USDA Natural Resources
Conservation Service

Ecological site F116AY023MO
Low-Base Sandstone Upland Woodland

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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.

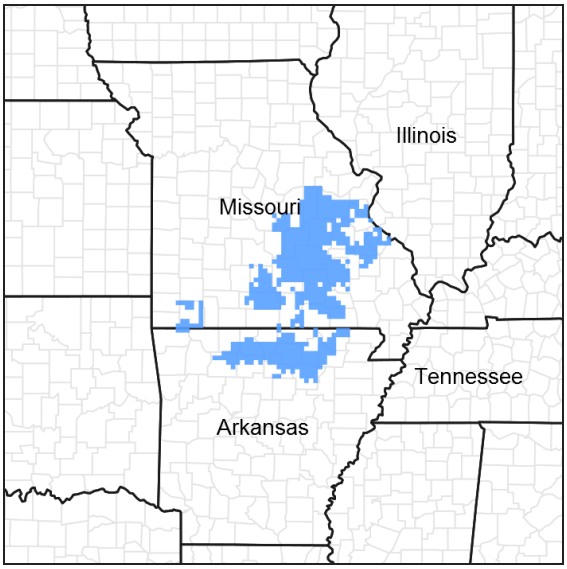


Figure 1. Mapped extent

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): 116A–Ozark Highland

The Ozark Highland constitutes the Salem Plateau of the Ozark Uplift. Elevation ranges from about 300 feet on the southeast edge of the Ozark escarpment, to about 1,600 feet in the west, adjacent to the Burlington Escarpment of the Springfield Plateau. The underlying bedrock is mainly horizontally bedded Ordovician-aged dolomites and sandstones that dip gently away from the uplift apex in southeast Missouri. Cambrian dolomites are exposed on deeply dissected hillslopes. In some places, Pennsylvanian and Mississipian sediments overlie the plateau. Relief varies, from the gently rolling central plateau areas to deeply dissected hillslopes associated with drainageways such as the Buffalo, Current, Eleven Point and White Rivers.

Classification relationships

Terrestrial Natural Community Type in Missouri (Nelson, 2010):
The reference state for this ecological site is most similar to a Dry Sandstone Woodland.

Missouri Department of Conservation Forest and Woodland Communities (MDC, 2006):
The reference state for this ecological site is most similar to a Mixed Oak Woodland, or a Pine Oak Woodland in the historic pine range.

National Vegetation Classification System Vegetation Association (NatureServe, 2010):
The reference state for this ecological site is most similar to a Quercus alba - Quercus stellata - Quercus velutina / Schizachyrium scoparium Woodland (CEGL002150).

Geographic relationship to the Missouri Ecological Classification System (Nigh & Schroeder, 2002):
This ecological site is widespread across the Ozark Highlands Section.

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”.

Low-base Sandstone Upland Woodlands occur primarily in the north-central Ozark Highland, and are associated with the sandstone component of the Ordovician-aged Roubidoux formation. Soils are typically moderately deep over sandstone bedrock, acidic, and low in bases such as calcium, with an abundance of sandstone fragments. The reference plant community is woodland with an overstory dominated by post oak, black oak, scarlet oak, and white oak, with shortleaf pine in the historic pine range, and a ground flora of native grasses and forbs.

Associated sites

F116AY004MO	**Fragipan Upland Woodland** Fragipan Upland Woodlands are upslope on summits where a fragipan is present in the subsoil.
F116AY007MO	**Low-Base Loamy Upland Woodland** Low-base Loamy Upland Woodlands are upslope on summits and shoulders.
F116AY037MO	**Gravelly/Loamy Upland Drainageway Forest** Gravelly/Loamy Upland Drainageway Forests are often downslope.
F116AY045MO	**Low-Base Sandstone Protected Backslope Woodland** Low-base Sandstone Protected Backslope Woodlands are downslope, on steep lower backslopes with northern to eastern aspects.
F116AY053MO	**Low-Base Sandstone Exposed Backslope Woodland** Low-base Sandstone Exposed Backslope Woodlands are downslope, on steep lower backslopes with southern to western aspects.
R116AY027MO	**Shallow Sandstone Upland Glade/Woodland** Shallow Sandstone Upland Glade/Woodlands are adjacent, often downslope.

Similar sites

F116AY007MO	**Low-Base Loamy Upland Woodland** Low-base Loamy Upland Woodlands are similar landforms but are more productive.

Table 1. Dominant plant species

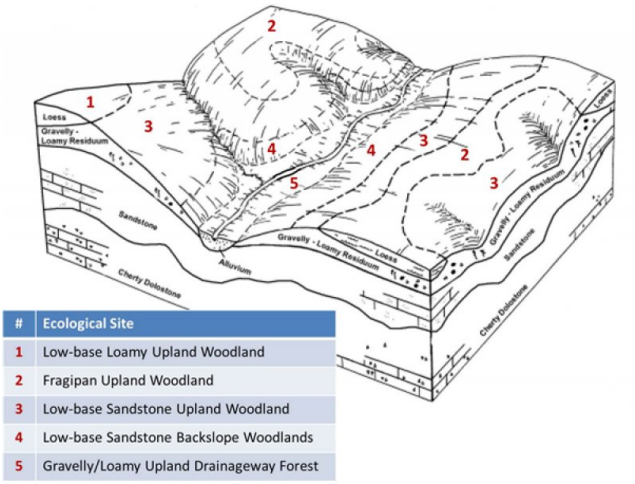
Tree	(1) *Quercus velutina* (2) *Pinus echinata*
Shrub	(1) *Vaccinium* (2) *Rhus aromatica*
Herbaceous	(1) *Schizachyrium scoparium*

Physiographic features

This site is on upland summits, shoulders and backslopes with slopes of 3 to 15 percent. The site generates runoff to adjacent, downslope ecological sites. This site does not flood.

The following figure (adapted from Skaer and Cook, 2005) shows the typical landscape position of this ecological site, and landscape relationships with other ecological sites. It is within the area labeled “3” on the figure. Low-base

Loamy Upland Woodland sites or Fragipan Upland Woodland sites are typically upslope, as shown in the figure, and Low-base Sandstone Backslope sites are often downslope.



#	Ecological Site
1	Low-base Loamy Upland Woodland
2	Fragipan Upland Woodland
3	Low-base Sandstone Upland Woodland
4	Low-base Sandstone Backslope Woodlands
5	Gravelly/Loamy Upland Drainageway Forest

Figure 2. Landscape relationships for this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Ridge (2) Hill (3) Interfluve
Flooding frequency	None
Ponding frequency	None
Slope	3–15%
Water table depth	152 cm
Aspect	Aspect is not a significant factor

Climatic features

The Ozark Highland 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 Ozark Highland experiences regional differences in climates, but these differences do not have obvious geographic boundaries. Regional climates grade inconspicuously into each other. The basic gradient for most climatic characteristics is along a line crossing the MLRA from northwest to southeast.
The average annual precipitation in almost all of this area is 38 to 45 inches. Snow falls nearly every winter, but the snow cover lasts for only a few days. The average annual temperature is about 53 to 60 degrees F. The lower temperatures occur at the higher elevations in the western part of the MLRA. Mean January minimum temperature follows a stronger north-to-south gradient. However, mean July maximum temperature shows hardly any geographic variation in the MLRA. Mean July maximum temperatures have a range of only two or three degrees across the area.

Mean annual precipitation varies along a northwest to southeast 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)	148-167 days
Freeze-free period (characteristic range)	179-193 days
Precipitation total (characteristic range)	1,194-1,245 mm
Frost-free period (actual range)	147-177 days
Freeze-free period (actual range)	178-204 days
Precipitation total (actual range)	1,143-1,270 mm
Frost-free period (average)	159 days
Freeze-free period (average)	187 days
Precipitation total (average)	1,219 mm

Climate stations used

- (1) EVENING SHADE 1 NNE [USC00032366], Evening Shade, AR
- (2) ALTON 6 SE [USC00230127], Alton, MO
- (3) GILBERT [USC00032794], Saint Joe, AR
- (4) ROLLA UNI OF MISSOURI [USC00237263], Rolla, MO

Influencing water features

The site generates runoff to adjacent, downslope ecological sites. This site does not flood.
The water features of this upland ecological site include evapotranspiration, surface runoff, and drainage. Each water balance component fluctuates to varying extents from year-to-year. Evapotranspiration remains the most constant. Precipitation and drainage are highly variable between years. Seasonal variability differs for each water component. Precipitation generally occurs as single day events. Evapotranspiration is lowest in the winter and peaks in the summer. Water stored as ice and snow decreases drainage and surface runoff rates throughout the winter and increases these fluxes in the spring. The surface runoff pulse is greatly influenced by extreme events. Conversion to cropland or other high intensities land uses tends to increase runoff, but also decreases evapotranspiration. Depending on the situation, this might increase groundwater discharge, and decrease baseflow in receiving streams.

Soil features

These soils are underlain with sandstone bedrock at 20 to over 60 inches deep. They have acidic subsoils that are low in bases. The soils were formed under woodland vegetation, and have thin, light-colored surface horizons. Parent material is slope alluvium and residuum weathered from sandstone, overlying sandstone bedrock. They have sandy loam or loam surface layers, with high amounts of sandstone gravel and cobbles. Subsoils are loamy and are skeletal, with high amounts of sandstone fragments. A few areas formed in colluvium and loess, and are not skeletal. These soils are not affected by seasonal wetness. Soil series associated with this site include Bender, Coulstone, and Lily.

The accompanying picture of the Bender series shows a thin, light-colored surface horizon over a brown loamy subsoil with abundant sandstone fragments. Sandstone bedrock is at 36 inches in this picture. Scale is in inches. Picture courtesy of John Preston, NRCS.

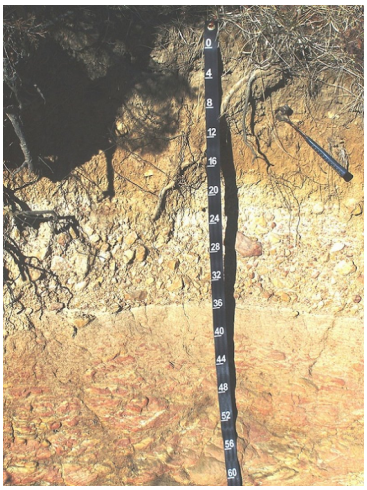


Figure 9. Bender series

Table 4. Representative soil features

Parent material	(1) Slope alluvium–sandstone (2) Residuum–sandstone
Surface texture	(1) Very cobbly fine sandy loam (2) Gravelly loam (3) Very gravelly sandy loam
Family particle size	(1) Loamy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Slow
Soil depth	51–183 cm
Surface fragment cover <=3"	3–33%
Surface fragment cover >3"	0–38%
Available water capacity (0-101.6cm)	5.08–15.24 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)	3.5–5.5

Subsurface fragment volume <=3" (Depth not specified)	0–40%
Subsurface fragment volume >3" (Depth not specified)	0–40%

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.

Historically, Low-Base Sandstone Upland Woodlands were dominated by drought and fire-tolerant trees such as black oak1, post oak and shortleaf pine. Species composition and structure of the reference plant community varied for this ecological site based on its relative location to the Ozark Highlands historic native shortleaf pine range. Fragmentary evidence from old records indicate that the original timber stands in the Ozark Highlands contained a large volume of shortleaf pine on relatively few, concentrated areas, (green area on adjacent map) but a relatively small volume of shortleaf pine on extensive areas (cross-hatched area on map) (Fletcher and McDermott, 1957). Because of this situation, this ecological site is classified into two community phases. When the ecological site occurs outside of the historic native pine range, the community phase expressed is a well-developed Oak Woodland dominated by an overstory of black oak and post oak. Within the historic native pine range, the community phase is characterized as Oak-Pine Woodland, with shortleaf pine as a common overstory species. Extreme soil chert, low soil bases and complicated landscape complexes are unifying soil features of these rather divergent community phases. Woodlands are distinguished from forests by their relatively open understory and the presence of sun-loving ground flora species.

Fire played an important role in the maintenance of these community phases. Their high, flat landscape positions likely supported a high fire frequency of every 3 to 5 years on the edge of the central plateau to over 10 years on ridges in the river breaks. These periodic fires would have kept woodlands open, removed the litter, and stimulated the growth and flowering of the native grasses and forbs. During fire free intervals, woody species would have increased and the herbaceous understory diminished. But historically, the return of fire would have opened the woodlands up again and stimulated an increase in the ground flora. Grazing by large native herbivores, such as bison, elk, and white-tailed deer, also influenced the understory, keeping it more open and structurally diverse. The high, droughty landscape position of Low-Base Sandstone Upland Woodlands limited the growth of trees and supported an abundance of native grasses and forbs in the understory. These woodlands ranged from open park-like woodlands on the highest, most exposed landscape positions to more closed woodlands in more dissected topography.

The Oak Woodland phase of Low-Base Sandstone Upland Woodland is a woodland with a moderately developed canopy (55 to 70 feet tall and 60 to 80 percent canopy closure) dominated by post oak along with black oak, scarlet oak, and white oak. Increased light from the more open canopy causes a diversity of ground flora species to flourish. Within the historical native pine range this ecological site contained drought and fire-tolerant shortleaf pine, with occasional to frequent black oak and post oak. These oak-pine woodlands ranged from open park-like woodlands to more closed woodlands. Canopy closure likely varied from 40 to 80 percent and tree height from 70 to 100 feet. Native prairie grasses dominated the open understory, along with a diverse mix of native legumes, asters, sunflowers and other forbs. Most of this oak-pine community was cleared by extensive logging around 1890 to 1920. Consequently, persistent sprouting of oak species, especially black and scarlet oak, replaced the pine.

Today, dense, even age stands of oak have replaced much of this community. Most occurrences today exhibit canopy closure of 80 to 100 percent with a greatly diminished ground flora. In the long term absence of fire, woody species, especially scarlet oak, hickory, and black oak have increased in these woodlands. Once established, these woodies can quickly fill the woodland system.

Uncontrolled domestic grazing is also impacting these communities, further diminishing the diversity of native plants

and introducing invasive species that are tolerant of grazing, such as coralberry, gooseberry, Virginia creeper. Grazed sites also have a more open understory. In addition, soil compaction and soil loss from grazing can lower site productivity.

These ecological sites are marginally productive. Some areas have been cleared for non-native pasture, but many areas have been repeatedly logged and high graded. Maintenance of the oak component will require disturbances that encourage more sun adapted species and reduce shading effects. 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. Removal of the younger understory and the application of prescribed fire have proven to be effective management applications.

Despite the widespread removal of shortleaf pine from this system, there are many areas with some pine present on this ecological site. Where present, selective cutting and prescribed fire can help recruit shortleaf pine, restore the more open structure, and increase the diversity of ground flora species.

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

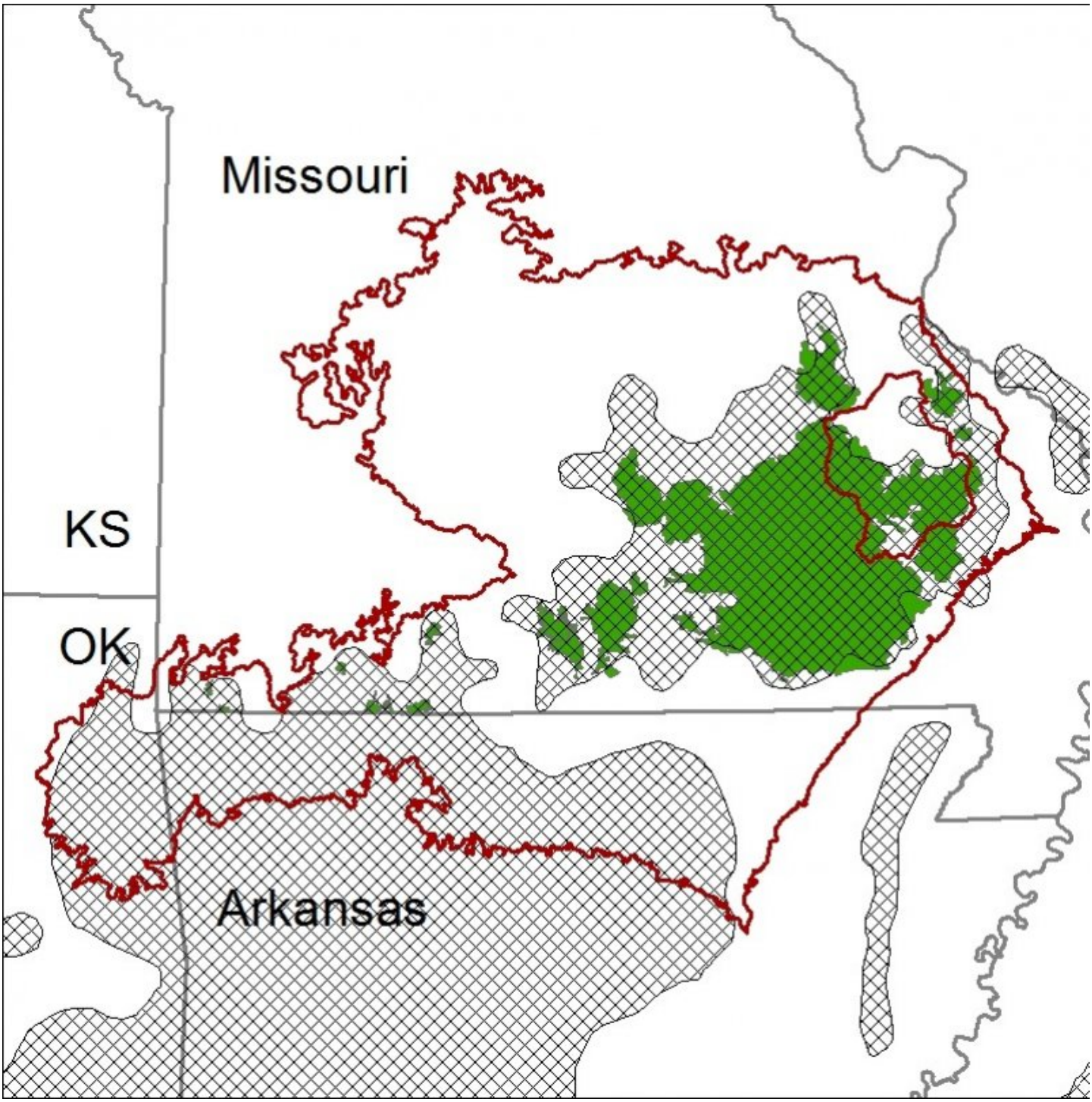
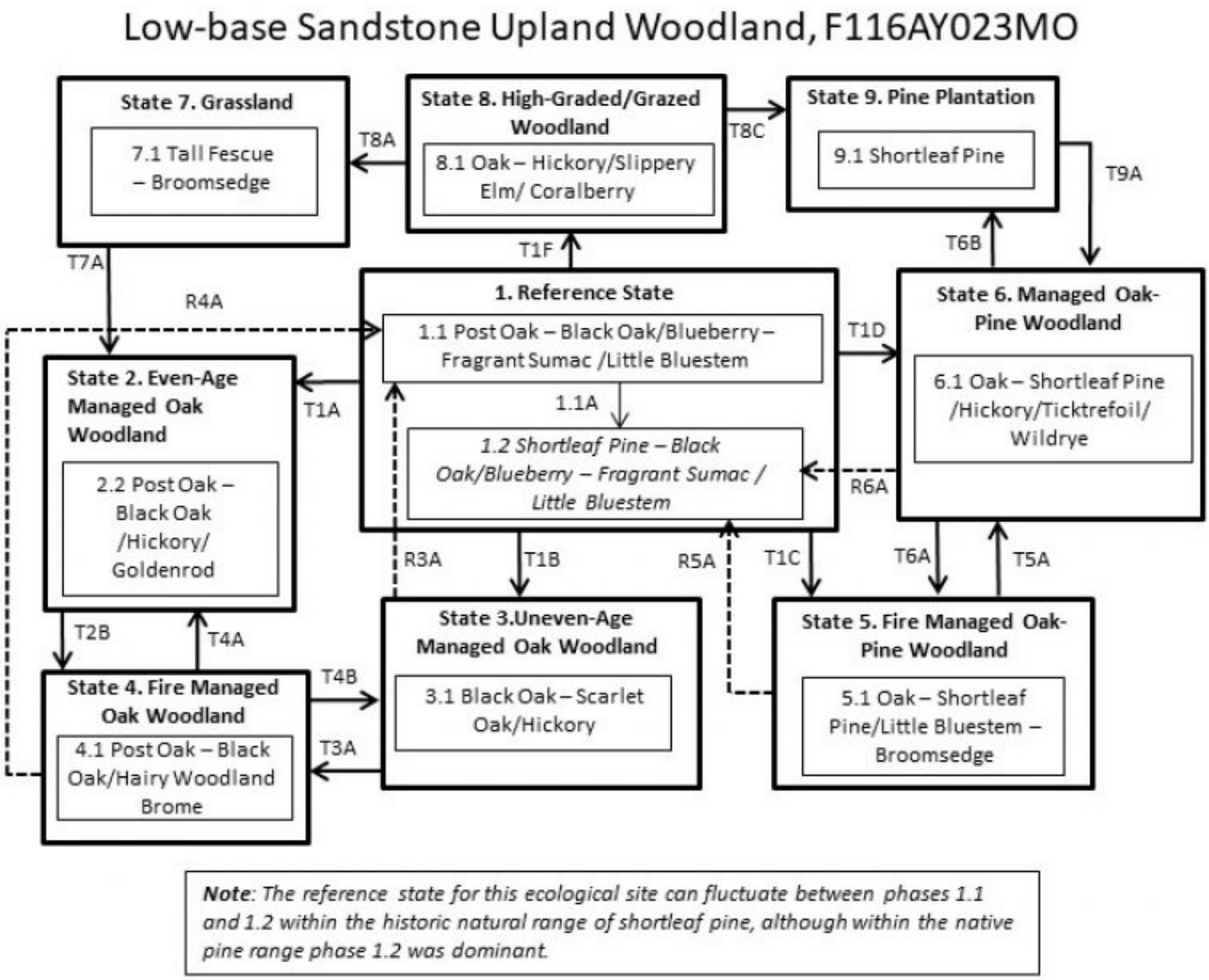


Figure 10. Range map with cross-hatching showing the historic distribution of shortleaf pine in the Midwest. Green shading show areas where shortleaf pine was a dominate overstory species.



***Note**: The reference state for this ecological site can fluctuate between phases 1.1 and 1.2 within the historic natural range of shortleaf pine, although within the native pine range phase 1.2 was dominant.*

Code	Event/Activity
T1A	Pines absent; fire suppression; even-age management
T1B, T4B	Pines absent; fire suppression; uneven-age management
T1C	Within native pine range; prescribed fire; managed harvests
T1D	Within native pine range; fire suppression; managed harvests
T1F	Poorly planned harvest (high grading); uncontrolled grazing; fire suppression
T2B, T3A, T6A	Thinning; prescribed fire; managed harvests
T2A	Uneven-age management
T4A, T5A	Fire suppression; managed harvests
T7A	Tree planting; long-term succession (+50-60 years)
T8C, T6B	Clearing and conversion to pine plantation
T8A	Clearing ; pasture planting; prescribed grazing
T9A	Thinning; allow oak sprouting; fire suppression
R4A	Forest stand improvement; extended rotations; prescribed fire
R3A, R5A, R6A	Prescribed fire; uneven-age management; extended rotations
1.1A	Within native pine range

Figure 11. State and Transition Model for this ecological site.

State 1
Reference State

The reference state for this ecological site was old growth oak or oak-pine woodland. The reference state was dominated by black oak, post oak and scarlet oak or with shortleaf pine as a common overstory component within the Ozark historic shortleaf pine range. 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 geographic location. The reference state for this ecological site can fluctuate between phases. Within the native shortleaf pine range phase 1.2 was dominant.

Community 1.1
Post Oak – Black Oak/Blueberry – Fragrant Sumac /Little Bluestem

Figure 12. Reference state at Bona Glade Natural Area, USCOE, Dade County, Missouri; photo credit Doug Wallace, NRCS

Two community phases are recognized in the reference state, with shifts between phases based on geographic location. The reference state for this ecological site can fluctuate between phases 1.1, and phase 1.2. Within the native pine range, phase 1.2 was dominant.

Forest overstory. Forest Overstory Composition based on Nelson (2010) and field surveys.

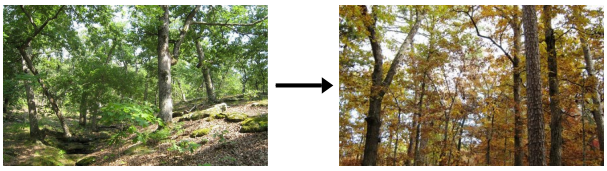
Forest understory. Forest Understory Composition based on Nelson (2010) and field surveys.

Community 1.2
Shortleaf Pine – Black Oak/Blueberry – Fragrant Sumac /Little Bluestem

Figure 13. Phase 1.2 reference state at Peter A. Eck Conservation Area, Texas County, Missouri; photo credit MDC.

Two community phases are recognized in the reference state, with shifts between phases based on geographic location. The reference state for this ecological site can fluctuate between phases 1.1, and phase 1.2. Within the native pine range, phase 1.2 was dominant.

Pathway P1.1A
Community 1.1 to 1.2



Post Oak – Black Oak/Blueberry – Fragrant Sumac /Little Bluestem

Shortleaf Pine – Black Oak/Blueberry – Fragrant Sumac /Little Bluestem

This pathway is the result of being within native shortleaf pine range.

State 2
Even-Age Managed Oak Woodland

Where all of the shortleaf pine was removed, this system became dominated by oak. This state starts with a sequence of early seral mixed oak woodlands, which mature over time. These woodlands tend to be rather dense, with a sparse understory and ground flora. Thinning can increase overall tree vigor and improve understory diversity. However, in the absence of fire, the diversity and cover of the ground flora is still diminished. Prescribed fire without extensive timber harvest will, over time, cause a transition to Fire Managed Oak Woodland (State 4).

Community 2.1
Post Oak - Black Oak/Hickory/Goldenrod

State 3
Uneven-Age Managed Oak Woodland

Where pine was removed from the system, but uneven-age management was applied, this system became dominated by oak. Composition is likely altered from the reference state depending on tree selection during harvest. Scarlet oak is often more abundant than historically. In addition, without a regular 15 to 20 year harvest re-entry into these stands, they will slowly increase in more shade tolerant species and white oak will become less dominant. Without periodic disturbance, stem density and fire intolerant species, like hickory, increase in abundance.

Community 3.1
Black Oak - Scarlet Oak/Hickory Saplings

State 4
Fire Managed Oak Woodland

Where pine was removed from the system, the Fire Managed Oak Woodland State will result from managing woodland communities from States 2 or 3 with prescribed fire. This state can resemble phase 1.1 of the reference state, but with younger maximum tree ages and lower ground flora diversity.

Community 4.1
Post Oak – Black Oak/Hairy Woodland Brome

State 5
Fire Managed Oak - Pine Woodland

Where some shortleaf pine remained after initial harvest, this state may occur. The Fire Managed Oak-Pine Woodland State results from managing State 6 with selective thinning and prescribed fire. A more open structure with abundant ground flora can be restored. But without planting or seeding of pine, they will not return to the reference state. In addition, it will take time to recover older maximum tree ages and ground flora diversity and cover.

Community 5.1
Oak – Shortleaf Pine/Little Bluestem – Broomsedge

State 6
Managed Oak-Pine Woodland

Where some shortleaf pine remained after initial harvest, the Managed Oak-Pine Woodland State may occur. While mature pines let more light to the ground than oak, these even-aged woodlands tend to be rather dense, with a depauperate understory and ground flora due to an increase in oak and hickory densities. Thinning can increase overall tree vigor and improve understory diversity. However, in the absence of fire, the diversity and cover of the ground flora is still diminished. A return to the phase 1.2 of the reference state will require prescribed fire along with no harvest or long rotations to restore uneven-age structure and pine densities and increase maximum tree age.

Community 6.1
Oak – Shortleaf Pine /Hickory/Ticktrefoil/ Wildrye

State 7
Grassland

Conversion of woodlands to non-native cool season grassland species such as tall fescue has been common. Low available water, abundant surface fragments, low organic matter contents and soil acidity make non-native grasslands difficult to maintain in a healthy, productive state on this ecological site. Occasionally, these pastures will have scattered patches of tall, mature pine. If grazing and pasture management is discontinued, oak sprouts will occur and the site will eventually transition to State 2. Forest stand improvement and tree planting practices can hasten this process.

Community 7.1
Tall Fescue-Broomsedge

State 8
High-Graded/Grazed Woodland

Ecological sites subjected to repeated, high-grading 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. This state can be transitioned to a grassland state through clearing and grassland planting or to a pine plantation through clearing, tree planting and fire control.

Community 8.1
Oak – Hickory/Slippery Elm/Coralberry

State 9
Pine Plantation

Many areas were planted to plantations of shortleaf pine from the 1940s to the early 1960s. They are now mature plantations that are usually a monoculture of a dense pine overstory with a brushy understory of oak and hickory and a dense carpet of shortleaf pine needles on the ground. They lack the diversity and structure. Restoration to phase 1.2 of the reference state is a long-term prospect, requiring extensive thinning, long-term prescribed fire, and planting of native ground flora species.

Community 9.1
Shortleaf Pine

Transition T1A
State 1 to 2

This transition typically results from even-age timber management practices, such as clear-cut, seed tree or shelterwood harvest.

Transition T1B
State 1 to 3

This transition typically results from uneven-age timber management practices, such as single tree or group selection harvest.

Transition T1C
State 1 to 5

This transition is the result of clearing the woodland community and planting pasture species. Soil erosion can be extensive in this process, along with loss of organic matter. Liming and fertilizing associated with pasture management typically raises the soil pH and increases the cation concentration (such as calcium and magnesium) of the upper soil horizons.

Transition T1D
State 1 to 6

This transition is the result of poorly planned timber harvest techniques such as high-grading, accompanied by unmanaged cattle grazing. Soil erosion and compaction often result from cattle grazing after the understory has been damaged.

Transition T1F
State 1 to 8

Ecological sites subjected to repeated, high-grading timber harvests and uncontrolled domestic grazing transition to this state.

Restoration pathway R2A
State 2 to 1

Restoration activities include prescribed fire, forest stand improvement, and extended rotations.

Transition T2B
State 2 to 4

This transition is the result of the systematic application of prescribed fire. Mechanical thinning may also be used.

Restoration pathway R3A
State 3 to 1

Restoration activities include prescribed fire, forest stand improvement, and extended rotations.

Transition T3A
State 3 to 4

This transition typically results from even-age timber management practices, such as clear-cut, seed tree or shelterwood harvest.

Transition T4A
State 4 to 2

This transition typically results from even-age timber management practices, such as clear-cut, seed tree or shelterwood harvest.

Transition T4B
State 4 to 3

This transition typically results from uneven-age timber management practices, such as single tree or group selection harvest.

Restoration pathway R5A
State 5 to 1

Restoration activities include forest stand improvement, extended rotations and prescribed fire.

Transition T5A
State 5 to 6

Restoration activities include fire suppression and managed harvests.

Restoration pathway R6A
State 6 to 1

Restoration activities include forest stand improvement, extended rotations and prescribed fire.

Transition T6A
State 6 to 5

This transition is the result of the systematic application of prescribed fire. Mechanical thinning may also be necessary along with extended rotations.

Transition T6B
State 6 to 9

This transition typically results from selective oak removal, maintaining existing pine, and pine planting.

Transition T7A
State 7 to 2

Transition activities include fire suppression, tree planting, longterm succession (+50 to 60 years).

Transition T8A
State 8 to 7

This state can be transitioned to a grassland state through clearing and grassland planting.

Transition T8C
State 8 to 9

This state can be transitioned to a pine plantation through clearing, tree planting and fire control.

Transition T9A
State 9 to 6

This state will trasnsition by thinning, allowing oak sprouting and fire suppression from a mature plantation that is usually a monoculture of a dense pine overstory with a brush understory of oak and hickory.

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							
post oak	QUST	*Quercus stellata*	Native	–	–	–	–
black oak	QUVE	*Quercus velutina*	Native	–	–	–	–
black hickory	CATE9	*Carya texana*	Native	–	–	–	–
red maple	ACRU	*Acer rubrum*	Native	–	–	–	–
white oak	QUAL	*Quercus alba*	Native	–	–	–	–
scarlet oak	QUCO2	*Quercus coccinea*	Native	–	–	–	–
shortleaf pine	PIEC2	*Pinus echinata*	Native	–	–	–	–
pignut hickory	CAGL8	*Carya glabra*	Native	–	–	–	–

Table 6. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	–	–
fuzzy wuzzy sedge	CAHI6	*Carex hirsutella*	Native	–	–
Muhlenberg's sedge	CAMU4	*Carex muehlenbergii*	Native	–	–
poverty oatgrass	DASP2	*Danthonia spicata*	Native	–	–

poverty oatgrass	DACH2	*Danthonia spicata*	Native	–	–
Virginia wildrye	ELVI3	*Elymus virginicus*	Native	–	–
big bluestem	ANGE	*Andropogon gerardii*	Native	–	–
Indiangrass	SONU2	*Sorghastrum nutans*	Native	–	–
slimleaf panicgrass	DILI2	*Dichanthelium linearifolium*	Native	–	–
broomsedge bluestem	ANVI2	*Andropogon virginicus*	Native	–	–
black edge sedge	CANI3	*Carex nigromarginata*	Native	–	–
hairy woodland brome	BRPU6	*Bromus pubescens*	Native	–	–
Forb/Herb					
woman's tobacco	ANPL	*Antennaria plantaginifolia*	Native	–	–
sawtooth sunflower	HEGR4	*Helianthus grosseserratus*	Native	–	–
sidebeak pencilflower	STBI2	*Stylosanthes biflora*	Native	–	–
prostrate ticktrefoil	DERO3	*Desmodium rotundifolium*	Native	–	–
flaxleaf whitetop aster	IOLI2	*Ionactis linariifolius*	Native	–	–
American ipecac	GIST5	*Gillenia stipulata*	Native	–	–
smooth violet prairie aster	SYTU2	*Symphyotrichum turbinellum*	Native	–	–
downy ragged goldenrod	SOPE	*Solidago petiolaris*	Native	–	–
wild quinine	PAIN3	*Parthenium integrifolium*	Native	–	–
trailing lespedeza	LEPR	*Lespedeza procumbens*	Native	–	–
queendevil	HIGR3	*Hieracium gronovii*	Native	–	–
fourleaf milkweed	ASQU	*Asclepias quadrifolia*	Native	–	–
pointedleaf ticktrefoil	DEGL5	*Desmodium glutinosum*	Native	–	–
nakedflower ticktrefoil	DENU4	*Desmodium nudiflorum*	Native	–	–
smooth small-leaf ticktrefoil	DEMA2	*Desmodium marilandicum*	Native	–	–
panicledleaf ticktrefoil	DEPA6	*Desmodium paniculatum*	Native	–	–
Virginia spiderwort	TRVI	*Tradescantia virginiana*	Native	–	–
late purple aster	SYPA11	*Symphyotrichum patens*	Native	–	–
eastern beebalm	MOBR2	*Monarda bradburiana*	Native	–	–
Sampson's snakeroot	ORPE	*Orbexilum pedunculatum*	Native	–	–
hairy goldenrod	SOHI	*Solidago hispida*	Native	–	–
manyray aster	SYAN2	*Symphyotrichum anomalum*	Native	–	–
gravelweed	VEHE	*Verbesina helianthoides*	Native	–	–
birdfoot violet	VIPE	*Viola pedata*	Native	–	–
Shrub/Subshrub					
American hazelnut	COAM3	*Corylus americana*	Native	–	–
St. Andrew's cross	HYHY	*Hypericum hypericoides*	Native	–	–
fragrant sumac	RHAR4	*Rhus aromatica*	Native	–	–
Blue Ridge blueberry	VAPA4	*Vaccinium pallidum*	Native	–	–
farkleberry	VAAR	*Vaccinium arboreum*	Native	–	–
deerberry	VAST	*Vaccinium stamineum*	Native	–	–
yellow honeysuckle	LOFL	*Lonicera flava*	Native	–	–
Tree					
common serviceberry	AMAR3	*Amelanchier arborea*	Native	–	–
sassafras	SAAL5	*Sassafras albidum*	Native	–	–

Animal community

Wildlife (MDC 2006):

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.

Oaks provide abundant hard mast; scattered shrubs provide soft mast; native legumes provide high-quality wildlife food.

Sedges and native cool-season grasses provide green browse.

Post-burn areas can provide temporary bare-ground – herbaceous cover habitat important for turkey poults and quail chicks.

Bird species associated with mid- to late successional oak dominated woodlands are Indigo Bunting, Red-headed Woodpecker, Eastern Bluebird, Northern Bobwhite, Summer Tanager, Eastern Wood-Pewee, Whip-poor-will, Chuck-will's widow, Red-eyed Vireo, Rose-breasted Grosbeak, Yellow-billed Cuckoo, and Broad-winged Hawk.

Bird species associated with Pine Woodlands are Carolina Chickadee, Great Crested Flycatcher, Pine Warbler, White-breasted Nuthatch, Cooper's Hawk, Yellow-throated Warbler, Summer Tanager, Black-and-white Warbler, and Northern Bobwhite.

Reptile and amphibian species associated with oak and pine woodlands include ornate box turtle, northern fence lizard, five-lined skink, broad-headed skink, six-lined racerunner, flat-headed snake, rough earth snake, and timber rattlesnake.

Other information

Forestry (NRCS 2002, 2014):

Management: Field measured site index averages are 51 for oak and 57 for shortleaf pine. Timber management opportunities are marginal. 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. Using prescribed fire can be an effective management tool for this ecological site.

Limitations: Large amounts of coarse fragments throughout profile; bedrock may be within 60 inches. Surface stones and rocks are problems for efficient and safe equipment operation and will make equipment use somewhat difficult. Disturbing the surface excessively in harvesting operations and building roads increases soil losses, which leaves a greater amount of coarse fragments on the surface. Hand planting or direct seeding may be necessary. Seedling mortality due to low available water capacity may be high. Mulching or providing shade can improve seedling survival. Mechanical tree planting will be limited. 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: Low-Base Sandstone Upland Woodland

Plot ECKCA_KS01 – Lily soil
Located in Eck Natural Area, Texas County, MO
Latitude: 37.587249
Longitude: -92.025963

Plot ECKCA_KS04 – Bender soil
Located in Eck Natural Area, Texas County, MO
Latitude: 37.589239

Longitude: -92.028961

Plot LORICA_KS02 – Lily soil
Located Long Ridge CA, Franklin County, MO
Latitude: 38.280622
Longitude: -91.174234

Plot WHRICA_KS01 – Lily soil
Located White River Trace CA, Dent County, MO
Latitude: 37.599871
Longitude: -91.721335

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Contributors

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Approval

Nels Barrett, 9/24/2020

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	05/03/2024
Approved by	Nels Barrett
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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:**

17. **Perennial plant reproductive capability:**