Ecological site R107XB013MO
Calcareous Loess Protected Backslope Savanna

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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): 107X–Iowa and Missouri Deep Loess Hills

The Iowa and Missouri Deep Loess Hills (MLRA 107B) includes the Missouri Alluvial Plain, Loess Hills, Southern Iowa Drift Plain, and Central Dissected Till Plains landform regions (Prior 1991; Nigh and Schroeder 2002). It spans four states (Iowa, 53 percent; Missouri, 32 percent; Nebraska, 12 percent; and Kansas 3 percent), encompassing over 14,000 square miles (Figure 1). The elevation ranges from approximately 1,565 feet above sea level (ASL) on the highest ridges to about 600 feet ASL along the Missouri River near Glasgow in central Missouri. Local relief varies from 10 to 20 feet in the major river floodplains, to 50 to 100 feet in the dissected uplands, and loess bluffs of 200 to 300 feet along the Missouri River. Loess deposits cover most of the area, with deposits reaching a thickness of 65 to 200 feet in the Loess Hills and grading to about 20 feet in the eastern extent of the region. Pre-Illinoian till, deposited more than 500,000 years ago, lies beneath the loess and has experienced extensive erosion and dissection. Pennsylvanian and Cretaceous bedrock, comprised of shale, mudstones, and sandstones, lie beneath the glacial material (USDA-NRCS 2006).

The vegetation in the MLRA has undergone drastic changes over time. Spruce forests dominated the landscape 30,000 to 21,500 years ago. As the last glacial maximum peaked 21,500 to 16,000 years ago, they were replaced with open tundras and parklands. The end of the Pleistocene Epoch saw a warming climate that initially prompted the return of spruce forests, but as the warming continued, spruce trees were replaced by deciduous trees (Baker et al. 1990). Not until approximately 9,000 years ago did the vegetation transition to prairies as climatic conditions continued to warm and subsequently dry. Between 4,000 and 3,000 years ago, oak savannas began intermingling within the prairie landscape. This prairie-oak savanna ecosystem formed the dominant landscapes until the arrival of European settlers (Baker et al. 1992).

Classification relationships

Major Land Resource Area (MLRA): Iowa and Missouri Deep Loess Hills (107B) (USDA-NRCS 2006)

USFS Subregions: Central Dissected Till Plains Section (251C), Loess Hills (251Cb) Subsection; Nebraska Rolling Hills Section (251H), Pawnee City-Seneca Rolling Hill (251Hd) (Cleland et al. 2007).

U.S. EPA Level IV Ecoregion: Steeply Rolling Loess Prairies (47e), Nebraska/Kansas Loess Hills (47h), Western Loess Hills (47m) (USEPA 2013)

Biophysical Setting (LANDFIRE 2009): North-Central Interior Oak Savanna (4213940)

Ecological Systems (National Vegetation Classification System, Nature Serve 2015): North-Central Interior Oak Savanna (CES202.698)

Iowa Department of Natural Resources (INAI 1984): Loess Hills Savanna

Missouri Natural Heritage Program (Nelson 2010): Dry-Mesic Loess/Glacial Till Savanna

Plant Associations (National Vegetation Classification System, Nature Serve 2015): Quercus macrocarpa – (Quercus alba, Quercus stellata)/ Andropogon gerardii Wooded Herbaceous Vegetation (CEGL002159)

Rosburg (1994): Bur Oak Woodland

Ecological site concept

Calcareous Loess Protected Backslope Savannas are mapped in complex with Calcareous Loess Exposed Backslope Prairies and are generally located within the green areas on the map (Figure 1). They occur on north- and east-facing backslopes with slopes greater than fifteen percent. Soils are Entisols that are well-drained and very deep, formed from loess with a significant component of calcium carbonates at or near the surface, resulting in an alkaline (high pH) environment. These fine-silty, fertile soils have high soil uniformity resulting in increased nutrient- and water-holding capacity, increased organic matter retention, and good soil aeration that allows deep penetration by plant roots, which generally results in high plant productivity (Catt 2001). These sites reside downslope from and adjacent to other calcareous loess ecological sites.

The historic pre-European settlement vegetation on this site was dominated by tall- and midgrass prairie species, with oaks interspersed across the landscape. Little bluestem (Schizachyrium scoparium (Michx.) Nash) , sideoats grama (Bouteloua curtipendula (Michx.) Torr.), and chinquapin oak (Quercus muehlenbergii Engelm.) represent the indicator species, while big bluestem (Andropogon gerardii Vitman), American hazelnut (Corylus americana Walter), and bur oak (Quercus macrocarpa Michx.) are the dominant species of their respective canopy class (Nuzzo 1994; Whitney 1994; Nelson 2010). Forb species typical of an undisturbed plant community associated with this ecological site include white prairie clover (Dalea candida Michx. ex Willd.) and rattlesnake master (Eryngium yuccifolium Michx.) (Drobney et al. 2001; Ladd and Thomas 2015). Wild plum (Prunus americana Marshall), leadplant (Amorpha canescens Pursh), and roughleaf dogwood (Cornus drummondii C.A. Mey.) are common shrubs that can be found scattered throughout the savanna. Fire was the primary disturbance factor that maintained this site, while drought and native large mammal grazing were secondary factors.

Relative to other calcareous loess prairie ecological sites in the MLRA, Calcareous Loess Protected Backslope Forests occur downslope from Calcareous Loess Upland prairies and adjacent to Calcareous Loess Exposed Backslope Prairies. They support similar shrub and herbaceous species found in the prairie ecological site but due to the protected north- and east-aspects contains an open canopy of bur oak.

Associated sites

R107XB012MO	**Calcareous Loess Upland Prairie** Calcareous loess soils on upland summits and shoulders on slopes less than 15 percent, including Dow and Ida
R107XB006MO	**Calcareous Loess Exposed Backslope Prairie** Calcareous loess soils on slopes greater than 15 percent with south and west aspects, including Dow, Hamburg, and Ida

Similar sites

R107XB003MO	**Deep Loess Exposed Backslope Savanna** Deep Loess Exposed Backslope Savannas are similar in landscape position but only occur on south- and west-aspects and are dominated by white oaks

Table 1. Dominant plant species

Tree	(1) *Quercus macrocarpa* (2) *Quercus muehlenbergii*
Shrub	(1) *Corylus americana*
Herbaceous	(1) *Andropogon gerardii* (2) *Schizachyrium scoparium*

Physiographic features

Calcareous Loess Protected Backslope Savannas occur on upland backslopes with slopes greater than fifteen percent on dissected till plains (Figure 2). This ecological site is unique to the Loess Hills landform situated on elevations ranging from approximately 335 to 457 feet ASL. This site does not experience flooding but rather generates runoff to adjacent, downslope ecological sites.

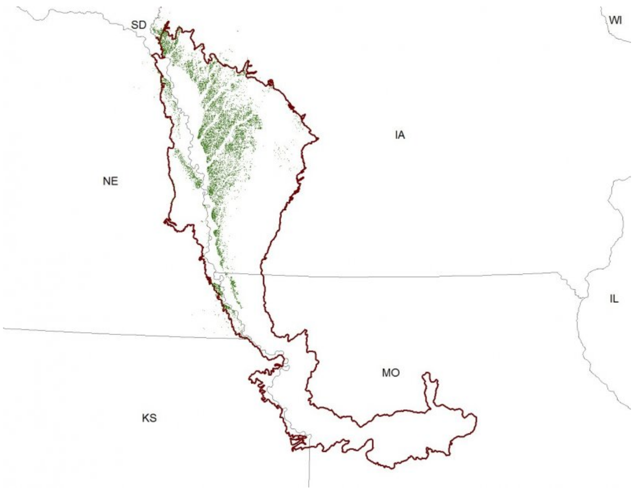


Figure 2. Figure 1. Location of Calcareous Loess Protected Backslope Savanna ecological site within MLRA 107B.

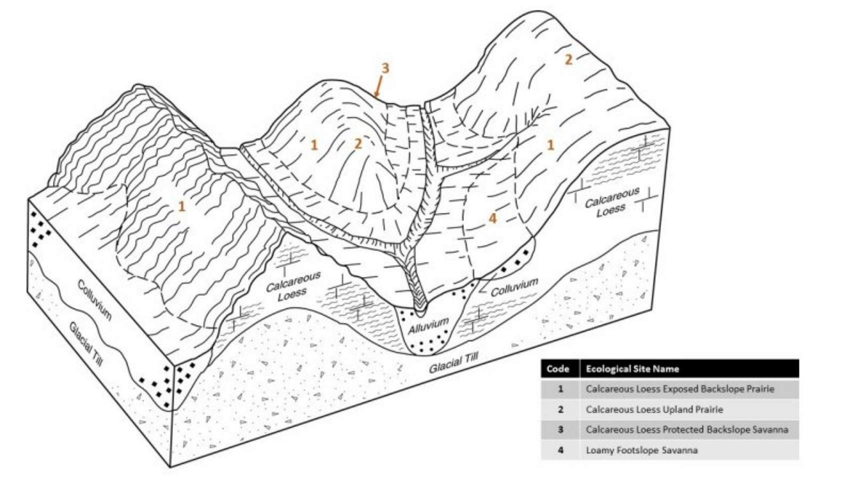


Figure 3. Figure 2. Representative block diagram of Calcareous Loess Protected Backslope Savanna and associated ecological sites.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope
Slope shape across	(1) Convex
Slope shape up-down	(1) Convex
Landforms	(1) Loess hill
Flooding frequency	None
Ponding frequency	None

Elevation	335–457 ft
Slope	15–25%
Aspect	N, NE, E, SE

Climatic features

The Iowa and Missouri Deep Loess Hills falls into two Köppen-Geiger climate classifications (Peel et al. 2007): hot humid continental climate (Dfa) dominates the majority of the MLRA with small portions in the south falling into the humid subtropical climate (Cfa). In winter, dry, cold air masses periodically shift south from Canada. As these air masses collide with humid air, snowfall and rainfall result. In summer, moist, warm air masses from the Gulf of Mexico migrate north, producing significant frontal or convective rains (Decker 2017). Occasionally, high pressure will stagnate over the region, creating extended droughty periods. These periods of drought have historically occurred on 22-year cycles (Stockton and Meko 1983).

The soil temperature regime of MLRA 107B is classified as mesic, where the mean annual soil temperature is between 46 and 59°F (USDA-NRCS 2006). Temperature and precipitation occur along a north-south gradient, where temperature and precipitation increase the further south you travel. The average freeze-free period of this ecological site is about 175 days, while the frost-free period is about 154 days (Table 2). The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is 28 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 38 and 61°F, respectively.

Climate data and analyses are derived from 30-year average gathered from six National Oceanic and Atmospheric Administration (NOAA) weather stations contained within the range of this ecological site (Table 4).

Table 3. Representative climatic features

Frost-free period (characteristic range)	133-152 days
Freeze-free period (characteristic range)	156-179 days
Precipitation total (characteristic range)	31-34 in
Frost-free period (actual range)	132-154 days
Freeze-free period (actual range)	156-184 days
Precipitation total (actual range)	28-34 in
Frost-free period (average)	140 days
Freeze-free period (average)	165 days
Precipitation total (average)	32 in

Climate stations used

- (1) SIDNEY [USC00137669], Sidney, IA
- (2) GLENWOOD 3SW [USC00133290], Glenwood, IA
- (3) LOGAN [USC00134894], Logan, IA
- (4) ONAWA 3NW [USC00136243], Onawa, IA
- (5) SIOUX CITY GATEWAY AP [USW00014943], Sioux City, IA
- (6) TARKIO [USW00014945], Tarkio, MO

Influencing water features

Calcareous Loess Protected Backslope Savannas are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is moderate (Hydrologic Group B), and surface runoff is high. Precipitation infiltrates the soil surface and percolates downward through the horizons unimpeded by any restrictive layer. The Dakota bedrock aquifer in the northern region of this ecological site is typically deep and confined, leaving it generally unaffected by recharge. However, there are surficial aquifers in the

Pennsylvanian strata in the southern extent of the ecological site that are shallow and allow some recharge (Prior et al. 2003). Surface runoff contributes some water to downslope ecological sites. Evapotranspiration rates occur on a latitudinal gradient, with the northern end of the ecological site receiving a greater number of days with sun and high winds resulting in a higher average evapotranspiration rate compared to the southern end (Visher 1954).

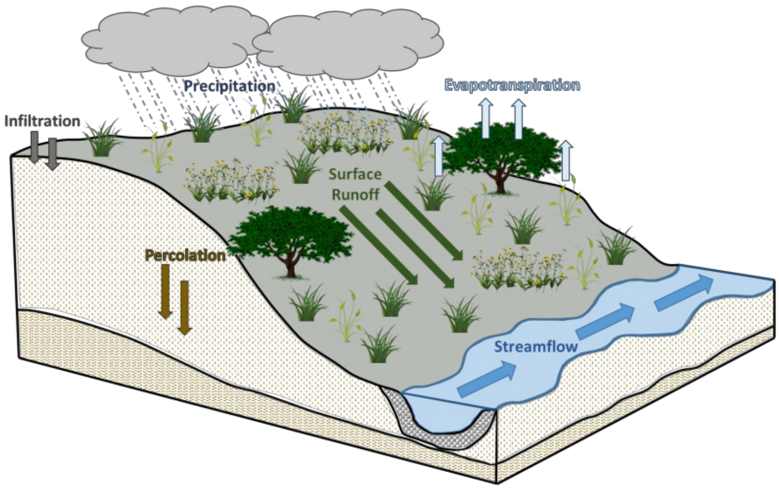


Figure 10. Figure 5. Hydrologic cycling in Calcareous Loess Protected Backslope Savanna ecological site.

Soil features

Soils of Calcareous Loess Protected Backslope Savannas are in the Entisol order, further classified as Typic Udorthents. They were formed under prairie vegetation, but have not developed dark surface horizons due to high surface runoff rates, high erosion rates, and dry environmental conditions. The soil series associated with this site includes Dow and Ida. The parent material is calcareous loess, and the soils are well-drained and very deep with no coarse fragments. Soil pH classes are neutral to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site. Average clay content is low limiting compaction susceptibility, but erosion from wind and water can be high.

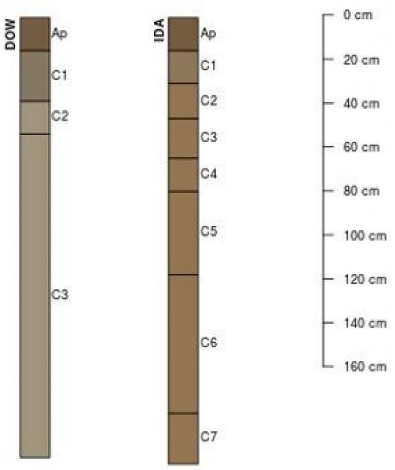


Figure 11. Figure 6. Profile sketches of soil series associated with Calcareous Loess Protected Backslope Savanna.

Table 4. Representative soil features

Parent material	(1) Calcareous loess
Surface texture	(1) Silt loam
Family particle size	(1) Fine-silty
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderately slow to moderate

Soil depth	80 in
Available water capacity (0-40in)	8 in
Calcium carbonate equivalent (0-40in)	5–30%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	6.6–8.4

Ecological dynamics

Calcareous Loess Protected Backslope Savannas form a vegetative continuum throughout the prairie-woodland borders of the Loess Hills (NatureServe 2015). This ecological site occurs on mesic north- and east-facing backslopes on well-drained calcareous soils. Species characteristic of this ecological site are scattered bur oaks and sun-loving, fire- and drought-adapted prairie plants in the understory.

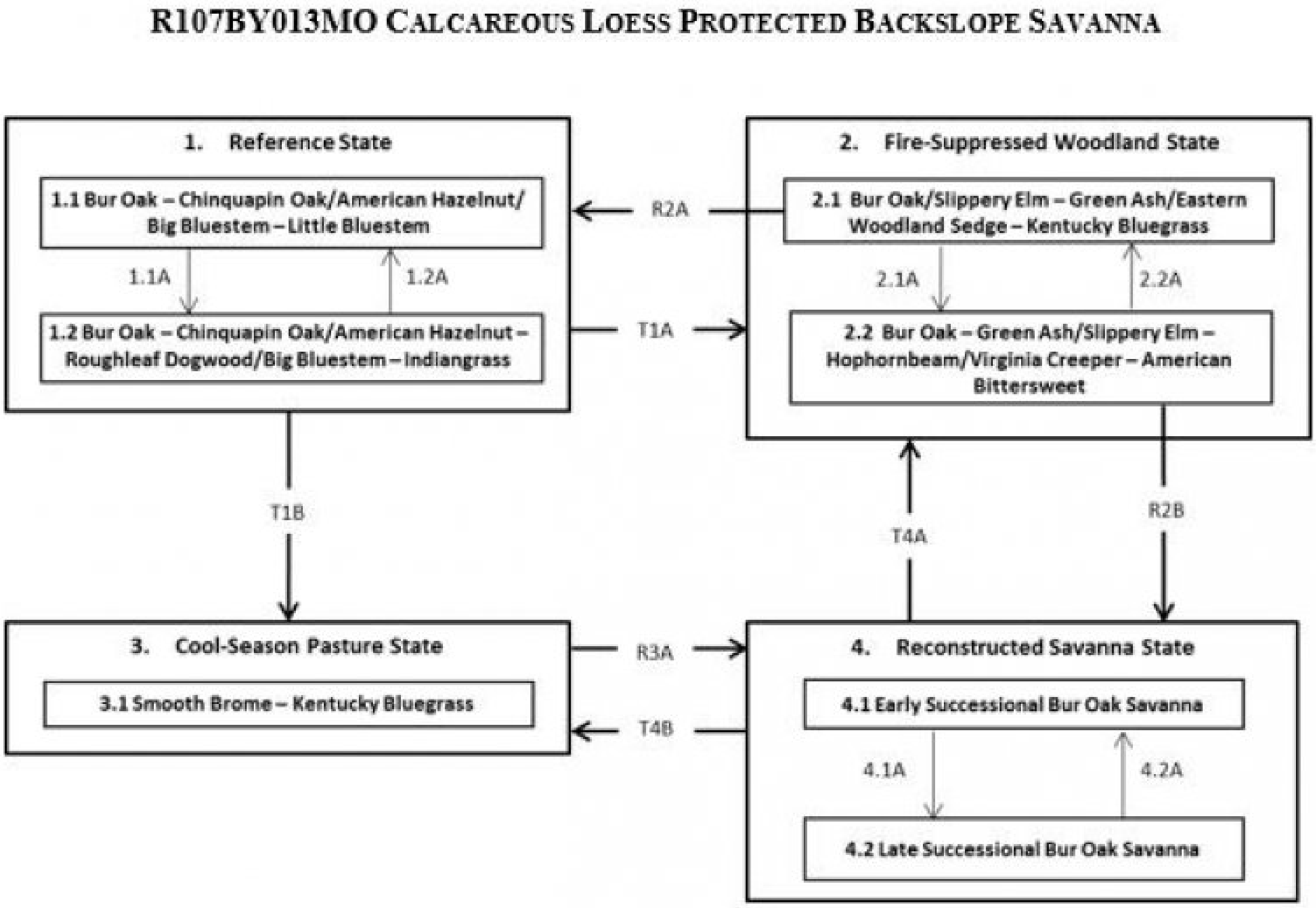
Fire is the most important ecosystem driver for maintaining this ecological site (Nelson 2010; Gucker 2011). Fire intensity was influenced by aspect, topography, weather, and plant productivity but typically consisted of periodic, low-intensity surface fires (Stambaugh et al. 2006; LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during the spring and fall seasons. Native Americans regularly set fires to improve sight lines for hunting, driving large game, improving grazing and browsing habitat, agricultural and village clearing, and enhancing vital ethnobotanical plants (Day 1953; Barrett 1980; White 1994). Fire frequency has been estimated to occur on average every 6.6 years in the Loess Hills region (Stambaugh et al. 2006). This continuous disturbance provided critical conditions for perpetuating the native savanna ecosystem.

Grazing by native ungulates is often cited as an important disturbance regime of North American grasslands, with bison (Bison bison), prairie elk (Cervus elaphus), and white-tailed deer (Odocoileus virginianus) serving as the dominant herbivores of the area. However, plant community succession in the Loess Hills region does not necessarily follow this hypothesis. The steep and rugged topography of the Loess Hills has been considered an impediment to grazing by large ungulates such as bison. Any role bison played in the area was most likely relegated to the northwestern extent where the terrain is milder (Dinsmore 1994). Browsing by elk and deer is believed to have played a relatively minimal role in reducing woody biomass in the Loess Hills (Farnsworth 2009; LANDFIRE 2009).

Drought has also played a role in shaping the prairie-savanna trajectories in the Loess Hills. The periodic episodes of reduced soil moisture in conjunction with the well-drained soils have favored the proliferation of plant species tolerant of such conditions (Stambaugh et al. 2006). In addition, drought can also slow the growth of plants and result in dieback of certain species. When coupled with fire, periods of drought can also greatly delay the recovery of woody vegetation, substantially altering the extent of shrubs and trees (Pyne et al. 1996).

Today, Calcareous Loess Protected Backslope Savannas are limited in their extent, having been reduced as a result of long-term fire suppression or having been converted to cool-season grassland. Areas where slopes are less than twenty percent may have been converted to cropland, but these comprise a small portion of the landscape. What remnants do exist are either highly degraded and have been invaded by fire-intolerant species or show evidence of indirect anthropogenic influence as some non-native species (i.e., Kentucky bluegrass (*Poa pratensis* L.)) are present in the understory. A return to the historic plant community is likely not possible, but long-term restoration efforts can help to restore some natural diversity and ecological functioning.

State and transition model



Code	Process
T1A, T4A	Fire suppression
T1B, T4B	Woody species reduction, fire suppression, non-selective herbicide, interseeding of non-native cool-season grasses, and continuous grazing
1.1A	Fire-free period, 5-10 years
1.2A	Fire-free period, less than 5 years
R2A	Selective tree removal, non-native species control, and reintroduction of historic fire regime
2.1A	Fire-free period, >25 years
2.2A	Fire-free period, <25 years
R2B, R3A	Site preparation, invasive species control, and seeding native species
4.1A	Invasive species control and implementation of disturbance regimes
4.2A	Drought or improper timing/use of management actions

Figure 12. STM

State 1
Reference State

The reference plant community is categorized as an oak savanna and includes a continuous coverage of grasses and forbs, a ten to 30 percent canopy of oaks, and a sparse layer of shrubs (Asbjornsen et al. 2005; NatureServe 2015). The two community phases within the reference state are dependent on a fire frequency of every one to ten years (LANDFIRE 2009). Shorter fire intervals maintain dominance by grasses, while less frequent intervals allow woody vegetation to increase their importance in the plant canopy. Grazing and drought disturbances have less impact in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- chinquapin oak (*Quercus muehlenbergii*), tree
- American hazelnut (*Corylus americana*), shrub

- big bluestem (*Andropogon gerardii*), grass
- little bluestem (*Schizachyrium scoparium*), grass

Community 1.1
Bur Oak – Chinquapin Oak/American Hazelnut/Big Bluestem – Little Bluestem

This reference community phase supports sparse, widely-scatted bur and chinquapin oaks with a canopy coverage up to fifteen percent. Mean fire return interval is approximately five years (LANDFIRE 2009). Oaks are no approximately 30 to 60 feet tall and medium-sized (nine to 21 inch DBH) (LANDFIRE 2009; Nelson 2010). Shrubs are limited and generally consist of small patches of American hazelnut and leadplant. The understory supports a variety of tallgrass herbaceous species with little bluestem and sideoats grama the indicator species for this community.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- chinquapin oak (*Quercus muehlenbergii*), tree
- American hazelnut (*Corylus americana*), shrub
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass

Community 1.2
Bur Oak – Chinquapin Oak/American Hazelnut – Roughleaf Dogwood/Big Bluestem – Indiangrass

This reference community phase can occur when fire frequency is reduced to no more than ten years. The oak component matures, reaching large size classes (21 to 33 inch DBH) and canopies of 30 percent cover (LANDFIRE 2009). The native prairie grasses continue to form the dominant herbaceous canopy cover, but the reduced fire interval allows taller grasses, such as big bluestem and Indiangrass (*Sorghastrum nutans* (L.) Nash) to shade out some of the shorter stature species. American hazelnut increases its cover in the shrub canopy with roughleaf dogwood becoming co-dominant (Rosburg 1994; LANDFIRE 2009; Steinauer and Rolfsmeier 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- chinquapin oak (*Quercus muehlenbergii*), tree
- American hazelnut (*Corylus americana*), shrub
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass

Pathway P1.1A
Community 1.1 to 1.2

Pathway 1.1A – Natural succession as a result of a mean fire return interval of ten years.

Pathway P1.2A
Community 1.2 to 1.1

Pathway 1.2A – Natural succession as a result of a mean fire return interval of five years.

State 2
Fire Suppressed Woodland State

Long-term fire suppression can transition the reference savanna community into a fire-suppressed woodland state. As the natural fire regime is removed from the landscape, encroachment by shade-tolerant species ensues as the overstory canopy becomes denser (Asbjornsen et al 2005). Succession to this woodland state can occur in as little as 25 years from the last fire (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- hophornbeam (*Ostrya virginiana*), shrub
- slippery elm (*Ulmus rubra*), shrub
- Kentucky bluegrass (*Poa pratensis*), grass
- eastern woodland sedge (*Carex blanda*), grass

Community 2.1
Bur Oak/Slippery Elm – Green Ash/Eastern Woodland Sedge – Kentucky Bluegrass

This community phase represents the early stages of long-term fire-suppression of the native savanna. Bur oak is the dominant canopy component, and slippery elm (*Ulmus rubra* Muhl.) and green ash (*Fraxinus pennsylvanica* Marshall) arise in the sub-canopy. Roughleaf dogwood becomes the dominant shrub component, while eastern woodland sedge (*Carex blanda* Dewey) and Kentucky bluegrass (*Poa pratensis* L.) become important species of the understory (Rosburg 1994; Steinauer and Rolfsmeier 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- green ash (*Fraxinus pennsylvanica*), shrub
- slippery elm (*Ulmus rubra*), shrub
- eastern woodland sedge (*Carex blanda*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

Community 2.2
Bur Oak – Green Ash/Slippery Elm – Hophornbeam/Virginia Creeper – American Bittersweet

Sites falling into this community phase are still dominated by bur oak, but the fire-intolerant green ash becomes more conspicuous. Slippery elm persists as an important subcanopy component, while hophornbeam (*Ostrya virginiana* (Mill.) K. Koch) becomes an important indicator species (Rosburg 1994). The shrub component is sparse to non-existent, typically with roughleaf dogwood or chokecherry (Steinauer and Rolfsmeier 2010). The understory transitions to shade-tolerant species such as Virginia creeper (*Parthenocissus quinquefolia* (L.) Planch.) and American bittersweet (*Celastrus scandens* L.) (Rosburg 1994).

Pathway P2.1A
Community 2.1 to 2.2

Pathway 2.1A – Fire is removed from the landscape in excess of 30 years.

Pathway P2.2A
Community 2.2 to 2.1

Fire is restored to the landscape within 25 years of initial encroachment.

State 3
Cool Season Pasture State

The cool-season pasture state occurs when the reference state has been anthropogenically-altered for livestock production. Fire suppression, seeding of non-native cool-season grasses, removal of woody vegetation, and grazing by domesticated livestock transition and maintain this simplified grassland state (Rosburg 1994). Early settlers seeded such non-native cool-season species as smooth brome (*Bromus inermis* Leyss.) and Kentucky bluegrass in order to help extend the grazing season (Smith 1998). Scattered bur oaks may have escaped harvest by settlers and could be present. Over time, as lands were continually grazed by large herds of cattle, the non-native species were able to spread and expand across the prairie habitat, reducing the native species diversity.

Community 3.1
Smooth Brome – Kentucky Bluegrass

Species characteristic of this community phase include big bluestem, smooth brome, and Kentucky bluegrass. While the native big bluestem forms the dominant component of the canopy, smooth brome and Kentucky bluegrass occur in higher frequencies across the site. Annuals and biennials are important components of this community phase and are indicative of the disturbed nature of the site (Rosburg 1994).

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

State 4
Reconstructed Savanna State

Savanna reconstruction has become an important tool for repairing natural ecological functioning and providing habitat protection for numerous grassland-dependent species. The historic plant community of the tallgrass oak savanna was extremely diverse and complex, and habitat replication is not considered to be possible once the native vegetation has been altered by post-European settlement land uses. Therefore ecological restoration should aim to aid the recovery of degraded, damaged, or destroyed ecosystems. A successful restoration will have the ability to structurally and functionally sustain itself, demonstrate resilience to the natural ranges of stress and disturbance, and create and maintain positive biotic and abiotic interactions (SER 2002). The reconstructed savanna state is the result of a long-term commitment involving a multi-step, adaptive management process. Bur oak plantings or selective tree thinning of non-oak species will be required in order to reproduce the overstory canopy (Asbjornsen et al. 2005). Diverse, species-rich seed mixes may be important to utilize as they allow the site to undergo successional stages that exhibit changing composition and dominance over time (Smith et al. 2010). On-going management via prescribed fire and/or light grazing will help the site progress from an early successional community dominated by annuals and some weeds to a later seral stage composed of native perennial grasses, forbs, shrubs, and eventually mature bur oaks. Establishing a prescribed fire regime that mimics natural disturbance patterns can increase native species cover and diversity while reducing cover of non-native forbs and grasses. Light grazing alone can help promote species richness, while grazing accompanied with fire can control the encroachment of undesirable woody vegetation (Brudvig et al. 2007).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree

Community 4.1
Early Successional Reconstructed Oak Savanna

This community phase represents early community assembly and is highly dependent on the timing and priority of planting and/or tree thinning operations and the seed mix utilized. If bur oak planting is needed, acorns should be planted shortly after harvest as acorns germinate shortly after seedfall and require no cold stratification. Browse protection may need to be installed to protect newly established seedlings from animal predation (Gucker 2011). If selective tree removal is needed, canopy reduction should encompass between 16 to 45 percent of the undesirable species in a single year (Asbjornsen et al. 2005). The seed mix should look to include a diverse mix of native cool-season and warm-season annual and perennial grasses and forbs typical of the reference state. Native, cool-season annuals can help to provide litter that promotes cool, moist soil conditions to the benefit of the other species in the seed mix. The first season following site preparation and seeding will typically result in annuals and other volunteer species forming the vegetative cover. Control of non-native species, particularly perennial species, is crucial at this point in order to ensure they do not establish before the native vegetation (Martin and Wilsey 2012). After the first season, native warm-season grasses should begin to become more prominent on the landscape and over time close the canopy.

Community 4.2
Late Successional Reconstructed Oak Savanna –

Appropriately timed disturbance regimes (e.g., prescribed fire) applied to the early successional community phase can help increase the beta diversity, pushing the site into a late successional community phase over time. While oak savanna communities are dominated by grasses, these species can suppress forb establishment and reduce overall diversity and ecological functioning (Martin and Wilsey 2006; Williams et al. 2007). Reducing accumulated plant litter from such tallgrasses as big bluestem and Indiangrass allows more light and nutrients to become available for forb recruitment, allowing for greater ecosystem complexity (Wilsey 2008). Prescribed fire should be used no on a cycle no less than every five years in order to allow the oaks to establish and mature (Gucker 2011).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree

Pathway P4.1A
Community 4.1 to 4.2

Selective herbicides are used to control non-native species, and prescribed fire and/or light grazing help to increase the native species diversity and control non-oak woody vegetation.

Pathway P4.2A
Community 4.2 to 4.1

Reconstruction experiences a decrease in native species diversity from drought or improper timing of management actions (e.g., reduced fire frequency, use of non-selective herbicides).

Transition T1A
State 1 to 2

Fire suppression transitions this site to the fire-suppressed woodland state (2).

Transition T1B
State 1 to 3

Woody species reduction, fire suppression, non-selective herbicide, interseeding of non-native cool-season grasses, and continuous grazing transition this site to the cool-season pasture state (3).

Restoration pathway R2A
State 2 to 1

Mechanical or chemical control of undesirable woody species and non-native species and reintroduction of a historic fire regime restore the site back to the reference state (1).

Restoration pathway R2B
State 2 to 4

Site preparation, invasive species control (native and non-native), and seeding native species transition this site to the reconstructed savanna state (4).

Restoration pathway R3A
State 3 to 4

Site preparation, invasive species control (native and non-native), and seeding native species transition this site to the reconstructed savanna state (4).

Transition T4A
State 4 to 2

Fire suppression and removal of active management transitions this site to the fire-suppressed woodland state (2).

Transition T4B
State 4 to 3

Land is converted to the cool-season pasture state through the use of non-selective herbicide and seeding of non-native cool-season grasses (3).

Additional community tables

Animal community

Wildlife*

Prairie Phase:
Game species that utilize this ecological site include:
Northern Bobwhite will utilize this ecological site for food (seeds, insects) and cover needs (escape, nesting and roosting cover).

Cottontail rabbits will utilize this ecological site for food (seeds, soft mast) and cover needs.

Turkey will utilize this ecological site for food (seeds, green browse, soft mast, and insects) and nesting and brood-rearing cover. Turkey poults feed heavily on insects provided by this site type.

Bird species associated with this ecological site's reference state condition:
Breeding birds as related to vegetation structure (related to time since fire, grazing, haying, and mowing):
Vegetation Height Short (< 0.5 meter, low litter levels, bare ground visible):
Grasshopper Sparrow, Horned Lark, Northern Bobwhite

Medium Vegetation Height (0.5 – 1 meter, moderate litter levels, some bare ground visible): Eastern Meadowlark, Dickcissel, Field Sparrow, Northern Bobwhite, Bobolink, Eastern Kingbird

Brushy – Mix of grasses, forbs, native shrubs (e.g., Rhus copallina, Prunus americana, Rubus spp., Rosa carolina) and small trees (e.g., Cornus drummondii):
Bell's Vireo, Yellow-Breasted Chat, Loggerhead Shrike, Brown Thrasher, Common Yellowthroat

Amphibian and reptile species associated with this ecological site's reference state condition: Ornate Box Turtle (Terrapene ornata ornata), Western Slender Glass Lizard (Ophisaurus attenuatus attenuatus), Great Plains Skink (Eumeces obsoletus), Northern Prairie Skink (E. septentrionalis septentrionalis), Prairie Kingsnake (Lampropeltis calligaster calligaster), and Bullsnake (Pituophis catenifer sayi).

Small mammals associated with this ecological site's reference state condition:
Prairie Vole (Microtus ochrogaster), Meadow Jumping Mouse (Zapus hudsonius), Plains Pocket Gopher (Geomys bursarius), Franklin's Ground Squirrel (Spermophilus franklinii), and Thirteen-lined Ground Squirrel (Spermophilus tridecemlineatus).

Invertebrates:
Many native insect species are likely associated with this ecological site, especially native bees, ants, beetles, butterflies and moths, and crickets, grasshoppers and katydids. However information on these groups is often lacking enough resolution to assign them to individual ecological sites.

Insect species known to be associated with this ecological site's reference state condition include: Prairie Meadow Katydid (Conocephalus saltans), Packard's Grasshopper (Melanoplus packardii), Mermiria Grasshopper (Mermiria picta), Black-margined Shield-back Katydid (Pediodectes nigromarginata), Ottoe Skipper butterfly (Hesperia ottoe) and two native bees (Tetraloniella albata, Diadasia enavata).

Savanna Phase:
Oaks and hickories provide an important food source for many animals including White-tailed Deer, Wild Turkey, and Fox Squirrel.

Both snags and live cavity or den trees provide important food and cover for vertebrate wildlife. Snags are also very important to invertebrate species. Fox Squirrel, Red-headed Woodpecker and Eastern Bluebird utilize snags and den trees for foraging, nesting or shelter. “Wolf” trees are a particularly valuable type of live cavity tree. These large diameter, often open-grown, old-ages, hollow trees provide both cavities for wildlife and usually hard or soft mast food sources. Large diameter snags and den trees are particularly important wildlife habitat features to retain.

Game species that utilize this ecological site include:
Northern Bobwhite will utilize this ecological site for food (seeds, insects) and cover needs (escape, nesting and roosting cover).

Cottontail rabbits will utilize this ecological site for food (seeds, soft mast) and cover needs.

Turkey will utilize this ecological site for food (seeds, green browse, soft mast, insects) and nesting and brood-rearing cover. Turkey poults feed heavily on insects provided by this site type.

White-tailed Deer will utilize this ecological site for browse (plant leaves in the growing season, seeds and soft mast in the fall/winter). This site type also can provide escape cover.

Bird species associated with this ecological site’s reference state condition:
Breeding birds: Northern Bobwhite, Eastern Kingbird, Eastern Bluebird, Brown Thrasher, White-eyed Vireo, Prairie Warbler, Field Sparrow, Eastern Towhee, Red-headed Woodpecker, Great Crested Flycatcher, Loggerhead Shrike

Winter resident: American Tree Sparrow, Harris’ Sparrow

Amphibian and reptile species associated with this ecological site’s reference state condition: Ornate Box Turtle (Terrapene ornata ornata), Northern Fence Lizard (Sceloporus undulates hyacinthinus), Five-lined Skink (Eumeces fasciatus), Western Slender Glass Lizard (Ophisaurus attenuatus attenuatus), Eastern Yellow-bellied Racer (Coluber constrictor flaviventris), Prairie Ring-necked Snake (Diadophis punctatus arnyi), and Rough Green Snake (Opheodrys aestivus aestivus). Sites containing or nearby to fishless or ephemeral ponds/pools can support the Eastern Tiger Salamander (Ambystoma tigrinum tigrinum).

Small mammals associated with this ecological site’s reference state condition: Fox Squirrel (Sciurus niger), Woodland Vole (Microtus pinetorum), Least Shrew (Cryptotis parva), and Indiana Bat (Myotis sodalis). Indiana bats utilize suitable live, dying or dead roost trees for summer habitat and raising young. Suitable roost trees typically have exfoliating or flaking bark and are larger in diameter.

Invertebrates – Many native insect species are likely associated with this phase of this ecological site’s reference state condition, especially native bees, ants, beetles, butterflies and moths, and crickets, grasshoppers and katydids. However we don’t have enough information on these groups to assign them to this phase of this ecological site’s reference state condition at this time.

*This section prepared by Mike Leahy, Natural Areas Coordinator, Missouri Department of Conservation, 2013

Other information

Forestry

Management: This ecological site is not recommended for traditional timber management activity. Historically this site was dominated by a ground cover of native prairie grasses and forbs. Some scattered open grown trees may have also been present. May be suitable for non-traditional forestry uses such as windbreaks, environmental plantings, alley cropping (a method of planting, in which rows of trees or shrubs are interspersed with rows of crops) or woody bio-fuels.

Inventory data references

No field plots were available for this site. A review of the scientific literature and professional experience were used to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in ecological site description.

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Approval

Chris Tecklenburg, 5/21/2020

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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)	Lisa Kluesner
Contact for lead author	
Date	02/10/2025
Approved by	Chris Tecklenburg
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):**

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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:

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

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

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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:**
