USDA Natural Resources Conservation Service

Ecological site F116AY007MO
Low-Base Loamy 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 Chert 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 Quercus stellata - Quercus marilandica - Quercus velutina - Carya texana / Schizachyrium scoparium Woodland (CEGL002149).

Geographic relationship to the Missouri Ecological Classification System (Nigh & Schroeder, 2002):
This ecological site occurs primarily within several Subsections in the central portion of 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 Loamy Upland Woodlands occur on high, rolling, weakly dissected portions of the Ozark Highland, particularly in Howell and Texas counties, Missouri. This ecological site occurs on high, flat uplands between the rivers of the region. Low-Base Loamy Upland Woodlands also occur in the inter-knob basins of the St. Francis Mountains. These ecological sites are often part of a complex with Loess Fragipan Upland Flatwoods and Chert Woodlands. They are similar, although slightly more productive than Loess Fragipan Upland Flatwoods. Soils are typically very deep, acidic, and low in bases such as calcium, with an abundance of chert fragments. Soil acidity is an important factor affecting the distribution of both tree and ground flora species and their growth. As a soil profile approaches or arrives at lower levels of pH, exchangeable aluminum comes into solution and can directly impact plant growth and composition. The reference state for this ecological site was old growth oak woodland or oak-pine woodland.

Associated sites

F116AY002MO	**Chert Protected Backslope Forest** Chert Protected Backslope Forests are downslope in areas where the underlying dolomite bedrock is relatively near the surface, on steep backslopes with northern to eastern aspects.
F116AY004MO	**Fragipan Upland Woodland** Fragipan Upland Woodlands are adjacent on summits where a fragipan is present in the subsoil.
F116AY011MO	**Chert Upland Woodland** Chert Upland Woodlands are typically downslope in areas where the underlying dolomite bedrock is relatively near the surface, on gently sloping summit crests, shoulders, and upper backslopes.
F116AY012MO	**Low-Base Chert Upland Woodland** Low-base Chert Upland Woodlands are often downslope in areas where the underlying dolomite bedrock is very deep, on gently sloping summit crests, shoulders, and upper backslopes.
F116AY013MO	**Low-Base Chert Protected Backslope Woodland** Low-base Chert Exposed Backslope Woodlands are downslope in areas where the underlying dolomite bedrock is very deep, on steep backslopes with southern to western aspects.
F116AY049MO	**Low-Base Chert Exposed Backslope Woodland** Low-base Chert Protected Backslope Forests are downslope in areas where the underlying dolomite bedrock is very deep, on steep backslopes with northern to eastern aspects.
F116AY062MO	**Chert Exposed Backslope Woodland** Chert Exposed Backslope Woodlands are downslope in areas where the underlying dolomite bedrock is relatively near the surface, on steep backslopes with southern to western aspects.

Similar sites

F116AY012MO	**Low-Base Chert Upland Woodland** Low-base Chert Upland Woodlands are often on gently sloping summit crests, shoulders, and upper backslopes. These sites are less productive. Species composition is often similar.

Table 1. Dominant plant species

Tree	(1) *Quercus stellata* (2) *Quercus velutina*
Shrub	(1) *Ceanothus americanus* (2) *Rhus aromatica*
Herbaceous	(1) *Schizachyrium scoparium*

Physiographic features

This site is on upland summit crests, shoulders, and upper backslopes, with slopes of 1 to 15 percent. The site generates runoff to adjacent, downslope ecological sites. This site does not flood.

The following figure (adapted from Vander Veen and Preston, 2006) shows the typical landscape position of this ecological site, and landscape relationships with other ecological sites. The site is within the area labeled “1”, on broadly convex upland summits. A variety of ecological sites may occur downslope, such as the Chert Upland Woodland sites within the area labeled “2”, and the Chert Backslope sites on steep lower backslopes, labeled “3”. In many areas, Low-base Chert Upland Woodland sites and Low-base Chert Backslope Woodland sites are downslope.

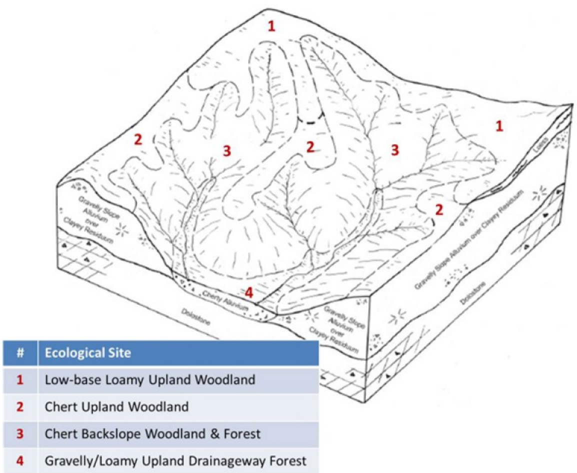


Figure 2. Landscape relationships for this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Ridge (2) Interfluve (3) Hill
Flooding frequency	None
Ponding frequency	None
Slope	1–15%
Water table depth	18–60 in
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)	139-153 days
Freeze-free period (characteristic range)	166-177 days
Precipitation total (characteristic range)	46-48 in
Frost-free period (actual range)	136-156 days
Freeze-free period (actual range)	165-182 days
Precipitation total (actual range)	45-48 in
Frost-free period (average)	146 days
Freeze-free period (average)	172 days
Precipitation total (average)	47 in

Climate stations used

- (1) DORA 1N [USC00232302], Dora, MO
- (2) SALEM [USC00237506], Salem, MO

- (3) GREENVILLE 6 N [USC00233451], Silva, MO

Influencing water features

Water features associated with this upland ecological site are influenced by karst landscapes throughout the area (see 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).

The accompanying map 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. Image from Wikimedia Commons developed from the Missouri Department of Natural Resources, Division of Geology and Land Survey.

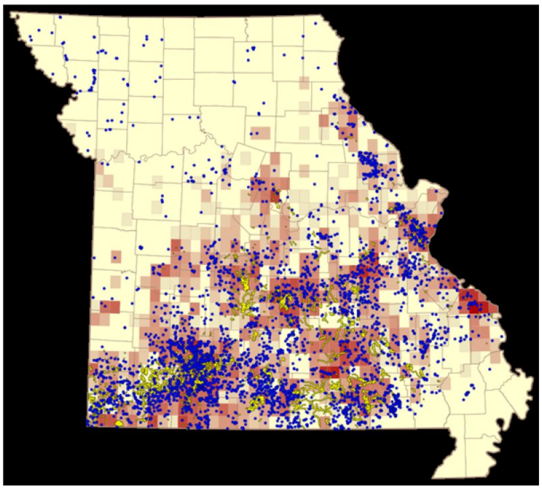


Figure 9. Distribution of karst-related features in Missouri. Image from Wikimedia Commons developed from the Missouri Department of Natural Resources, Division of Geology and Land Survey.

Soil features

These soils have acidic subsoils that are low in bases. Soils having low concentrations of calcium and containing few calcium bearing minerals along with increased levels of aluminum may also be vulnerable to base depletion by timber harvesting, plant uptake, and leaching. The soils were formed under woodland vegetation, and have thin, light-colored surface horizons. Parent material is loess over slope alluvium over residuum weathered from limestone and dolomite. The soils have silt loam surface horizons. Subsoils are silty clay loam in the upper part, and are very gravelly and cobbly silty clay loam in the underlying slope alluvium and residuum. A few of these soils are slightly affected by seasonal wetness. Soil series associated with this site include Fanchon, Firebaugh, Horneybuck, Macedonia, and Viburnum.

The accompanying picture of the Viburnum series shows a thin, light-colored silt loam surface horizon and brown silty clay loam subsoil, over red very gravelly clay at about 30 inches. Scale is in inches. (Photo credit - NRCS)

Figure 10. Viburnum series

Table 4. Representative soil features

Parent material	(1) Loess (2) Slope alluvium (3) Residuum–limestone and dolomite
Surface texture	(1) Silt loam (2) Gravelly (3) Very gravelly
Family particle size	(1) Loamy
Drainage class	Moderately well drained to well drained
Permeability class	Very slow to moderately slow
Soil depth	72 in
Surface fragment cover <=3"	2–50%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	4–7 in
Calcium carbonate equivalent (0-40in)	0%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	3.5–6.5
Subsurface fragment volume <=3" (Depth not specified)	15–45%
Subsurface fragment volume >3" (Depth not specified)	0–3%

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 Loamy Upland Woodlands were dominated by drought and fire-tolerant trees such as black oak, 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 small, concentrated areas, (green area on following map) but a relatively smaller 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 content, low soil bases, and intricate 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 edge of 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 the abundant ground flora. Grazing by large native herbivores also influenced the understory, keeping it more open and structurally diverse. The high, droughty landscape position of Low-Base Loamy 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 Loamy Upland Woodland has a moderately tall canopy (60 to 70 feet) but is less dense (65 to 85 percent canopy) than protected slopes and Chert Upland Woodlands. 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 was dominated by 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 eastern red cedar, hickory, and black oak have increased in these woodlands. Once established, these woodies can quickly fill the woodland system.

Uncontrolled domestic grazing has also impacted 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 sites are moderately productive. Some areas have been cleared for non-native pasture, but many areas have been repeatedly logged and high graded. However, in the absence of fire and continual management treatments, oak sprouting will be prevalent again shading out the sun-loving ground flora. Removal of the younger understory and the application of prescribed fire have proven to be effective management applications.

These managed areas show an exceptional resiliency. This type of management may provide timber products, wildlife habitat, and potential native forage. 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. Managed areas show exceptional resiliency. In the Oak-Pine Woodland community phase in particular, these practices encourage recruitment of shortleaf pine when mature pines are nearby to provide a seed source. Despite the widespread removal of 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 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

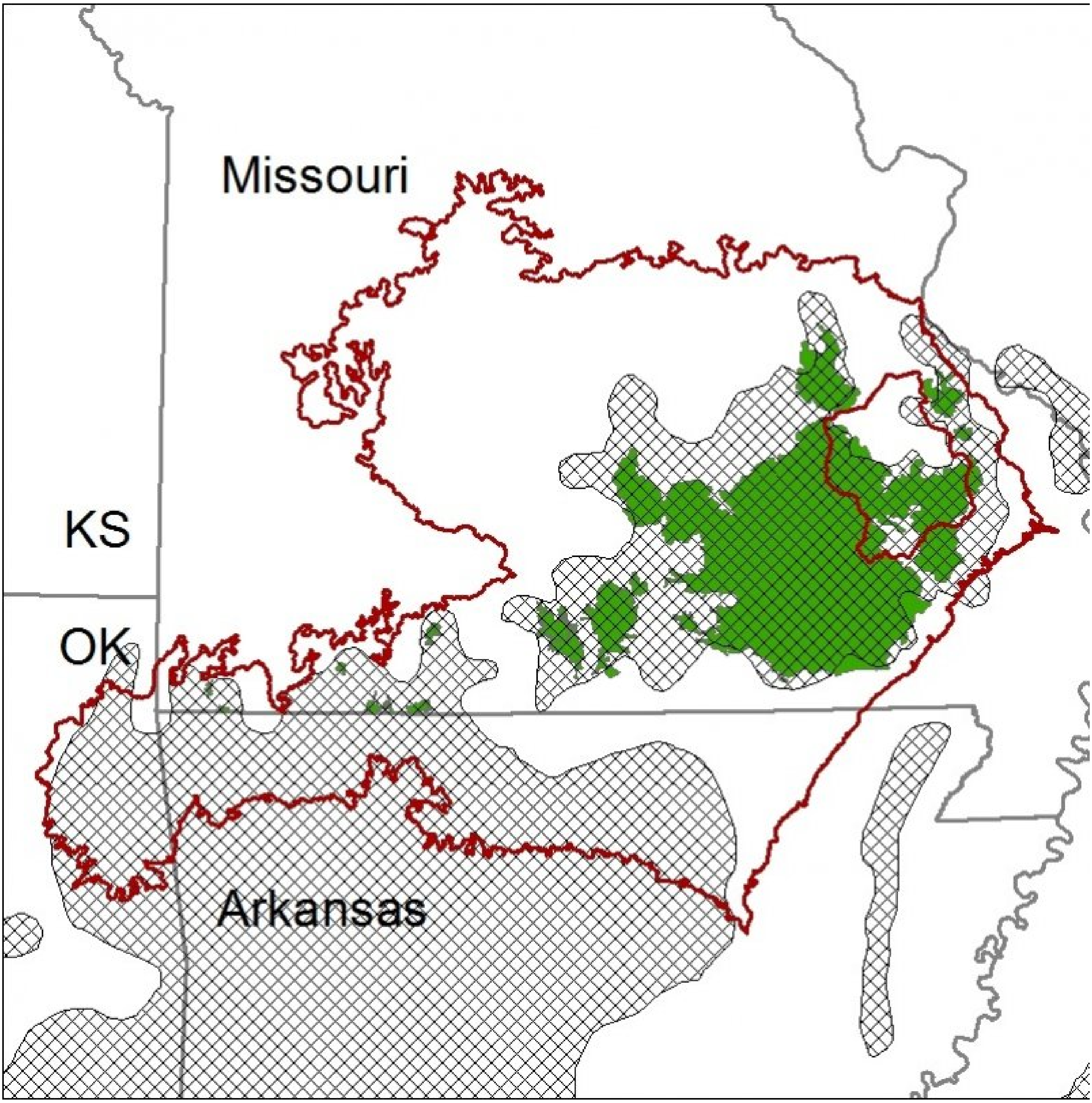
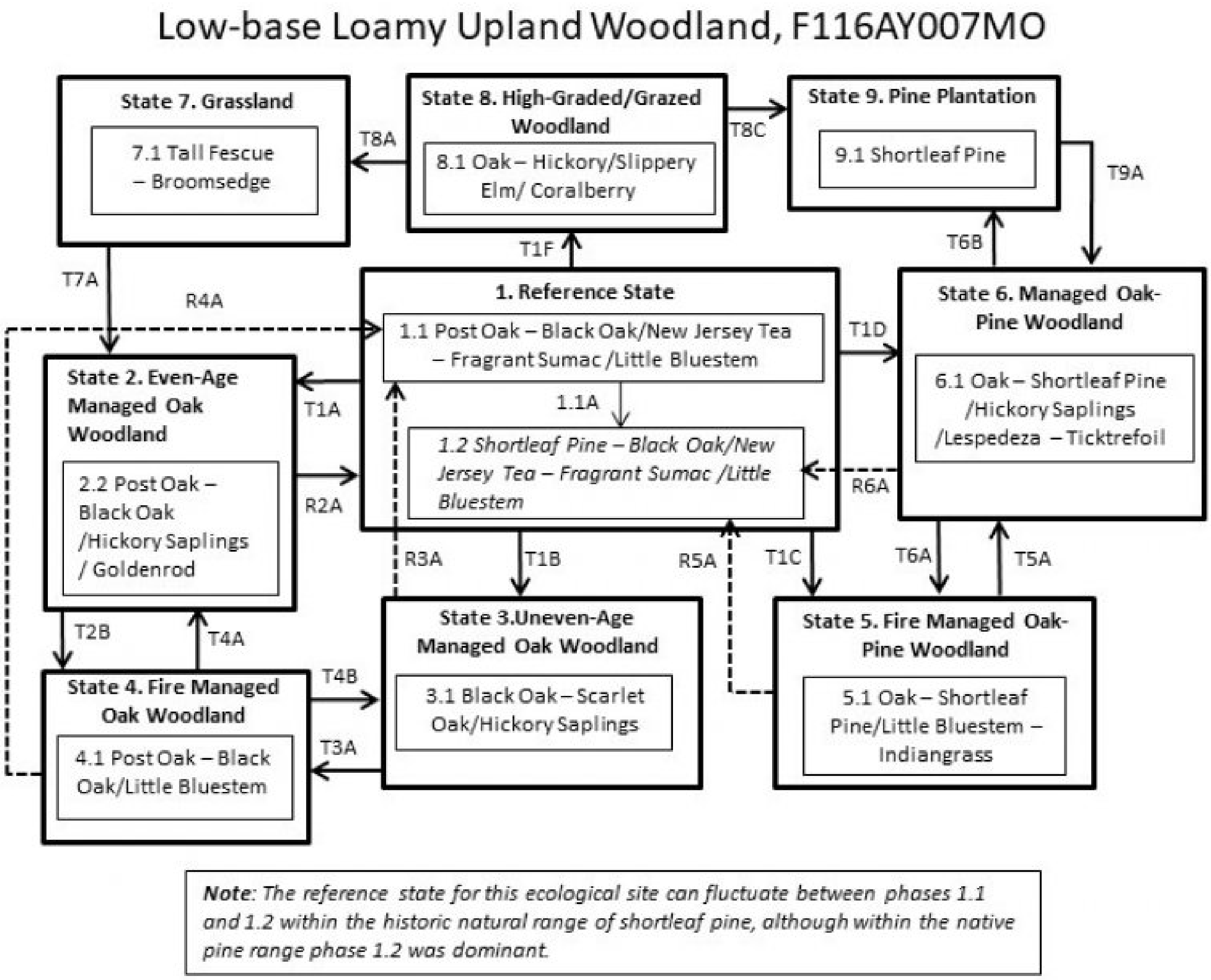


Figure 11. Range map with cross-hatching showing the historic distribution of shortleaf pine in the Midwest. Green shading show areas where shortleaf pine was a dominate overstory species.



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	Fire suppression; tree planting; long-term succession (+50-60 years)
T8C, T6B	selective oak removal, maintaining existing pine; pine planting
T8A	Clearing; pasture planting; prescribed grazing
T9A	Thinning; allow oak sprouting; fire suppression
R4A	Forest stand improvement; extended rotations; prescribed fire
R2A, R3A, R5A, R6A	Prescribed fire; management; extended rotations
1.1A	Within native pine range

Figure 12. State and Transition Model for this ecological site.

State 1
Reference State

The reference state for this ecological site was old growth oak woodland or oak-pine woodland. The reference state was dominated by black oak, post oak and scarlet oak or with shortleaf pine, as an overstory component within the Ozark historic 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 pine range phase 1.2 was dominant.

Community 1.1
Post Oak – Black Oak/New Jersey Tea – Fragrant Sumac /Little Bluestem

Figure 13. Reference state at Montauk State Park, Dent County, Missouri. Photo credit MDC.

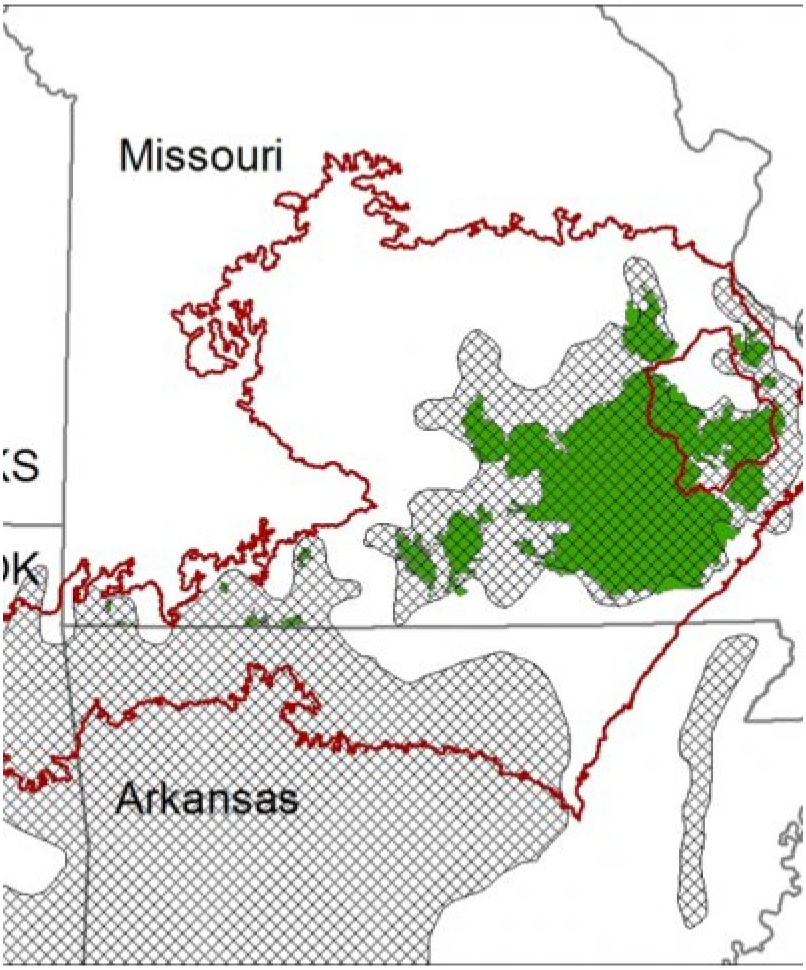


Figure 14. Range map with cross-hatching showing the historic distribution of shortleaf pine in the Midwest. Green shading show areas where shortleaf pine was a dominate overstory species.

Forest overstory. The 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. The 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
Shortleaf Pine – Black Oak/New Jersey Tea – Fragrant Sumac /Little Bluestem

Forest overstory. The Overstory Species list is based on commonly occurring species listed in Nelson (2010).

Forest understory. The Understory Species list is based on commonly occurring species listed in Nelson (2010).

Pathway P1.1A
Community 1.1 to 1.2

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 oaks. 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).

Dominant resource concerns

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

Community 2.1
Post Oak – Black Oak /Hickory Saplings / 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 oaks. Uneven-Age Managed Woodlands can resemble the non-pine Reference State. The biggest differences are tree age, most being only 50 to 90 years old and denser understories. Composition is also 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.

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 – 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.

Dominant resource concerns

- Plant productivity and health
- Terrestrial habitat for wildlife and invertebrates

Community 4.1
Post Oak – Black Oak/Little Bluestem

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 – Indiangrass

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 Saplings /Lespedeza – Ticktrefoil

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.

Dominant resource concerns

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

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 mono-culture of a dense shortleaf pine overstory with a brushy understory of oak and hickory and a dense carpet of 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 perhaps planting of native ground flora species.

Dominant resource concerns

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

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.

Restoration pathway R4A
State 4 to 1

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

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

Transition 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, long-term succession (+50-60 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 mono-culture 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 (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
shortleaf pine	PIEC2	*Pinus echinata*	Native	–	0–70	–	–
post oak	QUST	*Quercus stellata*	Native	–	5–40	–	–
black oak	QUVE	*Quercus velutina*	Native	–	5–40	–	–
scarlet oak	QUCO2	*Quercus coccinea*	Native	–	5–40	–	–
black hickory	CATE9	*Carya texana*	Native	–	5–40	–	–
white oak	QUAL	*Quercus alba*	Native	–	5–10	–	–

Table 6. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	–	5–20
big bluestem	ANGE	*Andropogon gerardii*	Native	–	5–20
Indiangrass	SONU2	*Sorghastrum nutans*	Native	–	5–20
Virginia wildrye	ELVI3	*Elymus virginicus*	Native	–	5–20
slimleaf panicgrass	DILI2	*Dichanthelium linearifolium*	Native	–	5–20
broomsedge bluestem	ANVI2	*Andropogon virginicus*	Native	–	5–20
eastern star sedge	CARA8	*Carex radiata*	Native	–	5–20
poverty oatgrass	DASP2	*Danthonia spicata*	Native	–	5–20
fuzzy wuzzy sedge	CAHI6	*Carex hirsutella*	Native	–	5–20
Muhlenberg's sedge	CAMU4	*Carex muehlenbergii*	Native	–	5–20
western panicgrass	DIACF	*Dichanthelium acuminatum var. fasciculatum*	Native	–	5–20
whitetinge sedge	CAALA	*Carex albicans var. albicans*	Native	–	5–20
blue sedge	CAGL6	*Carex glaucodea*	Native	–	5–20
Muhlenberg's sedge	CAMU4	*Carex muehlenbergii*	Native	–	5–20
black edge sedge	CANI3	*Carex nigromarginata*	Native	–	5–20
reflexed sedge	CARE9	*Carex retroflexa*	Native	–	5–20

roundseed panicgrass	DISPI	*Dichanthelium sphaerocarpon var. isophyllum*	Native	–	5–20
bashful bulrush	TRPL6	*Trichophorum planifolium*	Native	–	5–20
Forb/Herb					
American ipecac	GIST5	*Gillenia stipulata*	Native	–	1–10
calico aster	SYLA4	*Symphyotrichum lateriflorum*	Native	–	1–10
late purple aster	SYPAP2	*Symphyotrichum patens var. patens*	Native	–	1–10
largeflower yellow false foxglove	AUGR	*Aureolaria grandiflora*	Native	–	1–10
Parlin's pussytoes	ANPA9	*Antennaria parlinii*	Native	–	1–10
arrowleaf violet	VISA2	*Viola sagittata*	Native	–	1–10
hairy bedstraw	GAPI2	*Galium pilosum*	Native	–	1–10
Virginia tephrosia	TEVI	*Tephrosia virginiana*	Native	–	1–10
queendevil	HIGR3	*Hieracium gronovii*	Native	–	1–10
hairy sunflower	HEHI2	*Helianthus hirsutus*	Native	–	1–10
elmleaf goldenrod	SOUL2	*Solidago ulmifolia*	Native	–	1–10
American hogpeanut	AMBR2	*Amphicarpaea bracteata*	Native	–	1–10
stiff tickseed	COPA10	*Coreopsis palmata*	Native	–	1–10
smooth small-leaf ticktrefoil	DEMA2	*Desmodium marilandicum*	Native	–	1–10
panicledleaf ticktrefoil	DEPA6	*Desmodium paniculatum*	Native	–	1–10
trailing lespedeza	LEPR	*Lespedeza procumbens*	Native	–	1–10
creeping lespedeza	LERE2	*Lespedeza repens*	Native	–	1–10
slender lespedeza	LEVI7	*Lespedeza virginica*	Native	–	1–10
sidebeak pencilflower	STBI2	*Stylosanthes biflora*	Native	–	1–10
smooth violet prairie aster	SYTU2	*Symphyotrichum turbinellum*	Native	–	1–10
longbract wild indigo	BABR2	*Baptisia bracteata*	Native	–	1–10
white prairie clover	DACA7	*Dalea candida*	Native	–	1–10
purple prairie clover	DAPU5	*Dalea purpurea*	Native	–	1–10
Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	Native	–	1–10
wild quinine	PAIN3	*Parthenium integrifolium*	Native	–	1–10
hairy goldenrod	SOHI	*Solidago hispida*	Native	–	1–10
gray goldenrod	SONE	*Solidago nemoralis*	Native	–	1–10
downy ragged goldenrod	SOPE	*Solidago petiolaris*	Native	–	1–10
manyray aster	SYAN2	*Symphyotrichum anomalum*	Native	–	1–10
stiff ticktrefoil	DEOB5	*Desmodium obtusum*	Native	–	1–10
flaxleaf whitetop aster	IOLI2	*Ionactis linariifolius*	Native	–	1–10
hairy lespedeza	LEHI2	*Lespedeza hirta*	Native	–	1–10
violet lespedeza	LEVI6	*Lespedeza violacea*	Native	–	1–10
tall blazing star	LIAS	*Liatris aspera*	Native	–	1–10
scaly blazing star	LISQ	*Liatris squarrosa*	Native	–	1–10
Shrub/Subshrub					
New Jersey tea	CEAM	*Ceanothus americanus*	Native	–	5–10
fragrant sumac	RHAR4	*Rhus aromatica*	Native	–	5–10
St. Andrew's cross	HYHY	*Hypericum hypericoides*	Native	–	5–10
American hazelnut	COAM3	*Corylus americana*	Native	–	5–10

American hazelnut	COAM3	*Corylus americana*	Native	–	5–10
American hazelnut	COAM3	*Corylus americana*	Native	–	5–10
leadplant	AMCA6	*Amorpha canescens*	Native	–	5–10
common dittany	CUOR	*Cunila origanoides*	Native	–	5–10
Virginia tephrosia	TEVI	*Tephrosia virginiana*	Native	–	5–10
Blue Ridge blueberry	VAPA4	*Vaccinium pallidum*	Native	–	5–10
Tree					
common serviceberry	AMAR3	*Amelanchier arborea*	Native	–	1–5
sassafras	SAAL5	*Sassafras albidum*	Native	–	1–5
farkleberry	VAAR	*Vaccinium arboreum*	Native	–	1–5
rusty blackhaw	VIRU	*Viburnum rufidulum*	Native	–	1–5

Table 7. Community 1.2 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
shortleaf pine	PIEC2	*Pinus echinata*	Native	–	40–70	–	–
scarlet oak	QUCO2	*Quercus coccinea*	Native	–	10–20	–	–
white oak	QUAL	*Quercus alba*	Native	–	5–10	–	–
post oak	QUST	*Quercus stellata*	Native	–	5–10	–	–
black oak	QUVE	*Quercus velutina*	Native	–	5–10	–	–
black hickory	CATE9	*Carya texana*	Native	–	5–10	–	–

Table 8. Community 1.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	–	20–30
big bluestem	ANGE	*Andropogon gerardii*	Native	–	10–20
Indiangrass	SONU2	*Sorghastrum nutans*	Native	–	10–20
Virginia wildrye	ELVI3	*Elymus virginicus*	Native	–	10–20
slimleaf panicgrass	DILI2	*Dichanthelium linearifolium*	Native	–	10–20
broomsedge bluestem	ANVI2	*Andropogon virginicus*	Native	–	10–20
eastern star sedge	CARA8	*Carex radiata*	Native	–	5–20
poverty oatgrass	DASP2	*Danthonia spicata*	Native	–	10–20
fuzzy wuzzy sedge	CAHI6	*Carex hirsutella*	Native	–	5–20
Muhlenberg's sedge	CAMU4	*Carex muehlenbergii*	Native	–	–
western panicgrass	DIACF	*Dichanthelium acuminatum var. fasciculatum*	Native	–	–
whitetinge sedge	CAALA	*Carex albicans var. albicans*	Native	–	–
blue sedge	CAGL6	*Carex glaucodea*	Native	–	–
Muhlenberg's sedge	CAMU4	*Carex muehlenbergii*	Native	–	–
black edge sedge	CANI3	*Carex nigromarginata*	Native	–	–
reflexed sedge	CARE9	*Carex retroflexa*	Native	–	–
roundseed panicgrass	DISPI	*Dichanthelium sphaerocarpon var. isophyllum*	Native	–	–
bashful bulrush	TRPL6	*Trichophorum planifolium*	Native	–	–

Forb/Herb					
American ipecac	GIST5	*Gillenia stipulata*	Native	–	5–10
calico aster	SYLA4	*Symphyotrichum lateriflorum*	Native	–	5–10
late purple aster	SYPAP2	*Symphyotrichum patens var. patens*	Native	–	5–10
largeflower yellow false foxglove	AUGR	*Aureolaria grandiflora*	Native	–	5–10
Parlin's pussytoes	ANPA9	*Antennaria parlinii*	Native	–	5–10
arrowleaf violet	VISA2	*Viola sagittata*	Native	–	5–10
hairy bedstraw	GAPI2	*Galium pilosum*	Native	–	5–10
Virginia tephrosia	TEVI	*Tephrosia virginiana*	Native	–	5–10
queendevil	HIGR3	*Hieracium gronovii*	Native	–	5–10
hairy sunflower	HEHI2	*Helianthus hirsutus*	Native	–	5–10
elmleaf goldenrod	SOUL2	*Solidago ulmifolia*	Native	–	5–10
American hogpeanut	AMBR2	*Amphicarpaea bracteata*	Native	–	5–10
stiff tickseed	COPA10	*Coreopsis palmata*	Native	–	5–10
smooth small-leaf ticktrefoil	DEMA2	*Desmodium marilandicum*	Native	–	5–10
panicledleaf ticktrefoil	DEPA6	*Desmodium paniculatum*	Native	–	5–10
trailing lespedeza	LEPR	*Lespedeza procumbens*	Native	–	5–10
creeping lespedeza	LERE2	*Lespedeza repens*	Native	–	5–10
slender lespedeza	LEVI7	*Lespedeza virginica*	–	–	5–10
sidebeak pencilflower	STBI2	*Stylosanthes biflora*	Native	–	5–10
smooth violet prairie aster	SYTU2	*Symphyotrichum turbinellum*	Native	–	–
longbract wild indigo	BABR2	*Baptisia bracteata*	Native	–	–
white prairie clover	DACA7	*Dalea candida*	Native	–	–
purple prairie clover	DAPU5	*Dalea purpurea*	Native	–	–
Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	Native	–	–
wild quinine	PAIN3	*Parthenium integrifolium*	Native	–	–
hairy goldenrod	SOHI	*Solidago hispida*	Native	–	–
gray goldenrod	SONE	*Solidago nemoralis*	Native	–	–
downy ragged goldenrod	SOPE	*Solidago petiolaris*	Native	–	–
manyray aster	SYAN2	*Symphyotrichum anomalum*	Native	–	–
stiff ticktrefoil	DEOB5	*Desmodium obtusum*	Native	–	–
flaxleaf whitetop aster	IOLI2	*Ionactis linariifolius*	Native	–	–
hairy lespedeza	LEHI2	*Lespedeza hirta*	Native	–	–
violet lespedeza	LEVI6	*Lespedeza violacea*	Native	–	–
tall blazing star	LIAS	*Liatris aspera*	Native	–	–
scaly blazing star	LISQ	*Liatris squarrosa*	Native	–	–
Shrub/Subshrub					
New Jersey tea	CEAM	*Ceanothus americanus*	Native	–	5–20
fragrant sumac	RHAR4	*Rhus aromatica*	Native	–	5–20
St. Andrew's cross	HYHY	*Hypericum hypericoides*	Native	–	5–20
American hazelnut	COAM3	*Corylus americana*	Native	–	5–20
American hazelnut	COAM3	*Corylus americana*	Native	–	5–20
leadplant	AMCA6	*Amorpha canescens*	Native	–	–

common dittany	CUOR	*Cunila origanoides*	Native	–	–
Virginia tephrosia	TEVI	*Tephrosia virginiana*	Native	–	–
Blue Ridge blueberry	VAPA4	*Vaccinium pallidum*	Native	–	–
Tree					
common serviceberry	AMAR3	*Amelanchier arborea*	Native	–	–
sassafras	SAAL5	*Sassafras albidum*	Native	–	–
farkleberry	VAAR	*Vaccinium arboreum*	Native	–	–
rusty blackhaw	VIRU	*Viburnum rufidulum*	Native	–	–
Vine/Liana					
summer grape	VIAE	*Vitis aestivalis*	Native	–	–

Table 9. Community 2.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
post oak	QUST	*Quercus stellata*	Native	–	–	–	–
black oak	QUVE	*Quercus velutina*	Native	–	–	–	–
black hickory	CATE9	*Carya texana*	Native	–	–	–	–

Table 10. Community 2.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Forb/Herb					
Missouri goldenrod	SOMI2	*Solidago missouriensis*	Native	–	–

Table 11. Community 3.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
black oak	QUVE	*Quercus velutina*	Native	–	–	–	–
scarlet oak	QUCO2	*Quercus coccinea*	Native	–	–	–	–
black hickory	CATE9	*Carya texana*	Native	–	–	–	–

Table 12. Community 4.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
post oak	QUST	*Quercus stellata*	Native	–	–	–	–
black oak	QUVE	*Quercus velutina*	Native	–	–	–	–

Table 13. Community 4.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	–	–

Table 14. Community 5.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
post oak	QUST	*Quercus stellata*	Native	–	–	–	–
shortleaf pine	PIEC2	*Pinus echinata*	Native	–	–	–	–

Table 15. Community 5.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	–	–
Indiangrass	SONU2	*Sorghastrum nutans*	Native	–	–

Table 16. Community 6.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
post oak	QUST	*Quercus stellata*	Native	–	–	–	–
shortleaf pine	PIEC2	*Pinus echinata*	Native	–	–	–	–
black hickory	CATE9	*Carya texana*	Native	–	–	–	–

Table 17. Community 6.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Forb/Herb					
trailing lespedeza	LEPR	*Lespedeza procumbens*	Native	–	–
pointedleaf ticktrefoil	DEGL5	*Desmodium glutinosum*	Native	–	–

Table 18. Community 7.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
tall fescue	SCAR7	*Schedonorus arundinaceus*	Introduced	–	–
broomsedge bluestem	ANVI2	*Andropogon virginicus*	Native	–	–

Table 19. Community 8.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
post oak	QUST	*Quercus stellata*	Native	–	–	–	–
black hickory	CATE9	*Carya texana*	Native	–	–	–	–
slippery elm	ULRU	*Ulmus rubra*	Native	–	–	–	–

Table 20. Community 8.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Shrub/Subshrub					
coralberry	SYOR	*Symphoricarpos orbiculatus*	Native	–	–

Animal community

Wildlife (MDC 2006):

Sedges and native cool-season grasses provide green browse.

Extensive native warm-season grasses provide cover and nesting habitat; and a diversity of forbs provides a diversity and abundance of insects.

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

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

Bird species associated with mid- to late successional oak 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 oak-pine woodland sites 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.

Other information

Forestry (NRCS 2002, 2014):

Management: Field measured site index values range from 50 to 59 for oak and 48 to 70 for shortleaf pine. Timber management opportunities are generally good. 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 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 is an effective management tool.

Limitations: Large amounts of coarse fragments in lower soil profile; 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. Erosion is a hazard when slopes exceed 15 percent.

Inventory data references

Potential Reference Sites: Low-Base Loamy Upland Woodland

Plot CASPFS01 – Fanchon soil
Located in Carman Springs Natural Area, USFS, Howell County, MO
Latitude: 36.935136
Longitude: -92.0837

Plot PIKNFS_KS01 – Viburnum soil
Located in Pine Knot, Mark Twain National Forest, Carter County, MO
Latitude: 36.891043
Longitude: -91.205505

Plot WHNUCA_KS02 – Viburnum soil
Located in White (George O) Nursery, Texas County, MO
Latitude: 37.548699
Longitude: -91.896824

Plot WHNUCA_KS04 – Viburnum soil
Located in White (George O) Nursery, Texas County, MO
Latitude: 37.561423
Longitude: -91.894599

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Contributors

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Approval

Nels Barrett, 9/24/2020

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Missouri Department of Conservation and Missouri Department of Natural Resources personnel provided significant and helpful field and technical support during this project.

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	04/26/2024
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):**

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

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17. **Perennial plant reproductive capability:**
