodic disturbances from fire, wind or ice maintained the dominance of white oak by opening up the canopy and allowing more light for white oak reproduction. Long disturbance-free periods allowed an increase in more shade tolerant species such as northern red oak and sugar maple. Two community phases are recognized in this state, with shifts between phases based on disturbance frequency.

The reference state can be found in scattered locations throughout the MLRA. Some sites have been converted to grassland (State 4). Others have been subject to repeated, high-graded timber harvests coupled with uncontrolled domestic livestock grazing (State 5). Fire suppression throughout the region has resulted in increased canopy density, which has affected the abundance and diversity of ground flora. Many reference sites have been effectively managed for timber harvesting, resulting in either even-age (State 2) or uneven-age (State 3) managed forests depending upon the removal intensity and the species selection.

Community Phase 1.1: White Oak – Red Oak/Eastern Hop Hornbeam – Ohio Buckeye / Harbinger of Spring – May Apple

(Photo on left: White oak dominated canopy at Hungry Mother Conservation Area, Howard County, Missouri - photo from MDC)

This phase is one of the more productive upland forests in the MLRA. While the overstory is dominated by white oak and northern red oak, hickories can also be common. This forest community has a multi-tiered structure, and a canopy that is 75 to 100 feet tall with 80 to 100 percent closure. The sub-canopy and understory are well developed, with eastern hop hornbeam and Ohio buckeye (Iowa) as a dominant understory species. A moderate abundance of shade tolerant forest generalists, such as May apple, ferns, tick trefoils and white snakeroot cover the ground.

Community Phase Pathway 1.1A
Over time with the absence of disturbance, more shade tolerant species such as sugar maple (black maple (*Acer nigrum*) in Iowa), bitternut hickory, white ash, basswood (*Tilia americana*) and others increase in importance and add structural diversity to the system. In addition, more shade-loving forest shrub (e.g., pawpaw) and herbaceous (e.g., bloodroot) species also increase.

Structure and Cover – Community Phase 1.1

Soil Surface Cover

Cover type	Minimum	Maximum
Litter	75%	100%

Downed woody material	Minimum	Maximum	Predominant decomposition class*
Downed wood, fine-small (<0.40" diameter; 1-hour fuels)	0.03%	0.33%	N
Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels)	0.03%	0.33%	N
Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels)	0.03%	0.33%	N
Downed wood, coarse-small (3.00-8.99" diameter; 1000-hour fuels)	0.1%	2%	N
Downed wood, coarse-large (>9.00" diameter; 10000-hour fuels)	0%	.99%	

Tree snags** per acre		
Hard snags***	0	20
Soft snags***	0	10

* Decomposition classes: N=No or little integration with the soil surface. I=Partial to nearly full integration with the soil surface.
** >4" diameter at 4.5' above ground and >6' height. If diameter or height is smaller, use applicable downed wood type.
*** Hard=Tree is dead with most or all of bark intact. Soft=Most of bark has sloughed off.

Ground Cover

Vegetative cover	Minimum	Maximum
Grasses/grasslikes	0.01%	0.99%
Forbs	0.01%	0.99%
Shrubs/vines	0.01%	0.99%
Trees	0.1%	2%
Nonvascular plants	0%	0%
Biological crust	0%	0%

Non-vegetative cover	Minimum	Maximum
Litter	75%	100%
Surface fragments >0.25" and <=3"	0%	0%
Surface fragments >3"	0%	0%
Bedrock	0%	0%
Water	0%	0%
Bare ground	0.01%	0.99%

Structure of Canopy Cover

	Grasses/grasslikes		Forbs		Shrubs/vines		Trees	
Height above ground	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
<=0.5 foot	0%	1%	2%	10%	0%	25%	0%	5%
>0.5 to <1 foot	0%	5%	2%	25%	1%	10%	1%	25%
>1 to <=2 feet	0%	1%	0%	10%	1%	25%	2%	50%
>2 to <4.5 feet	0%	0%	0%	0%	0%	2%	1%	50%
>4.5 to <=13 feet	--	--	--	--	--	--	10%	95%
>13 to <40 feet	--	--	--	--	--	--	2%	25%
<40 to >=80 feet	--	--	--	--	--	--	25%	95%
>80 to <120 feet	--	--	--	--	--	--	--	95%
>=120 feet	--	--	--	--	--	--	--	--

Forest Overstory

White oak and red oak dominate with scattered hickory and black oak.

Forest Overstory Characterization Summary (trees >13 feet in height)

	Low canopy cover %	RV canopy cover %	High canopy cover %
Forest canopy:	80	90	100

Overstory plant type: Tree

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top	Tree diameter low	Tree diameter high	Basal area low	Basal area high
SHAGBARK HICKORY *Carya ovata*	CAOV2	N	1.0	2.0	60.0	100.0	5.0	7.0	1.4	4.1
WHITE OAK *Quercus alba*	QUAL	N	10.0	95.0	60.0	100.0	7.0	25.0	123.5	177.9
WHITE ASH *Fraxinus americana*	FRAM2	N	2.0	5.0	60.0	90.0	6.0	8.0	2.6	2.8
BLACK OAK *Quercus velutina*	QUVE	N	0.0	10.0		90.0				
mockernut hickory *Carya alba(syn)*	CAAL27	N	5.0	10.0		80.0				
NORTHERN RED OAK *Quercus rubra*	QURU	N	30.0	50.0		80.0				
BLACK MAPLEe *Acer nigrum*	ACNI5	N	0.0	5.0		70.0				
SUGAR MAPLE *Acer saccharum*	ACSA3	N	5.0	10.0		70.0				
SLIPPERY ELM *Ulmus rubra*	ULRU	N	10.0	20.0		50.0				

Forest Understory

The understory layer is well-developed with white ash, eastern hop hornbeam, Ohio buckeye and haws. The ground flora has many spring ephemerals and other shade loving herbaceous plant species.

Forest Understory Canopy Cover Summary *(all species <13 feet in height)*

Understory plant type: Grass/grass-like (Graminoids)

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
HAIRY WOODLAND BROME *Bromus pubescens*	BRPU6	N	0.1	1.0	0.3	2.0
NODDING FESCUE *Festuca subverticillata*	FESU3	N	0.0	0.1	0.3	2.0
WOODLAND SEDGE *Carex blanda*	CABL	N	0.0	0.1	0.3	1.0
WOODBANK SEDGE *Carex cephalophora*	CACE	N	0.1	1.0	0.3	1.0
PENNSYLVANIA SEDGE *Carex pensylvanica*	CAPE6	N	0.1	5.0	0.3	0.5
ARTIC BROME *Bromus purgans(syn)*	BRPU4	N	1.0	2.0		

Understory plant type: Forb/Herb

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
VIRGINIA-SNAKEROOT *Aristolochia serpentaria*	ARSE3	N	1.0	2.0		3.0
DOWNY AGRIMONY *Agrimonia pubescens*	AGPU	N	0.1	1.0	0.3	2.0
HEMP DOGBANE *Apocynum cannabinum*	APCA	N	0.0	0.1	0.3	2.0
WHITE AVENS *Geum canadense*	GECA7	N	0.0	0.1	0.3	2.0
GOLDEN SEAL *Hydrastis canadensis*	HYCA	N	1.0	2.0		2.0
VIRGINIA KNOTWEED *Polygonum virginianum*	POVI2	N	0.0	0.1	0.3	2.0
CLUSTERED BLACKSNAKEROOT *Sanicula odorata*	SAOD	N	0.1	5.0	0.3	2.0
GOLDENROD *Solidago*	SOLID	N	0.1	1.0	0.5	2.0
DRUMMOND'S ASTER *Symphyotrichum drummondii*	SYDR	N	0.1	1.0	1.0	2.0
VENUS' LOOKING-GLASS *Triodanis perfoliata*	TRPE4	N	0.0	0.1	1.0	2.0
JACK IN THE PULPIT *Arisaema triphyllum*	ARTR	N	0.1	1.0	0.5	1.0
FOUR-LEAF MILKWEED *Asclepias quadrifolia*	ASQU	N	0.0	0.1	0.3	1.0
VIRGINIA SPRINGBEAUTY *Claytonia virginica*	CLVI3	N	1.0	5.0		1.0
LESSER YELLOW LADY'S SLIPPER *Cypripedium parviflorum var. parviflorum*	CYPAP4	N	0.0	5.0		1.0
LARGE FLOWER TICKCLOVER *Desmodium glutinosum*	DEGL5	N	1.0	10.0	0.5	1.0
NAKED-FLOWER TICK-TREFOIL *Desmodium nudiflorum*	DENU4	N	1.0	2.0	0.3	1.0
WHITE DOG'S TOOTH VIOLET *Erythronium albidum*	ERAL9	N	1.0	5.0		1.0
HARBINGER-OF-SPRING *Erigenia bulbosa*	ERBU	N	0.1	5.0		1.0
CAROLINA GERANIUM *Geranium carolinianum*	GECA5	N	0.1	1.0	0.5	1.0
HEPATICA *Hepatica nobilis*	HENO2	N	1.0	2.0		1.0
FEATHERY FALSE SOLOMON'S-SEAL *Maianthemum racemosum*	MARA7	N	0.1	1.0	0.3	1.0
MAYAPPLE *Podophyllum peltatum*	POPE	N	1.0	5.0		1.0
BRISTLY BUTTERCUP *Ranunculus hispidus*	RAHI	N	0.0	0.1	0.3	1.0
WIDOWSFRILL *Silene stellata*	SIST	N	0.1	1.0	0.5	1.0
RUE-ANEMONE *Thalictrum thalictroides*	THTH2	N	0.1	1.0	0.3	1.0
TOAD SHADE *Trillium sessile*	TRSE2	N	1.0	5.0		1.0

BELLWORT *Uvularia grandiflora*	UVGR	N	1.0	2.0		1.0
HOGPEANUT *Amphicarpaea bracteata*	AMBR2	N	1.0	2.0	0.3	0.5
SHINING BEDSTRAW *Galium concinnum*	GACO3	N	0.1	2.0	0.3	0.5
CLAYTON'S SWEETROOT *Osmorhiza claytonii*	OSCL	N	0.1	1.0	0.3	0.5
AMERICAN GINSENG *Panax quinquefolius*	PAQU	N	0.1	25.0	0.3	0.5
WILD BLUE PHLOX *Phlox divaricata*	PHDI5	N	0.1	1.0	0.3	0.5
LOPSEED *Phryma leptostachya*	PHLE5	N	0.0	1.0	0.3	0.5
BLOODROOT *Sanguinaria canadensis*	SACA13	N	0.0	0.1	0.3	0.5

Understory plant type: Shrub/Subshrub

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
POISON IVY *Toxicodendron radicans*	TORA2	N	0.1	2.0	0.3	16.0
PRICKLY ASH *Zanthoxylum americanum*	ZAAM	N	1.0	2.0	0.5	8.0
MULTIFLORA ROSE *Rosa multiflora*	ROMU	I	0.0	1.0	2.0	4.0
HAZELNUT *Corylus americana*	COAM3	N	1.0	3.0		3.0
FRAGRANT SUMAC *Rhus aromatica*	RHAR4	N	0.1	2.0	0.3	2.0
GOOSEBERRY *Ribes missouriense*	RIMI	N	0.1	1.0	1.0	2.0
BLACKBERRY *Rubus allegheniensis*	RUAL	N	1.0	2.0	0.5	2.0
BUCKBRUSH *Symphoricarpos orbiculatus*	SYOR	N	0.1	1.0	0.5	2.0
BLACKHAW *Viburnum prunifolium*	VIPR	N	0.1	2.0	0.5	2.0

Understory plant type: Fern

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
CHRISTMAS FERN *Polystichum acrostichoides*	POAC4	N	1.0	5.0		2.0
MAIDENHAIR FERN *Adiantum pedatum*	ADPE	N	0.1	1.0	0.5	1.0
LOWLAND BLADDER FERN *Cystopteris protrusa*	CYPR4	N	0.1	1.0	0.5	1.0
RATTLESNAKE FERN *Botrychium virginianum*	BOVI	N	0.0	0.1	0.3	0.5

Understory plant type: Tree

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
WHITE OAK *Quercus alba*	QUAL	N	0.1	5.0	0.3	40.0
BLACK OAK *Quercus velutina*	QUVE	N	0.1	2.0	1.0	40.0
PAWPAW *Asimina triloba*	ASTR	N	1.0	5.0		20.0
OHIO BUCKEYE *Aesculus glabra*	AEGL	N	0.1	10.0	0.5	16.0
REDBUD *Cercis canadensis*	CECA4	N	1.0	50.0	0.5	16.0
WHITE ASH *Fraxinus americana*	FRAM2	N	1.0	10.0	1.0	16.0
EASTERN REDCEDAR *Juniperus virginiana*	JUVI	N	0.0	0.1	0.3	16.0
EASTERN HOPHORNBEAM *Ostrya virginiana*	OSVI	N	0.1	50.0	0.3	16.0
BLACK HICKORY *Carya texana*	CATE9	N	1.0	2.0	0.5	8.0
COMMON HOPTREE *Ptelea trifoliata*	PTTR	N	0.1	1.0	0.5	8.0
NORTHERN RED OAK *Quercus rubra*	QURU	N	0.0	0.1	0.3	8.0
JUNEBERRY *Amelanchier arborea*	AMAR3	N	1.0	5.0	0.3	2.0
PIGNUT HICKORY *Carya cordiformis*	CACO15	N	0.1	2.0	0.5	2.0
BLACK CHERRY *Prunus serotina*	PRSE2	N	0.1	1.0	0.3	2.0
SLIPPERY ELM *Ulmus rubra*	ULRU	N	0.0	10.0	0.3	2.0
STIFF DOGWOOD *Cornus foemina*	COFO	N	0.1	1.0	0.5	1.0
BASSWOOD *Tilia americana*	TIAM	N	0.0	0.1	0.3	0.5

Understory plant type: Vine

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
WINTER GRAPE *Vitis vulpina*	VIVU	N	0.1	2.0	0.3	80.0
FOURLEAF YAM *Dioscorea quaternata*	DIQU	N	0.1	1.0	0.3	2.0
BITTERSWEET *Celastrus scandens*	CESC	N	0.0	0.1	0.3	1.0
VIRGINIA CREEPER *Parthenocissus quinquefolia*	PAQU2	N	5.0	10.0	0.3	1.0
SUMMER GRAPE *Vitis aestivalis*	VIAE	N	1.0	2.0		

Community Phase 1.2: White Oak – Red Oak / Sugar Maple – Ohio Buckeye/ Harbinger of Spring – May Apple

(Photo below: White oak dominated reference site at Rebels Cove Conservation Area, Schuyler County, MO - photo from MDC)

This phase is similar to community phase 1.1 but red oak and hickory densities are increasing due to longer periods of fire suppression (>20 years) and lack of natural disturbances such as ice and wind. Displacement of some less shade tolerant grasses and forbs such as nodding fescue and goldenrods along with lower densities of most species may be occurring due to shading and competition from the increased densities of oak, maple and hickory saplings in the mid-story.

Community Phase Pathway 1.2A
With periodic disturbances, such as fire, ice and wind that create canopy gaps, white oak and red oak are allowed to successfully reproduce and enter the canopy. Over time, these disturbance events result in a community phase transition back to the phase 1.1.

Forest Overstory
White oak and red oak dominate with scattered hickory and sugar maple.

Forest Overstory Characterization Summary (tree and vine species >13 feet in height)

	Low canopy cover %	RV canopy cover %	High canopy cover %
Forest canopy:	85	90	100

Overstory plant type: Tree

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top	Tree diameter low	Tree diameter high	Basal area low	Basal area high
SUGAR MAPLE *Acer saccharum*	ACSA3	N	5.0	20.0		90.0				
MOCKERNUT HICKORY *Carya alba(syn)*	CAAL27	N	5.0	10.0		90.0				
WHITE OAK *Quercus alba*	QUAL	N	10.0	70.0		90.0				
NORTHERN RED OAK *Quercus rubra*	QURU	N	30.0	50.0		90.0				
BLACK OAK *Quercus velutina*	QUVE	N	0.0	10.0		90.0				
WHITE ASH *Fraxinus americana*	FRAM2	N	5.0	10.0		80.0				
BLACK MAPLE *Acer nigrum*	ACNI5	N	0.0	10.0		70.0				

Forest Understory

This woodland community has a multi-tiered structure due to lack of disturbance activities. The understory layer is well-developed with maple, white ash, eastern hop hornbeam, Ohio buckeye and haws. The ground flora has many spring ephemerals and other shade loving herbaceous plant species.

Forest Understory Canopy Cover Summary (all species <13 feet in height)

Understory plant type: Grass/grass-like

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
WOODLAND SEDGE *Carex blanda*	CABL	N	0.0	1.0		
PENNSYLVANIA SEDGE *Carex pensylvanica*	CAPE6	N	0.0	1.0		

Understory plant type: Forb/Herb

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
JACK IN THE PULPIT *Arisaema triphyllum*	ARTR	N	0.0	5.0		
LARGE FLOWER TICKCLOVER *Desmodium glutinosum*	DEGL5	N	0.0	5.0		
NAKED-FLOWER TICK-TREFOIL *Desmodium nudiflorum*	DENU4	N	0.0	5.0		
CAROLINA GERANIUM *Geranium carolinianum*	GECA5	N	0.0	5.0		
FEATHERY FALSE SOLOMON'S-SEAL *Maianthemum racemosum*	MARA7	N	0.0	5.0		
CLAYTON'S SWEETROOT *Osmorhiza claytonii*	OSCL	N	0.0	5.0		
AMERICAN GINSENG *Panax quinquefolius*	PAQU	N	0.0	1.0		
WILD BLUE PHLOX *Phlox divaricata*	PHDI5	N	0.0	5.0		
SOLOMON'S SEAL *Polygonatum biflorum*	POBI2	N	1.0	2.0		
VIRGINIA KNOTWEED *Polygonum virginianum*	POVI2	N	0.0	5.0		
BLOODROOT *Sanguinaria canadensis*	SACA13	N	1.0	5.0		
CLUSTERED BLACKSNAKEROOT *Sanicula odorata*	SAOD	N	0.0	5.0		
RUE-ANEMONE *Thalictrum thalictroides*	THTH2	N	0.0	1.0		
BELLWORT *Uvularia grandiflora*	UVGR	N	1.0	5.0		

Understory plant type: Fern

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
MAIDENHAIR FERN *Adiantum pedatum*	ADPE	N	0.0	5.0		
RATTLESNAKE FERN *Botrychium virginianum*	BOVI	N	0.0	5.0		

Understory plant type: Shrub/Subshrub

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
BUCKBRUSH *Symphoricarpos orbiculatus*	SYOR	N	0.0	5.0		
BLACKHAW *Viburnum prunifolium*	VIPR	N	0.0	5.0		

Understory plant type: Tree

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
OHIO BUCKEYE *Aesculus glabra*	AEGL	N	5.0	10.0		
JUNEBERRY *Amelanchier arborea*	AMAR3	N	0.0	5.0		
REDBUD *Cercis canadensis*	CECA4	N	0.0	5.0		

Understory plant type: Vine

Name	Symbol	Nativity	Cover low %	Cover high %	Canopy height bottom	Canopy height top
VIRGINIA CREEPER *Parthenocissus quinquefolia*	PAQU2	N	1.0	5.0		
POISON IVY *Toxicodendron radicans*	TORA2	N	1.0	2.0		
WINTER GRAPE *Vitis vulpina*	VIVU	N	1.0	2.0		

Transition T1A
Fire suppression and even-aged forest timber management and harvesting will result in a transition to community phase 2.1.

Transition T1B
Fire suppression and uneven-aged forest timber management and harvesting will result in a transition to community phase 3.1.

Transition 1C
Clearing, pasture planting and grassland management will result in a transition to community phase 4.1.

Transition 1D
High grade logging and uncontrolled grazing will result in a transition to community phase 5.1.

State 2: Even-Age Managed Forest

This forest tends to be rather dense with an even-aged overstory and an under developed understory and ground flora. Thinning can increase overall tree vigor and improve understory diversity. Continual timber harvesting, depending on the practices used and age classes removed, will either maintain this state, or convert the site to uneven-age (State 3) forests.

This state can be restored to a reference state by modifying or eliminating timber harvests, extending rotations, incorporating selective thinning, and re-introducing prescribed fire. (See Ecological Dynamics section for caution on sites with invasive non-native species of earthworms)

Community Phase 2.1: White Oak – Red Oak/ Eastern Hop Hornbeam / Pennsylvania Sedge
(Photo below: Even-aged shelterwood harvest - photo credit USDA Forest Service)

This is an even-aged forest management phase. Logging activities are removing higher volumes of white oak causing a decrease in white oak in the canopy and an increase in red oak. Large group, shelterwood or clearcut harvests create a more uniform age class structure throughout the canopy layer while also opening up the understory and allowing more sunlight to reach the forest floor.

Community Phase Pathway 2.1A
This pathway results in a cessation or reduction of harvesting frequencies.

Forest Overstory
Red oak and white oak are common overstory species along with hickory. Canopy levels can approach 90 percent.

Forest Understory
Rather dense ground cover dominated by forbs and shrubs especially after harvests.

Community Phase 2.2: White Oak – Red Oak/ Eastern Hop Hornbeam – Ohio Buckeye / Pennsylvania Sedge
With cessation of harvesting and no other management inputs this community phase will slowly increase in more shade tolerant species such as hickories, white ash and maple. Over time white oak may become less dominant.

Community Phase Pathway 2.2A
Re-initiation of harvesting and other forest management activities will transition this community phase back to community phase 2.1.

Forest Overstory
White oak and red oak are common. Hickory species are increasing in the overstory.

Forest Understory
In the long term absence of disturbance, oak and hickory saplings, black cherry and hornbeam encroach into the understory of these woodlands.

Transition 2A
Thinning and selective harvesting will result in a transition to a un-evenage forest stand.

Transition 2B
High-grade harvesting and introduction of uncontrolled grazing will cause a transition to community phase 5.1

Restoration Pathway 1B
This state can be restored to a reference state by modifying or eliminating timber harvests, extending rotations, incorporating selective thinning and allowing long-term succession to occur.

State 3: Uneven-Age Managed Forest

An uneven-age managed forest can resemble the reference state. The primary difference is tree age, most being only 50 to 90 years old. Composition is also likely altered from the reference state depending on tree selection during harvests and disturbance activities. Without a regular 15 to 20 year harvest re-entry into these stands, they will slowly increase in more shade tolerant species such as sugar maple (black maple in Iowa) and white oak will become less dominant.

This state can be restored to a reference state by modifying timber harvests, extending rotations, incorporating selective thinning, and re-introducing prescribed fire. (See Ecological Dynamics section for caution on sites with invasive non-native species of earthworms)

Community Phase 3.1: Red Oak – White Oak /Sugar Maple Saplings/ Ferns

(Photo on left: Unevenage selective harvesting - photo credit Dwyer Forestry Consulting)

This is an uneven-aged forest management phase. Selective logging activities are removing higher volumes of white oak causing a decrease in white oak in the canopy and an increase in red oak. Densities numbers, especially more shade tolerant species, are increasing at the lower size-class levels.

Community Phase Pathway 3.1A
This pathway results in a cessation or reduction of harvesting frequencies.

Forest Overstory
Red oak and white oak dominate the overstory.

Forest Understory
Maple, oak and hickory saplings, black cherry, Ohio buckeye and hop hornbeam are common understory species.

Community Phase 3.2: Red Oak – White Oak – Sugar Maple/Ohio Buckeye – Pawpaw / Ferns
With cessation of harvesting and no other management inputs this community phase will slowly increase in more shade tolerant species such as hickories, white ash, red oak and maple in both the canopy layer and the understory.

Community Phase Pathway 3.2A
Re-initiation of harvesting and other forest management activities will transition this community phase back to community phase 2.1.

Forest Overstory
Red oak and white oak along with increasing densities of maple dominate the overstory.

Forest Understory
In the long term absence of disturbance, maple, oak and hickory saplings, black cherry, Ohio buckeye and hop hornbeam encroach into the understory of these woodlands.

Transition 3B
High-grade harvesting and introduction of uncontrolled grazing will cause a transition to community phase 5.1

Transition 3A
Thinning and large group harvesting will result in a transition to an evenage forest stand.

Restoration Pathway 1A
This state can be restored to a reference state by modifying or eliminating timber harvests, extending rotations, incorporating selective thinning and allowing long-term succession to occur.

State 4: Grassland

Conversion of forests to planted, non-native cool season grasses and legumes has been common. *(Photo below: Well-managed cool season pasture near Lake Wapello State Park, Iowa - photo from MDC)* Without proper grassland management these ecological sites are challenging to maintain in a healthy, productive state. With over grazing and cessation of active pasture management, tall fescue, white clover and multi-flora rose will increase in density.

In some instances, this state has been converted to native warm season grasses, primarily big bluestem, switchgrass, and Indian grass or pure stands of single species.

Community Phase 4.1: Cool Season Grasses – Legumes
This phase is well-managed grassland, composed of non-native cool season grasses and legumes. Grazing and haying is occurring. The effects of long-term liming on soil pH, and calcium and magnesium content, is most evident in this phase. Studies show that these soils have higher pH and higher base status in soil horizons as much as two feet below the surface, relative to poorly managed grassland (phase 4.2) and to woodland communities (where liming is not practiced).

Community Phase Pathway 4.1A
This pathway results from over grazing and cessation of active pasture management.

Community Phase 4.2: Tall fescue – White Clover/Multi-flora Rose
(Photo on left: Cool season pasture showing weedy invasion due to poor management near Bloomfield, Iowa - photo from MDC) This phase is the result of poor grassland management. Over grazing and inadequate or no fertility application has allowed tall fescue, multi-flora rose, thistle and other weedy species to increase in cover and density reducing overall forage quality and site productivity. White clovers such as ladino and alsike will decrease or go away with no fertilization and

overgrazing although Dutch white clover will leave last. Soil pH and bases such as calcium and magnesium are lower, relative to well-managed pastures (Phase 4.1).

Community Phase Pathway 4.2A
To return to Community Phase 4.1, requires brush management, grassland seeding, rotational grazing, and integrated pest management.

Community Phase 4.3: Native Warm Season Grasses
In some instances, this state has been converted to native warm season grasses, primarily big bluestem, switchgrass, and Indian grass or pure stands of single species. These sites are typically converted through a federal cost share program such as the Conservation Reserve Program (CRP) or the Environmental Quality Incentives Program (EQIP). Some sites are associated with an active rotational grazing system.

(Photo on left: Native grasses and legumes on CRP land in southern Iowa - photo from NRCS)

Transition 4A
This state will transition to a high-graded/grazed woodland idle phase with long term succession allowing woody species to become established and little to no grazing.

State 5: High-Graded/Grazed Forest

Reference or managed forested states subjected to repeated, high-grading timber harvests and uncontrolled cattle grazing transition to this degraded state. This state exhibits an over-abundance of hickory and other less economically desirable tree species and weedy understory species such as buckbrush, gooseberry, poison ivy and multi-flora rose. The vegetation offers little nutritional value for cattle, and excessive livestock stocking damages tree boles, degrades understory species composition and results in soil compaction and accelerated erosion and runoff. Browsing by goats using good rotational management can open up the shrub layer, eliminate many of the weedy species and increase both native herbaceous vegetation and may induce regeneration of oak and hickory species. Cessation of active logging and exclusion of livestock from sites in this state will create an idle phase that experiences an increase in black cherry and Ohio buckeye in the understory layer.

Transition back to either an even-age managed or uneven-age managed forest will required dynamic and sustained forest stand improvements, cessation of grazing, and selective thinning of overstory and understory canopies. (See Ecological Dynamics section for caution on sites with invasive non-native species of earthworms)

Community Phase 5.1: Black Oak-Hickory/Hickory saplings -Gooseberry-Multiflora Rose/Fragile Fern-Jack in the pulpit

Due to high-grade logging and uncontrolled grazing, this community phase exhibits an over-abundance of hickory and other less economically desirable tree species and weedy understory species such as buckbrush, gooseberry, poison ivy and multi-flora rose. The understory vegetation offers little nutritional value for cattle, and excessive livestock stocking damages tree boles, degrades understory species composition and results in soil compaction and accelerated erosion and runoff.

(Photo on left: Actively grazed woodland creating an open understory - photo from NRCS)

Community Phase Pathway 5.1A
This pathway results from cessation of active logging and periodic exclusion of livestock or reduction in grazing intensity.

Forest Overstory
Canopy exhibits an over-abundance of hickory and other less economically desirable tree species such as black oak.

Forest Understory
Over time, understory species such as buckbrush, gooseberry, poison ivy and multi-flora rose increase in density.

Community Phase 5.2: Black Oak- Hickory/Black Cherry- Gooseberry / Fragile Fern – Jack in the pulpit-Geranium

Cessation of active logging and reduction in grazing intensity will create an idle phase that experiences an increase in black cherry and Ohio buckeye and weedy species such as buckbrush and gooseberry in the understory layer.

(Photo on left: Lamson Woods State Preserve showing high-graded formerly grazed woodland near Fairfield, Iowa - photo from MDC)

Community Phase Pathway 5.2A
This pathway results in a return to unrestricted logging activity and increased grazing intensities and frequencies.

Forest Overstory
Canopy exhibits an over-abundance of hickory and other less economically desirable tree species such as black oak.

Forest Understory
Understory densities levels are increasing. Species such as black cherry, buckbrush, gooseberry, poison ivy and multi-flora rose are common.

Transition 5A
This state will transition to a grassland state with clearing, pasture planting, and grassland managment.

Transition 5B
This state will transition to a managed forest state with selective timber harvesting, forest stand improvement, and suppression of grazing.

Transition 5C
This state will transition to a managed forest state with even-aged management, forest stand improvement, and suppression of grazing.

Section II: Ecological Site Interpretations

Forest Site Productivity

Common Name	Symbol	Site Index Low	Site Index High	CMAI Low	CMAI High	Age of CMAI	Site Index Curve Code	Site Index Curve Basis	Citation
WHITE OAK	*QUAL*	53	72	34	48	50	820	50TA	Schnur, G. Luther. 1937. Yield, stand, and volume tables for even-aged upland oak forests. United States Department of Agriculture Technical Bulletin 560
NORTHERN RED OAK	*QURU*	55	80	34	50	50	820	50TA	Schnur, G. Luther. 1937. Yield, stand, and volume tables for even-aged upland oak forests. United States Department of Agriculture Technical Bulletin 560

Animal Community

Wildlife:

This forest type contains high structural and compositional diversity important for a number of songbirds and amphibians. Wild turkey, white-tailed deer, and eastern gray squirrel depend on hard and soft mast food sources and are typical upland game species of this type (Pitts and McGuire 2000; Schwartz, et al. 2001).

Birds associated with late-successional, mature forests are Whip-poor-will, Great Crested Flycatcher, Ovenbird, Pileated Woodpecker, Yellow-billed Cuckoo, Summer Tanager, Wood Thrush, Red-eyed Vireo, Scarlet Tanager, Northern Parula (near streams), and Louisiana Water thrush (near streams). (Fitzgerald and Pashley 2000b; Jacobs 2001)

Reptiles and amphibians associated with these forests include: ringed salamander, spotted salamander, marbled salamander, central newt, long-tailed salamander, dark-sided salamander, southern red-backed salamander, small-mouthed salamander, three-toed box turtle, ground skink, western worm snake, western earth snake, American toad, and timber rattlesnake (Johnson 2000).

Domestic livestock:

Currently, domestic cattle grazing is occurs on some sites but concerns with lack of water, access issues, and high amounts of acorns on the ground in the fall that are detrimental to cattle limits its usefulness. On sites that have been cleared of trees and converted to cool-season grasses cattle grazing is common.

Hydrology Functions

Most precipitation on sites in reference or well-managed timber states infiltrates the soil, and either recharges the local groundwater or moves slowly as lateral flow, surfacing in headwaters of ephemeral streams. The trees, the shrub and herbaceous understories, and the litter provide nearly 100 percent soil cover. Little or no surface runoff occurs on these sites, except for rare, high-intensity storms. These sites provide high yields of good-quality groundwater, which is released slowly into ephemeral streams over time.

In high graded woodland or poorly managed pasture states, soil compaction and reduced surface cover generally results in reduced infiltration and increased runoff. Groundwater recharge is reduced. Surface runoff results in soil erosion, which degrades water quality. The rapid release of runoff into ephemeral streams increases the risk of downstream flooding, and shortens the time when ephemeral streams are active.

Recreational Uses

Hunting, bird watching, horseback riding, camping, and hiking are recreational uses of this ecological site. Reference and well managed sites provide good hunting for turkey, white-tailed deer, and squirrel. Recreational

uses are reduced in the heavily grazed grassland state and high-graded woodland state. In many areas of this predominantly agricultural MLRA, these sites provide the only forests available for recreational use.

Wood Products
This ecological site is productive. Timber harvesting can occur but care should be taken to maintain the integrity and character of the site. Potential products include lumber, oak staves, pallet materials, and in some cases oak and walnut veneer (only on well managed or old growth sites).

Forest farming, sometimes referred to as multi-story cropping, is an agroforestry practice that is suitable for this site. Forest farming is the intentional manipulation, integration, and intensive management of woodlands that capitalize on specific plant interactions to produce non-timber products. Many high-value specialty crops can be cultivated under the protection of a forest canopy that has been modified to provide the appropriate microclimate and light conditions. To support this practice forest stand improvement activities can be carried out to develop the appropriate understory conditions. Shade tolerant crops like ginseng, shiitake mushrooms, and decorative ferns can be grown and sold for medicinal, culinary, or ornamental uses. Forest farming activities modify the forest ecosystem but do not significantly interfere with its crucial contributions of water capture and filtering, soil erosion control, microclimate moderation, and wildlife habitat.

Other Information
Forest Management: Site index values range from 53 to 80 for oak. Timber management opportunities are excellent. This group responds well to management. A wide variety of management treatments are appropriate with this ecological site. Create group openings of at least 2 acres. Large clearcuts should be minimized if possible to reduce impacts on wildlife and aesthetics. Uneven-aged management using single tree selection or small group selection cuttings of ½ to 2 acre are options that can be used if clear cutting is not desired or warranted. Uneven-aged management may slowly cause an increase in more shade tolerant species such as maple. Using prescribed fire as a management tool could have a negative impact on timber quality, may not be fitting, or should be used with caution with this site if timber management is the primary objective. Where possible, favor white oak, black walnut, black cherry, and northern red oak.

Supporting Information

Associated Sites

Site name	Site ID	Site narrative
Loess Upland Woodland	*F109XY003MO*	Loess Upland Woodlands are often upslope from Till Protected Backslope Forests.
Till Upland Woodland	*F109XY007MO*	Till Upland Woodlands are often upslope from Till Protected Backslope Forests.
Shale Protected Backslope Forest	*F109XY013MO*	Shale Protected Backslope Forests are downslope from Till Protected Backslope Forests in some places.
Till Exposed Backslope Woodland	*F109XY022MO*	Till Exposed Backslope Woodlands are mapped in complex with the Till Protected Backslope Forests, on southerly and westerly aspects

Similar Sites

Site name	Site ID	Site narrative
Till Upland Woodland	*F109XY007MO*	Till Upland Woodlands are on upper slopes and shoulders, with white oak and black oak dominating the canopy. Both the overstory and understory are more open that till protected backslope forests.
Shale Protected Backslope Forest	*F109XY013MO*	Shale Protected Backslope Forests are downslope from Till Protected Backslope Forests in some places. Canopy composition is similar but these sites are somewhat less productive.

State Correlation
This site has been correlated with the following states: IA MO

Data Source of ECS-5 plots (for Lindley, Keswick and Winnegan soils)

	Sample ID					
Data source	Number	Year	State code	County code	State	County
ECS-5	6	1990	29	01	Missouri	Adair
	8	1990	29	01	Missouri	Adair
	9	1990	29	01	Missouri	Adair
	2	1964	29	027	Missouri	Callaway
	11	1984	29	027	Missouri	Callaway
	7	1991	29	041	Missouri	Chariton
	5	1990	29	045	Missouri	Clark
	1	1969	29	103	Missouri	Knox
	4	1982	29	111	Missouri	Lewis
	12	1984	29	113	Missouri	Lincoln
	7	1984	29	113	Missouri	Lincoln
	9	1984	29	113	Missouri	Lincoln
	10	1984	29	115	Missouri	Linn
	2	1984	29	115	Missouri	Linn
	3	1988	29	121	Missouri	Macon
	4	1988	29	121	Missouri	Macon
	2	1975	29	127	Missouri	Marion
	6	1973	29	139	Missouri	Montgomery
	5	1975	29	173	Missouri	Ralls
	10	1982	29	175	Missouri	Randolph
	3	1983	29	175	Missouri	Randolph
	6	1985	29	195	Missouri	Saline
	3	1969	29	205	Missouri	Shelby
	10	1990	29	211	Missouri	Sullivan
	5	1990	29	211	Missouri	Sullivan
	6	1990	29	211	Missouri	Sullivan
	4	1973	29	219	Missouri	Warren
	5	1973	29	219	Missouri	Warren
	6	1973	29	219	Missouri	Warren

Hierarchical Classification Relationships
Atlas of Missouri Ecoregions (Nigh & Schroeder, 2002): This ecological site occurs in many Land Type Associations within the following Subsections:

- Chariton River Hills
- Claypan Till Plains
- Mississippi River Hills
- Wyaconda River Dissected Till Plains

Terrestrial Natural Community Type in Missouri (Nelson, 2010):
The reference state for this ecological site is most similar to a Dry-Mesic Loess/Glacial Till Forest.

Missouri Department of Conservation Forest and Woodland Communities (Missouri Department of Conservation, 2006): The reference state for this ecological site is most similar to White Oak Loess/Glacial Till Forest.

National Vegetation Classification System Vegetation Association (NatureServe, 2010): The reference state for this ecological site is within the North-Central Interior Dry-Mesic Oak Forest and Woodland (CES202.046), and is most similar to *Quercus alba - Quercus rubra - Carya ovata* Glaciated Forest (CEGL002068).

Section III: Inventory Data Collection

The data contained in this document is derived from analysis of inventories, ecological interpretation from field evaluations, and various reference papers and books. Destructive plant sampling was not allowed on the public reference sites. Site index information on woody species was collected to provide estimates of site productivity.

Inventory Data References
Site concept developed from Paul Nelson's Terrestrial Natural Communities and other works and refined with Amber Steele's thesis.

- Steele, Amber M.; Kabrick, John M.; Miles, Randall J. 2013. Regional and geomorphic influence on the productivity, composition, and structure of oak ecosystems in the western central hardwoods region. In: Miller, Gary W.; Schuler, Thomas M.; Gottschalk, Kurt W.; Brooks, John R.; Grushecky, Shawn T.; Spong, Ben D.; Rentch, James S., eds. Proceedings, 18th Central Hardwood Forest Conference; 2012 March 26-28; Morgantown, WV; Gen. Tech. Rep. NRS-P-117. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 80-92.
- Nelson, Paul W. 2010. The Terrestrial Natural Communities of Missouri. Missouri Department of
- Conservation, Jefferson City, Missouri.
- Yatskievych, George A. 1999/2006/2013. Flora of Missouri. Missouri Dept. of Conservation in cooperation with Missouri Botanical Garden Press, Volumes 1-3.

Sampling methods (nested plots/transects/releve)

Level 2 and reconnaissance inventory:

- 2007: Kolaks/Meinert reconnaissance at Little Lost Creek CA and Rudolph Bennitt CA
- 2009/10: Steele/Steele/Kabrick reconnaissance for Till Backslope thesis study site selection (Atlanta CA, Hidden Hollow CA, Hungry Mother CA, Rebel's Cove CA, Union Ridge CA, Sugar Creek CA, others)
- 2014: Reconnaissance in Iowa: (Lamson Woods, Lacey Keosaqua SP. others)
- 2014: Reconnaissance and Tier III plot establishment in Missouri (Dark Hollow CA, Mineral Hills CA, Union Ridge CA, Thousand Hills SP, Rudolph Bennitt CA)

Reference Inventory Plots:

- RECOCA02 Rebel's Cove Conservation Area
- DAHOCA01 Dark Hollow Natural Area
- HNMOCA01 Hungry Mother Conservation Area

Type Localities for Reference State Data Plots:

State:	**MO**
County:	Howard
Township:	51N
Range:	15W
Section:	1
Datum:	WGS84
Zone:	15
Northing:	4343709
Easting:	538887
General legal description:	Plot HNMOCA01: Hungry Mother Conservation Area; Winnegan pedon (from Steele, 2011)

Latitude degrees:	39
Latitude minutes:	14
Latitude seconds:	30
Latitude decimal:	55
Longitude degrees:	92
Longitude minutes:	32
Longitude seconds:	57
Longitude decimal:	77
Universal Transverse Mercator (UTM) system:	WGS84154343709538887
State:	**MO**
County:	Schuyler
Township:	66N
Range:	16W
Section:	5
Datum:	WGS84
Zone:	15
Northing:	4489496
Easting:	523448
General legal description:	Plot RECOCA02: Rebel's Cove Conservation Area; Winnegan pedon (from Steele, 2011)
Latitude degrees:	40
Latitude minutes:	33
Latitude seconds:	21
Latitude decimal:	24
Longitude degrees:	92
Longitude minutes:	43
Longitude seconds:	22
Longitude decimal:	98
Universal Transverse Mercator (UTM) system:	WGS84154489496523448
State:	**MO**
County:	Sullivan
Township:	46N
Range:	18W
Section:	28
Datum:	WGS84
Zone:	15
Northing:	4463746
Easting:	506077
General legal description:	Plot DAHOCA01: Dark Hollow Natural Area; Winnegan pedon
Latitude degrees:	40
Latitude minutes:	19
Latitude seconds:	27
Latitude decimal:	19
Longitude degrees:	92
Longitude minutes:	55
Longitude seconds:	42
Longitude decimal:	49
Universal Transverse Mercator (UTM) system:	WGS84154463746506077

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Rep. NRS-P-117. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 80-92.

Glossary

Backslope – a hillslope profile position that forms the steepest and generally linear, middle portion of the slope.

Backswamp – marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces

Calcareous – the presence of calcium carbonate in the soil parent material within the rooting zone; relatively alkaline

Claypan – a dense, compact, slowly permeable layer in the subsoil having much higher clay content than the overlying material

Chert – hard, extremely dense or compact crystalline sedimentary rock, consisting dominantly of interlocking crystals of quartz

Cliff – a significant vertical, or near vertical, rock exposure

Deep Loess – a geographic area characterized by thick, dissected loess deposits, formed immediately adjacent to the edges of the Missouri and Mississippi River floodplains

Dolomite – a type of sedimentary rock that is a carbonate mineral composed of calcium magnesium carbonate

Drainageway – the upper most reach of a stream channel system characterized by little meandering

Dry – a site where soil moisture is limiting during the growing season; low available water capacity

Dune – a low mound, ridge, bank or hill of loose, wind-blown sand

Exposed – steep, south and west-facing slopes, which are warmer and drier than other slope aspects

Flatwoods – a type of woodland that occurs on soils with a root restricting subsoil layer within 20 to 30 inches, resulting in very slow runoff and ponding that remains saturated for most of the winter and early spring months but dries out and becomes very dry in the summer months; plants that grow there must be adapted to both conditions

Floodplain – the nearly level plain that borders a stream and is subject to inundation under flood-stage conditions

Footslope – a hillslope position at the base of a slope where hillslope sediment (colluvium) accumulates

Forest – a vegetative community dominated by trees forming a closed canopy and interspersed with shade-tolerant understory species

Fragipan – a dense, brittle subsoil horizon that is extremely hard and compact when dry

Glade – open, rocky, barren vegetative community dominated by drought-adapted forbs and grasses, typically with scattered, stunted woody plants

Igneous – bedrock created by cooling and crystallization of magma forming igneous rock. Granite and rhyolite are typical igneous bedrocks in Missouri

Knob – precambrian ancient exposed igneous rocks of prominent rounded mountain tops

Limestone – a type of sedimentary rock composed largely of calcium carbonate

Loess – material transported and deposited by wind and consisting predominantly of silt-size particles

Loamy – soil material containing a relatively equal mixture of sand and silt and a somewhat smaller proportion of clay

Marsh – a type of wetland that is dominated by herbaceous rather than woody plant species

Moist – a site that is moderately well to well drained and has high available water capacity, resulting in a well-balanced supply of moisture (neither too dry nor too wet).

Mudstone – blocky or massive, fine-grained sedimentary rock in which the proportions of clay and silt are approximately equal

Natric – a soil horizon that displays a blocky, columnar, or prismatic structure and has a subhorizon with an exchangeable-sodium saturation of over 15%

Outwash – stratified sediments of sand and gravel removed or "washed out" from a glacier by melt-water streams

Prairie – a vegetative community dominated by perennial grasses and forbs with scattered shrubs and very few trees

Protected – steep, north- and east-facing slopes, which are generally cooler and moister than other slope aspects

Residuum - unconsolidated, weathered, or partly weathered mineral material that accumulates by disintegration of bedrock in place

Riser – a component of terraces and flood-plain steps consisting of the steep side slope; the escarpment

Riverfront – a vegetative community in the floodplain immediately adjacent and generally parallel to a river or stream channel

Sandy – a coarse-sized soil containing a large mixture of sand and gravels and a somewhat smaller proportion of silts and clays with excessive drainage

Sandstone – a sedimentary rock containing dominantly sand-size particles

Savanna – grasslands interspersed with open-grown scattered trees, groupings of trees, and shrubs

Shale – a sedimentary rock formed from clay, silty clay, or silty clay loam deposits and having the tendency to split into thin layers

Shallow – a site with bedrock within 20 inches of the surface

Shoulder – the slope profile position that forms the convex surface near the top of a hill slope; it comprises the transition zone from summit to backslope

Sinkhole – a closed, circular or elliptical depression, commonly funnel-shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock or by collapse of underlying caves within bedrock

Summit – the top or highest area of a hillslope

Swale – shallow, closed depressions irregularly spaced across a floodplain or terrace with an irregularly undulating surface.

Swamp – an area of low, saturated ground, intermittently or permanently covered with water, and predominantly vegetated by shrubs and trees.

Talus – rock fragments of any size or shape (usually coarse and angular) derived from and lying at the base of a cliff or very steep rock slope.

Terrace – a step-like surface, bordering a valley floor that represents the former position of a flood plain

Till – dominantly unsorted and unstratified soil material deposited directly by a glacier

Upland – a general term for the higher ground of a region, in contrast with a low-lying, adjacent land such as a valley or floodplain

Wet – a somewhat poorly, poorly or very poorly drained site that has an oversupply of moisture during the growing season

Woodland – a highly variable vegetative community with a canopy of trees ranging from 30 to 100 percent closure with a sparse midstory and a dense ground flora of grasses, sedges and forbs

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