USDA Natural Resources Conservation Service

Ecological site F116BY018MO
Loamy Sinkhole Woodland

Last updated: 10/07/2020
Accessed: 05/18/2024

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

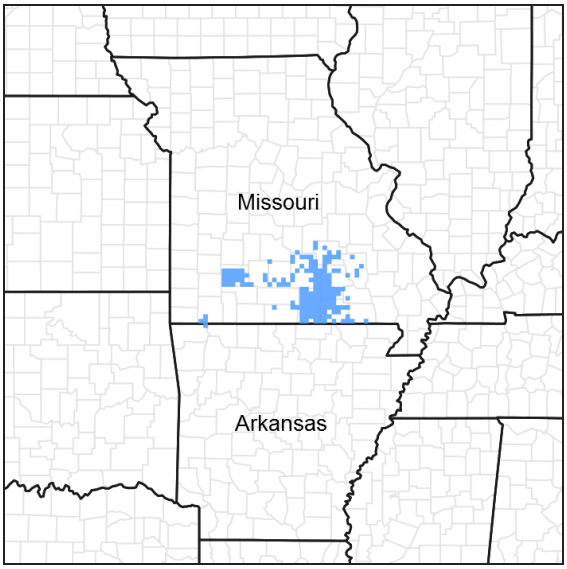


Figure 1. Mapped extent

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): 116B–Springfield Plain

The Springfield Plain is in the western part of the Ozark Uplift. It is primarily a smooth plateau with some dissection along streams. Elevation is about 1,000 feet in the north to over 1,700 feet in the east along the Burlington Escarpment adjacent to the Ozark Highlands. The underlying bedrock is mainly Mississippian-aged limestone, with areas of shale on lower slopes and structural benches, and intermittent Pennsylvanian-aged sandstone deposits on the plateau surface.

Classification relationships

Terrestrial Natural Community Type in Missouri (Nelson, 2010):
The reference state for this ecological site is not correlated to a community.

Missouri Department of Conservation Forest and Woodland Communities (Missouri Department of Conservation, 2006):
The reference state for this ecological site is most similar to an Upland Woodland.

National Vegetation Classification System Vegetation Association (NatureServe, 2010):
The reference state for this ecological site is not correlated to a community.

Geographic relationship to the Missouri Ecological Classification System (Nigh & Schroeder, 2002):
This ecological site occurs primarily within the Springfield Karst Prairie Plain Land Type Association.

Ecological site concept

NOTE: This is a “provisional” Ecological Site Description (ESD) that is under development. It contains basic ecological information that can be used for conservation planning, application and land management. After additional information is collected, analyzed and reviewed, this ESD will be refined and published as “Approved”.

Loamy Sinkhole Woodlands occur in karst areas, mainly around Springfield in Greene county. Soils are very deep, and are loamy throughout. The reference plant community is woodland with an overstory dominated by white oak and black oak and a ground flora of native grasses and forbs.

Associated sites

F116BY003MO	**Chert Upland Woodland** Chert Upland Woodlands and other ecological sites formed over limestone surround these sites.
F116BY004MO	**Low-Base Chert Upland Woodland** Low-base Chert Upland Woodlands and other ecological sites formed over limestone surround these sites.
F116BY005MO	**Low-Base Loamy Upland Woodland** Low-base Loamy Upland Woodlands and other ecological sites formed over limestone surround these sites.

Similar sites

R116BY040MO	**Ponded Sinkhole Wetland** Ponded Sinkhole Wetlands are also sinkholes but have standing water for at least part of the year.

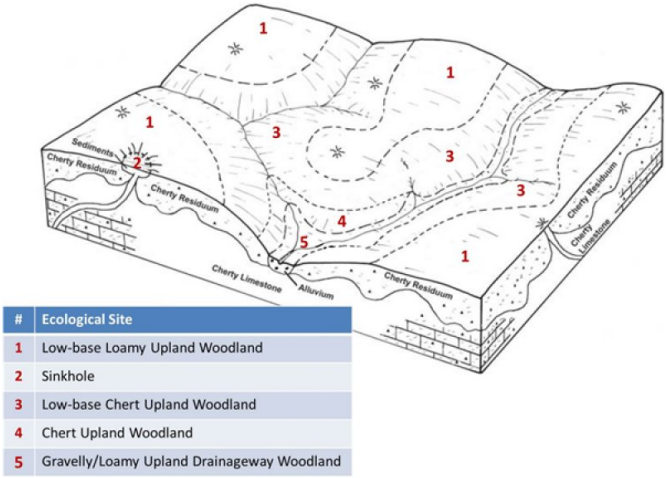
Table 1. Dominant plant species

Tree	(1) *Quercus velutina* (2) *Quercus alba*
Shrub	(1) *Vaccinium*
Herbaceous	(1) *Elymus virginicus* (2) *Carex pensylvanica*

Physiographic features

This site is on sinkholes with slopes of 1 to 3 percent. The site receives runoff from the adjacent uplands, and is subject to rare ponding in the winter months.

The following figure (adapted from Gregg and Woodward, 2006) shows the typical landscape position of this ecological site, and landscape relationships with other ecological sites. It is within the area labeled “2”, as well as in smaller sinkholes as shown on the figure. Sinkhole sites are associated with limestone, so adjacent ecological sites are typically underlain by limestone such as the sites shown in the figure.



#	Ecological Site
1	Low-base Loamy Upland Woodland
2	Sinkhole
3	Low-base Chert Upland Woodland
4	Chert Upland Woodland
5	Gravelly/Loamy Upland Drainageway Woodland

Figure 2. Landscape relationships for this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Sinkhole
Flooding frequency	None
Ponding duration	Very brief (4 to 48 hours) to brief (2 to 7 days)
Ponding frequency	Rare
Slope	1–3%
Water table depth	152 cm
Aspect	Aspect is not a significant factor

Climatic features

The Springfield Plain 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.

The Springfield Plain experiences few regional differences in climates. The average annual precipitation in this area is 41 to 45 inches. Snow falls nearly every winter, but the snow cover lasts for only a few days. The average annual temperature is about 55 to 58 degrees F. The lower temperatures occur at the higher elevations. Mean July maximum temperatures have a range of only one or two degrees across the area.
Mean annual precipitation varies along a west to east gradient. Seasonal climatic variations are more complex. Seasonality in precipitation is very pronounced due to strong continental influences. June precipitation, for example, averages three to four times greater than January precipitation. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer.

During years when precipitation comes in a fairly normal manner, moisture is stored in the top layers of the soil 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 affects plant and animal life by limiting water supplies, especially at times of high temperatures and high evaporation rates.

Superimposed upon the basic MLRA climatic patterns are local topographic influences that create topoclimatic, or microclimatic variations. In regions of appreciable relief, 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. Deep sinkholes often have a

microclimate significantly cooler, moister, and shadier than surrounding surfaces, a phenomenon that may result in a strikingly different ecology. Higher daytime temperatures of bare rock surfaces and higher reflectivity of these unvegetated surfaces may create distinctive environmental niches such as glades and cliffs. Slope orientation is an important topographic influence on climate. Summits and south-and-west-facing slopes are regularly warmer and drier than adjacent north- and-east-facing slopes. Finally, the climate within a canopied forest is measurably different from the climate of a more open grassland or savanna areas.

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/

Table 3. Representative climatic features

Frost-free period (characteristic range)	151-163 days
Freeze-free period (characteristic range)	184-191 days
Precipitation total (characteristic range)	1,143-1,168 mm
Frost-free period (actual range)	145-164 days
Freeze-free period (actual range)	181-192 days
Precipitation total (actual range)	1,143-1,168 mm
Frost-free period (average)	156 days
Freeze-free period (average)	187 days
Precipitation total (average)	1,143 mm

Climate stations used

- (1) BILLINGS 1SW [USC00230657], Billings, MO
- (2) MT VERNON M U SW CTR [USC00235862], Mount Vernon, MO
- (3) SPRINGFIELD [USW00013995], Springfield, MO

Influencing water features

Water features associated with this upland ecological site are influenced by karst landscapes throughout the area (see following diagram). Rainfall enters the groundwater system through the soil or by flowing into sinkholes and streams. Springs form where land drops low enough to meet underground water tables. Dissolution of carbonate rocks along fractures and faults has produced cave systems, sinkholes (closed and open), springs, and natural tunnels in the region. These sinkholes and losing streams can rapidly transfer water from upland recharge areas to spring outlets. The most common mechanism for groundwater recharge occurs by the relatively slow downward movement of water through soil and carbonate bedrock over a large area known as diffuse recharge, which maintains a high storage volume providing a consistent supply of water to springs. In addition to diffuse recharge, aquifers in karst terrain receive the relatively rapid transfer of water through sinkholes or losing streams connected by subsurface conduits. Surface water entering the aquifer in this fashion has very little contact with soil or rock and consequently the chemical nature of the water changes little in route. Discharge variability does not seem to be controlled by drainage area, but rather the conduit capacity of losing stream sections that can transport the entire volume of base-flow during dry periods in the year. High variability in base flow shows the impact of karst in the form of losing and gaining stream sections (Owen and Pavlowsky 2010). A few areas that are affected by seasonal wetness are in the DEPRESSIONAL wetlands class of the Hydrogeomorphic (HGM) classification system (Brinson, 1993), and are Forested Palustrine wetlands (Cowardin et al., 1979).

The following graphic depicts the distribution of these karst-related features in the state of Missouri. Relative cave density per USGS 7.5" quadrangle is depicted by shades of red, deeper red signifying a larger number of caves in the quadrangle. Stretches of losing streams are shown in yellow. Known springs are shown as blue dots.

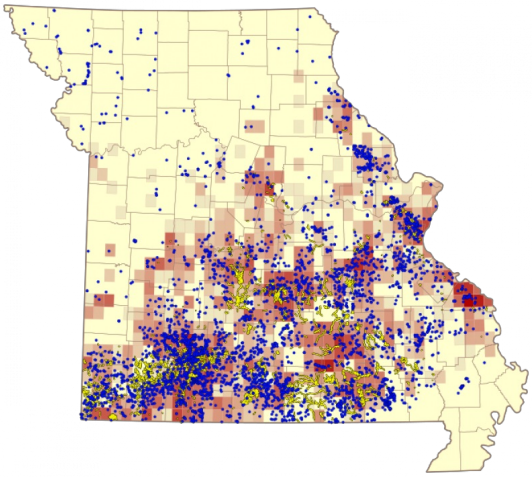


Figure 9. Image from Wikimedia Commons developed from the Missouri Department of Natural Resources, Division of Geology and Land Survey.

Soil features

These soils have no rooting restriction. The soils were formed under woodland vegetation, and have thin, light-colored surface horizons. Parent material is colluvium. They have silt loam surface horizons, and loamy subsoils. They are not affected by seasonal wetness. Soil series associated with this site include Grandgulf.

Table 4. Representative soil features

Parent material	(1) Colluvium
Surface texture	(1) Silt loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderately slow
Soil depth	183 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	20.32–22.86 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	4.5–6.5
Subsurface fragment volume <=3" (Depth not specified)	0%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

Information contained in this section was developed using historical data, professional experience, field reviews, and scientific studies. The information presented is representative of very complex vegetation communities. Key indicator plants, animals and ecological processes are described to help inform 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 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.

The reference plant community is variable, but most often well-developed woodland dominated by an overstory of black oak and white oak. The canopy is moderately tall (65 to 80 feet) but somewhat open (65 to 85 percent closure). Increased light from the open canopy causes a diversity of woodland ground flora species to flourish. In contrast to Ponded Sinkhole ecological sites, these units do not hold surface water. They range from very shallow depressions whose vegetation resembles the surrounding woodlands, to deep sinks with more shaded and moist conditions. Woodlands are distinguished from forest, by their relatively open understory, and the presence of sun-loving ground flora species. Characteristic plants in the ground flora can be used to gauge the restoration potential of a stand along with remnant open-grown old-age trees, and tree height growth.

Fire played an important role in the maintenance of these systems. It is likely that these ecological sites burned at least once every 5 to 10 years. These periodic fires kept woodlands open, removed the litter, and stimulated the growth and flowering of the grasses and forbs. During fire free intervals, woody understory species increased and the herbaceous understory diminished. The return of fire would open the woodlands up again and stimulate the abundant ground flora.

Loamy Sinkhole Woodlands were also subjected to occasional disturbances from wind and ice, as well as grazing by native large herbivores, such as bison, elk, and white-tailed deer. Wind and ice would have periodically opened the canopy up by knocking over trees or breaking substantial branches off canopy trees. Grazing by native herbivores would have effectively kept understory conditions more open, creating conditions more favorable to oak reproduction and sun-loving ground flora species.

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. In the long term absence of fire, woody species, especially hophornbeam, hickory and sugar maple, encroach into these woodlands. Once established, these woody plants can quickly fill the existing understory increasing shade levels with a greatly diminished ground flora. Removal of the younger understory and the application of prescribed fire have proven to be effective restoration means.

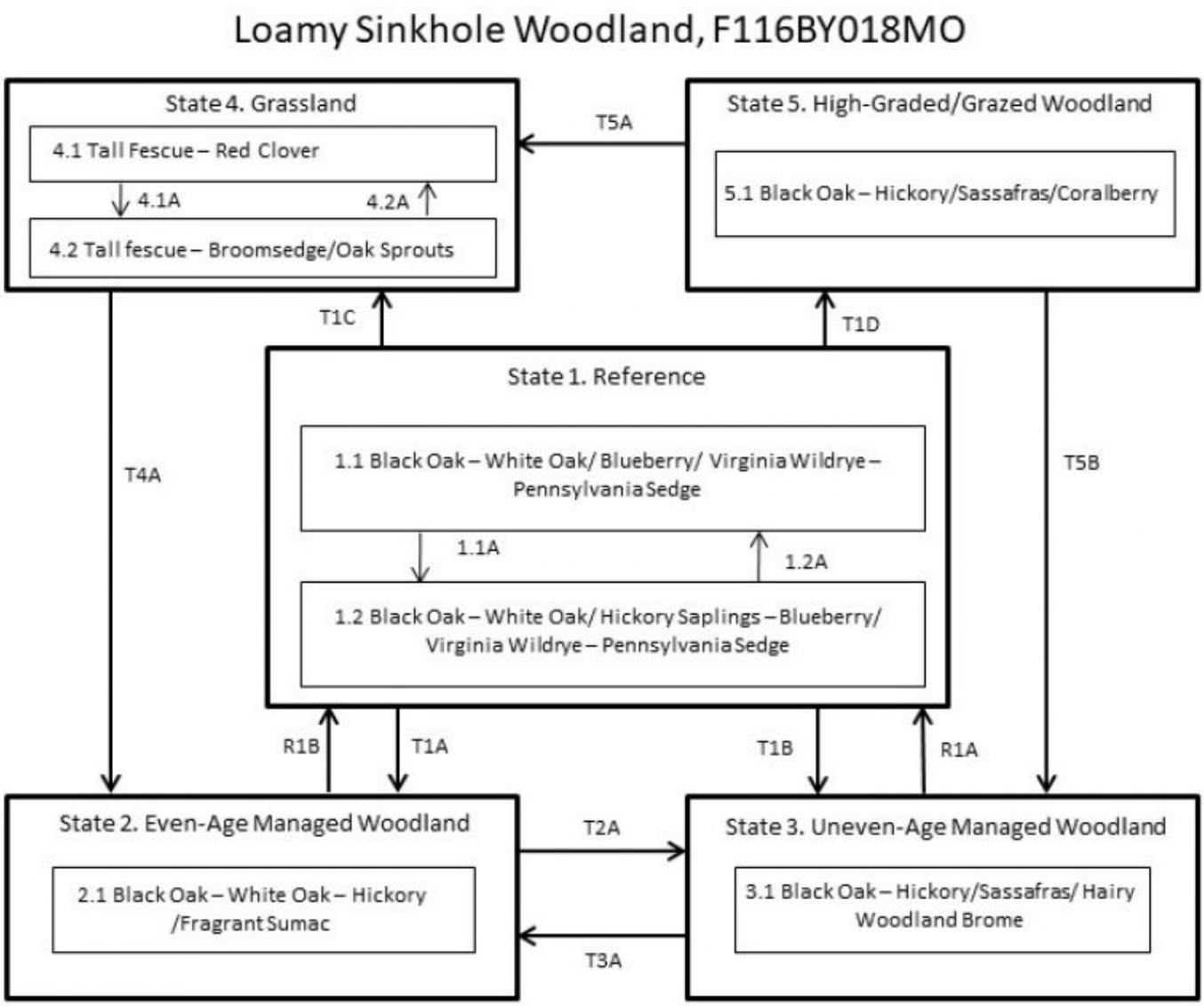
Uncontrolled domestic grazing has also impacted these communities, further diminishing the diversity of native plants and introducing species that are tolerant of grazing, such as coralberry, gooseberry, and Virginia creeper. Grazed sites also have a more open understory. In addition, soil compaction and soil erosion from grazing can be a problem and lower site productivity.

These ecological sites are moderately productive. 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 and the application of prescribed fire, the ground flora diversity may be shaded out and diversity of the stand may suffer.

A State and Transition Diagram 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.

State and transition model



Code	Event/Process
T1A	Even-aged management; fire suppression
T1B	Fire suppression; uneven-age management
T1C, T5A	Clearing; grassland planting; grassland management
T1D	Poorly planned harvest; uncontrolled grazing
T2A	Uneven-age management
T3A	Even-age management
T4A	Tree planting; long-term succession; no grazing
T5B	Uneven-age management; no grazing; forest stand improvement

Code	Event/Process
1.1A	No disturbances (10+ years)
1.2A	Disturbances (fire, wind, ice) < 10 years
4.1A	Over grazing; no fertilization
4.2A	Brush management; grassland seeding; grassland management

Code	Event/Process
R1A, R1B	Prescribed fire; extended rotations; forest stand improvement

Figure 10. State and transition diagram for this ecological site

State 1

Reference

The reference state for this ecological site was old growth oak woodland dominated by black oak, hickory, and white oak. Periodic disturbances from fire, wind or ice maintained the woodland structure and diverse ground flora species. Long disturbance-free periods allowed an increase in both the density of trees and the abundance of shade tolerant species. Two community phases are recognized in the reference state, with shifts between phases based on disturbance frequency. This reference state is uncommon today. Some sites have been converted to grassland (State 4). Others have been subject to repeated, high-graded timber harvest coupled with domestic livestock grazing (State 5). Fire suppression has resulted in increased canopy density, which has affected the abundance and diversity of ground flora. Many reference sites have been managed for timber harvest, resulting in either even-age (State 2) or uneven-age (State 3) woodlands.

Community 1.1
Black Oak – White Oak/ Blueberry/ Virginia Wildrye – Pennsylvania Sedge

Forest overstory. Forest Overstory Species list is based on field reconnaissance as well as commonly occurring species listed in Nelson 2010; names and symbols are from USDA PLANTS database.

Forest understory. Forest Understory Species list is based on field reconnaissance as well as commonly occurring species listed in Nelson 2010; names and symbols are from USDA PLANTS database.

Community 1.2
Black Oak – White Oak/ Hickory Saplings – Blueberry/ Virginia Wildrye – Pennsylvania Sedge

Pathway P1.1A
Community 1.1 to 1.2

No disturbances (10+ years)

Pathway P1.2A
Community 1.2 to 1.1

Disturbances (fire, wind, ice) < 10 years

State 2
Even-Age Managed Woodland

These former woodlands are now rather dense, with an under developed understory and ground flora. Thinning can increase overall tree vigor and improve understory diversity. Continual timber management, depending on the practices used, will either maintain this state, or convert the site to Uneven-age Managed (state 3) woodlands.

Dominant resource concerns

- Plant productivity and health
- Plant structure and composition
- Wildfire hazard from biomass accumulation
- Terrestrial habitat for wildlife and invertebrates

Community 2.1
Black Oak – White Oak – Hickory /Fragrant Sumac

State 3
Uneven-Age Managed Woodland

Composition and age are altered from the reference state depending on tree selection during harvest. In addition, without a regular 15 to 20 year harvest re-entry into these stands and use of prescribed fire, they will slowly increase in more shade tolerant species such as hickory, and white oak will become less dominant.

Dominant resource concerns

- Plant productivity and health
- Plant structure and composition
- Wildfire hazard from biomass accumulation
- Terrestrial habitat for wildlife and invertebrates

Community 3.1
Black Oak – Hickory/Sassafras/ Hairy Woodland Brome

State 4
Grassland

Conversion of woodlands to planted, non-native pasture species such as tall fescue has been common in this MLRA. If grazing and active pasture management is discontinued, the site will eventually transition to State 2.

Community 4.1
Tall Fescue - Red Clover

Dominant resource concerns

- Plant structure and composition
- Terrestrial habitat for wildlife and invertebrates

Community 4.2
Tall fescue - Broomsedge/Oak Sprouts

Dominant resource concerns

- Ephemeral gully erosion
- Nutrients transported to surface water
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance

Pathway P4.1A
Community 4.1 to 4.2

Over grazing; no fertilization

Pathway P4.2A
Community 4.2 to 4.1

Brush management; grassland seeding; grassland management

State 5
High-Graded Grazed Woodland

Ecological sites subjected to repeated, high-graded timber harvests and uncontrolled domestic grazing transition to this State. This state exhibits an over-abundance of hickory and other less desirable tree species, and weedy understory species such as coralberry, gooseberry, poison ivy and Virginia creeper. The vegetation offers little nutritional value for cattle, and excessive stocking damages tree boles, degrades understory species composition and results in soil compaction and accelerated erosion and runoff. Exclusion of livestock from sites in this state coupled with uneven-age management techniques will cause a transition to State 3.

Dominant resource concerns

- Ephemeral gully erosion
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Wildfire hazard from biomass accumulation
- Terrestrial habitat for wildlife and invertebrates

Community 5.1
Black Oak-Hickory/Sassafras/Buckbrush

Transition T1A
State 1 to 2

Even-aged management; fire suppression

Transition T1B
State 1 to 3

Fire suppression; uneven-age management

Transition T1C
State 1 to 4

Clearing; grassland planting; grassland management

Transition T1D
State 1 to 5

Poorly planned harvest; uncontrolled grazing

Restoration pathway R1B
State 2 to 1

Prescribed fire; extended rotations; forest stand improvement

Transition T2A
State 2 to 3

Uneven-age management

Restoration pathway R1A
State 3 to 1

Prescribed fire; extended rotations; forest stand improvement

Transition T3A
State 3 to 2

Even-age management

Transition T4A
State 4 to 2

Tree planting; long-term succession; no grazing

Transition T5B

State 5 to 3

Uneven-age management; no grazing; forest stand improvement

Transition T5A
State 5 to 4

Clearing; grassland planting; grassland management

Additional community tables

Table 5. Community 1.1 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	–	30–40	–	–
black oak	QUVE	*Quercus velutina*	Native	–	30–40	–	–
mockernut hickory	CATO6	*Carya tomentosa*	Native	–	10–20	–	–
shagbark hickory	CAOV2	*Carya ovata*	Native	–	10–20	–	–
sassafras	SAAL5	*Sassafras albidum*	Native	–	5–10	–	–

Table 6. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
eastern star sedge	CARA8	*Carex radiata*	Native	–	5–20
rock muhly	MUSO	*Muhlenbergia sobolifera*	Native	–	5–20
little bluestem	SCSC	*Schizachyrium scoparium*	Native	–	5–20
big bluestem	ANGE	*Andropogon gerardii*	Native	–	5–20
Virginia wildrye	ELVI3	*Elymus virginicus*	Native	–	5–20
parasol sedge	CAUM4	*Carex umbellata*	Native	–	5–20
hairy woodland brome	BRPU6	*Bromus pubescens*	Native	–	5–20
eastern bottlebrush grass	ELHY	*Elymus hystrix*	Native	–	5–20
Pennsylvania sedge	CAPE6	*Carex pensylvanica*	Native	–	5–20
broadleaf rosette grass	DILA8	*Dichanthelium latifolium*	Native	–	5–20
Forb/Herb					
elmleaf goldenrod	SOUL2	*Solidago ulmifolia*	Native	–	5–10
elmleaf goldenrod	SOUL2	*Solidago ulmifolia*	Native	–	5–10
nakedflower ticktrefoil	DENU4	*Desmodium nudiflorum*	Native	–	5–10
wild quinine	PAIN3	*Parthenium integrifolium*	Native	–	5–10
fourleaf milkweed	ASQU	*Asclepias quadrifolia*	Native	–	5–10
eastern purple coneflower	ECPU	*Echinacea purpurea*	Native	–	5–10
slender lespedeza	LEVI7	*Lespedeza virginica*	Native	–	5–10
Canadian blacksnakeroot	SACA15	*Sanicula canadensis*	Native	–	5–10
violet lespedeza	LEVI6	*Lespedeza violacea*	Native	–	5–10
hairy sunflower	HEHI2	*Helianthus hirsutus*	Native	–	5–10
smooth blue aster	SYLAL3	*Symphyotrichum laeve var. laeve*	Native	–	5–10
Shrub/Subshrub					
fragrant sumac	RHAR4	*Rhus aromatica*	Native	–	5–20
lowbush blueberry	VAAN	*Vaccinium angustifolium*	Native	–	5–20
farkleberry	VAAR	*Vaccinium arboreum*	Native	–	5–20
Tree					
common serviceberry	AMAR3	*Amelanchier arborea*	Native	–	5–20
flowering dogwood	COFL2	*Cornus florida*	Native	–	5–20

Animal community

Wildlife (MDC 2006):
Hard mast from the oaks, soft mast from shrubs, high nutrition seeds and forage is abundant in this ecological site. These food values and the two-tiered structure are attractive to abundant wildlife.

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.

Bird species associated with this ecological site include Red-headed Woodpecker, Eastern Wood-Pewee, Broad-winged Hawk, Great-Crested Flycatcher, Summer Tanager, Red-eyed Vireo, and Yellow-billed Cuckoo.

Amphibians and reptiles associated with ecological site include tiger salamander, small-mouthed salamander, ornate box turtle, northern fence lizard, five-lined skink, broad-headed skink, flat-headed snake, and rough earth snake.

Other information

Forestry (NRCS 2002; 2014)
Management: Estimated site index values range from 55 to 65 for oak. 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 1 acre are other options that can be used if clear cutting is not desired or warranted. Uneven-aged management will slowly cause an increase in more shade tolerant species such as sugar maple. Using prescribed fire as a management tool could have a negative impact on timber quality or should be used with caution on a particular site if timber management is the primary objective.

Limitations: No major equipment restrictions or limitations exist. Erosion is a hazard when slopes exceed 15 percent. On steep slopes greater than 35 percent, traction problems increase and equipment use is not recommended.

Inventory data references

Potential Reference Sites: Dry Footslope Woodland

No quality reference sites are known to exist

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Contributors

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Approval

Nels Barrett, 10/07/2020

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Missouri Department of Conservation and Missouri Department of Natural Resources personnel provided significant and helpful field and technical support in the development of this ecological site.

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	
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Approved by	Nels Barrett
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:**

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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):**

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:**
