Ecological site R107XA204IA
Calcareous Till Protected Backslope Savanna

Last updated: 5/21/2020
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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 Minnesota Loess Hills (MLRA 107A) includes the Northwest Iowa Plains, Inner Coteau, and Coteau Moraines landforms (Prior 1991; MDNR 2005). It spans two states (Iowa, 89 percent; Minnesota, 11 percent), encompassing approximately 4,470 square miles (Figure 1). The elevation ranges from approximately 1,700 feet above sea level (ASL) on the highest ridges to about 1,115 feet ASL in the lowest valleys. Local relief is mainly 10 to 100 feet. However, some valley floors can range from 80 to 200 feet, while some upland flats only range between 3 and 6 feet. The eastern half of the MLRA is underlain by Wisconsin-age till, deposited between 20,000 and 30,000 years ago and is known as the Sheldon Creek Formation. The western half is underlain by Pre-Illinoian glacial till, deposited more than 500,000 years ago and has since undergone extensive erosion and dissection. Both surfaces are covered by approximately 4 to 20 feet of loess on the hillslopes, and Holocene alluvium covers the till in the drainageways. Cretaceous bedrock, comprised of sandstone and shale, lies 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, while the more wooded and forested areas maintained a foothold in sheltered areas. This prairie-forest transition ecosystem formed the dominant landscapes until the arrival of European settlers (Baker et al. 1992).

Classification relationships

U.S. Forest Service Ecological Subregions: North Central Glaciated Plains (251B) Section, Outer Coteau des Prairies (251Bb), Northwest Iowa Plains (251Bd) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Loess Prairies (47a) (USEPA 2013)

National Vegetation Classification – Ecological System: North-Central Interior Oak Savanna (CES202.698) (NatureServe 2015)

National Vegetation Classification - Plant Associations: Quercus macrocarpa Northern Tallgrass Wooded Grassland

(CEGL002158) (NatureServe 2015)

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

Natural Resources Conservation Service – Iowa Plant Community Species List: Opening, Northern Bur Oak (USDA-NRCS 2007)

Iowa Department of Natural Resources: Tallgrass Savanna (INAI 1984)

Minnesota Department of Natural Resources: Ups14c Dry Hill Oak Savanna (Southern) (MDNR 2005)

Ecological site concept

Calcareous Till Protected Backslope Savannas are located within the green areas on the map (Figure 1). They occur on north and east-facing upland backslopes on slopes greater than 20 percent. The soils are Mollisols and Entisols that are well drained and deep, formed in calcareous glacial till. These fine-loamy soils experience moisture deficits during the growing season most years and frequent deficits during times of droughts (MDNR 2005; NatureServe 2015).

The historic pre-European settlement vegetation on this site was dominated by herbaceous species typical of a midgrass prairie and widely scattered trees. Little bluestem (Schizachyrium scoparium (Michx.) Nash) and sideoats grama (Bouteloua curtipendula (Michx.) Torr.) are the dominant grass species of Calcareous Till Protected Backslope Savannas, while bur oak (Quercus macrocarpa Michx.) is the dominant tree species. Other grasses that may occur include porcupinegrass (Hesperostipa spartea), Indiangrass (Sorghastrum nutans (L.) Nash), and Pennsylvania sedge (Carex pensylvanica) (MDNR 2005). Forbs typical of an undisturbed plant community associated with this ecological site include purple prairie clover (Dalea purpurea Vent.), candle anemone (Anemone cylindrica A. Gray), and hoary puccoon (Lithospermum canescens (Michx.) Lehm.) (Drobney et al. 2001; MDNR 2005). Shrub cover is sparse to patchy and can contain leadplant (Amorpha canescens Pursh), prairie rose (Rosa arkansana Porter), and smooth sumac (Rhus glabra L.) (MDNR 2005). Fire is the primary disturbance factor that maintains this site, while drought and herbivory are secondary factors (MDNR 2005; LANDFIRE 2009).

Associated sites

R107XA202IA	**Calcareous Till Upland Prairie** Glacial till on uplands that are shallow to calcium carbonates including Moneta and Steinauer
R107XA203IA	**Calcareous Till Exposed Backslope Prairie** Glacial till on south and west facing upland backslopes with slopes greater than 20 percent that are shallow to calcium carbonates including Cornell, Moneta, Steinauer, and soils that are moderately deep to carbonates.

Similar sites

R107XA203IA	**Calcareous Till Exposed Backslope Prairie** Calcareous Till Exposed Backslope Prairies are similar in parent material but occur on south and west aspects on upland backslopes

Table 1. Dominant plant species

Tree	(1) *Quercus macrocarpa*
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium* (2) *Bouteloua curtipendula*

Physiographic features

Calcareous Till Protected Backslope Savannas occur on north and east-facing upland backslopes on slopes greater than 20 percent (Figure 2). They are situated on elevations ranging from approximately 649 to 1801 feet ASL. The site does not experience flooding but rather generates runoff to adjacent, downslope ecological sites.

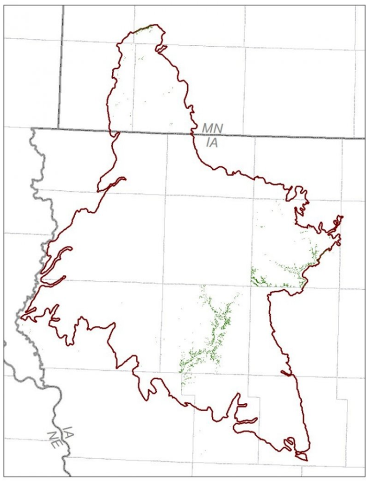


Figure 2. Figure 1. Location of Calcareous Till Protected Backslope Savanna ecological site within MLRA 107A.

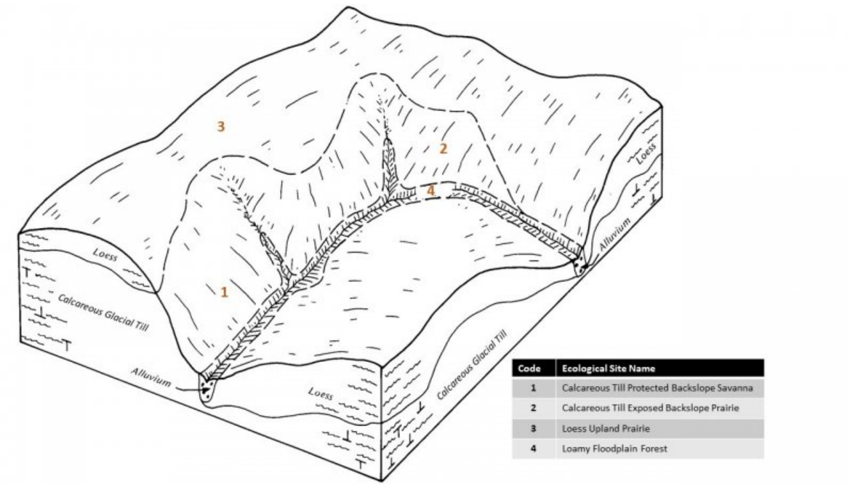


Figure 3. Figure 2. Representative block diagram of Calcareous Till Protected Backslope Savanna and associated ecological sites.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope
Slope shape across	(1) Convex
Slope shape up-down	(1) Convex
Landforms	(1) Upland > Hillslope
Runoff class	High to very high
Elevation	649–1,801 ft
Slope	15–45%
Water table depth	60–80 in
Aspect	N, NE, E, SE

Climatic features

The Iowa and Minnesota Loess Hills falls into the hot humid continental climate (Dfa) Köppen-Geiger climate classification (Peel et al. 2007). 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. Occasionally, hot, dry winds originating from the Desert Southwest will stagnate over the region, creating extended droughty periods in the summer from unusually high temperatures. Air masses from the Pacific Ocean can also spread into the region and dominate producing mild, dry weather in the autumn known as Indian Summers (NCDC 2006).

The soil temperature regime of MLRA 107A 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 one travels. The average freeze-free period of this ecological site is about 157 days, while the frost-free period is about 134 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 approximately 32 inches, which includes rainfall plus the water equivalent from snowfall. The average annual low and high temperatures are 36 and 58°F, respectively (Table 3).

Climate data and analyses are derived from 30-year averages gathered from two 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)	126 days
Freeze-free period (characteristic range)	147-149 days
Precipitation total (characteristic range)	31 in
Frost-free period (actual range)	126 days
Freeze-free period (actual range)	147-149 days
Precipitation total (actual range)	31-32 in
Frost-free period (average)	126 days
Freeze-free period (average)	148 days
Precipitation total (average)	31 in

Climate stations used

- (1) CHEROKEE [USC00131442], Cherokee, IA
- (2) SIOUX RAPIDS 4 E [USC00137726], Sioux Rapids, IA

Influencing water features

Calcareous Till 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 slow to moderate (Hydrologic Groups B, C) for undrained soils, and surface runoff is high to very high. Precipitation infiltrates the soil surface and percolates downward through the horizons unimpeded by any restrictive layer. The Dakota bedrock aquifer underlying this ecological site is typically deep and confined, leaving it generally unaffected by recharge (Prior et al. 2003). Surface runoff contributes some water to downslope ecological sites (Figure 5).

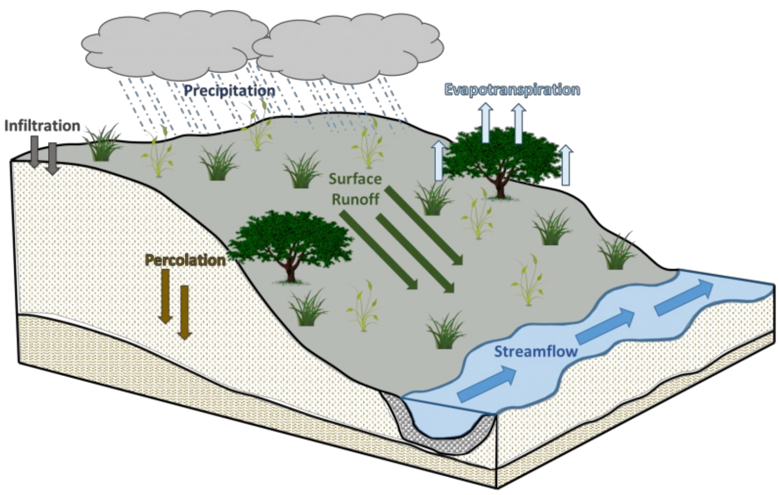


Figure 10. Figure 5. Hydrologic cycling in Calcareous Till Protected

Backslope Savanna ecological site.

Soil features

Soils of Calcareous Till Protected Backslope Savannas are in the Mollisols and Entisols orders, further classified as Entic Hapludolls, Oxyaquic Vertic Argiudolls, Typic Hapludolls, Udorthentic Haplustolls, and Typic Udorthents with slow to moderate infiltration and high to very high runoff potential. The soil series associated with this site includes Cornell, Moneta, Steinauer, Steinauer variant, and Soils that are moderately deep to carbonates (Figure 6). The parent material is calcareous glacial till and the soils are well drained and deep. Soil pH classes are slightly to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site (Table 5).

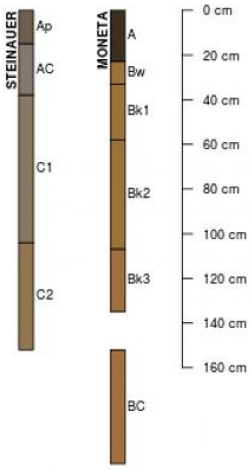


Figure 11. Figure 6. Profile sketches of soil series associated with Calcareous Till Protected Backslope Savanna.

Table 4. Representative soil features

Parent material	(1) Till
Family particle size	(1) Fine-loamy
Drainage class	Well drained
Permeability class	Slow
Soil depth	80 in

Ecological dynamics

The information in this Ecological Site Description, including the state-and-transition model (STM), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

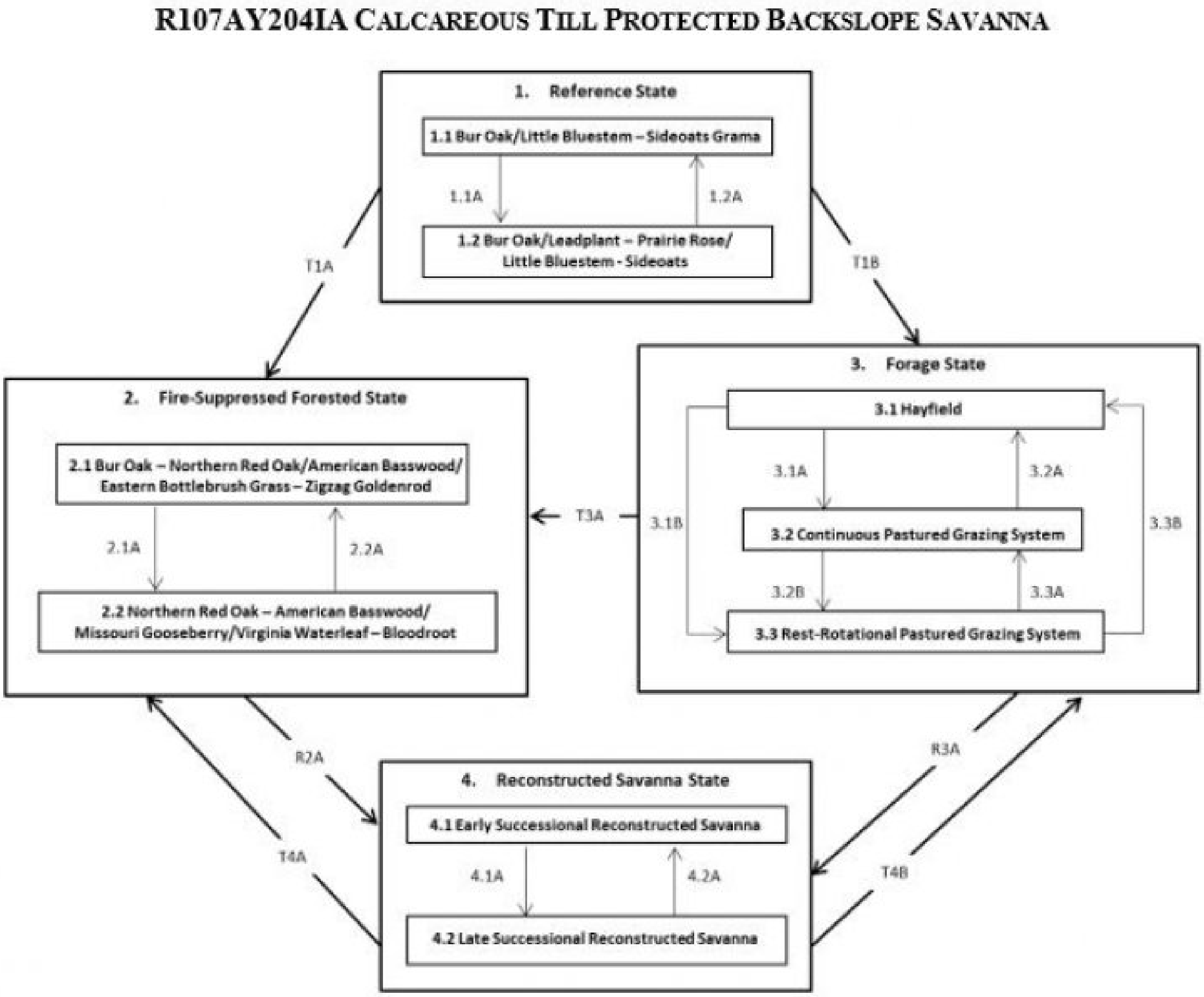
MLRA 107A is defined by a relatively low relief landscape that experiences lower rainfall amounts and available moisture compared to other MLRAs occurring to the south and east. As a result, prairie vegetation communities dominate the uplands, while forested communities are restricted to medium and large streams (Prior 1991; Eilers and Roosa 1994; MDNR 2017a, b). Calcareous Till Protected backslope Savannas form an aspect of this vegetative continuum. This ecological site occurs on north and east-facing upland backslopes on well-drained soils. Species characteristic of this ecological site consist of drought-tolerant, mid-grass herbaceous vegetation with scattered trees.

Fire is the dominant ecosystem driver for maintaining the vegetation of Calcareous Till Protected Backslope Savannas. Fire intensity typically consisted of periodic, high severity surface fires occurring every 1 to 10 years (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 clearing, and enhancing vital ethnobotanical plants (Barrett 1980; White 1994).

Drought and herbivory have also played a role in shaping this ecological site. 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. Drought can also slow the growth of plants and result in dieback of certain species. The steep slopes of this ecological site likely deterred extensive grazing, however some grazing could be expected from bison (Bos bison) and possibly prairie elk (Cervus elaphus), the main herbivores in northern tallgrass prairies (LANDFIRE 2009). When coupled with fire, periods of drought and herbivory can greatly delay the establishment of woody vegetation (Pyne et al. 1996).

Today, Calcareous Till Protected Backslope Savannas are likely extinct, having type-converted to a closed canopy forest as a result of long-term fire suppression or having been converted to pasture. Remnants that do exist show evidence of indirect anthropogenic influence as some non-native species are present in the species composition. A return to the historic plant community is highly challenging, but long-term reconstruction efforts can help to restore some the natural diversity and ecological function. The state-and-transition model that follows provides a detailed description of each state, community phase, pathway, and transition. This model is based on available experimental research, field observations, literature reviews, professional consensus, and interpretations.

State and transition model



Code	Process
T1A, T3A, T4A	Long-term fire suppression, land abandonment, and/or overgrazing
T1B, T4B	Cultural treatments are implemented to increase forage quality and yield
1.1A	Reduced fire return interval
1.2A	Increased fire return interval
2.1A	Forest succession from lack of disturbances, +30 years
2.2A	Recent disturbance event
3.1A	Mechanical harvesting is replaced with domestic livestock and continuous grazing
3.1B	Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing
3.2A, 3.3B	Domestic livestock grazing is replaced by mechanical harvesting
3.2B	Implementation of rest-rotational grazing
3.3A	Implementation of continuous grazing
R2A, R3A	Site preparation, selective tree thinning, invasive species control, and native seeding
4.1A	Invasive species control and implementation of disturbance regimes
4.2A	Drought or improper timing/use of management actions

State 1
Reference State

The reference plant community is categorized as an oak savanna and supports a continuous coverage of grasses and forbs, up to 50 percent canopy of oaks, and a sparse layer of shrubs (Asbjornsen et al. 2005; MDNR 2005; NatureServe 2015). The two community phases within the reference state are dependent on a fire frequency of every 1 to 10 years (LANDFIRE 2009). Shorter fire intervals maintain dominance by grasses, while less frequent intervals allow woody vegetation to increase their importance in the community composition. 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
- leadplant (*Amorpha canescens*), shrub
- prairie rose (*Rosa arkansana*), shrub
- little bluestem (*Schizachyrium*), grass
- sideoats grama (*Bouteloua curtipendula*), grass

Community 1.1
Bur Oak/Little Bluestem - Sideoats Grama

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) with canopy coverage between 20 and 50 percent (MDNR 2005; LANDFIRE 2009). The reduced fire interval allows the shrub canopy to become more prominent, with leadplant, prairie rose, smooth sumac, and western snowberry (*Symphoricarpos occidentalis* Hook.) being the most common species (Delong and Hooper 1996; MDNR 2005). Dotted hawthorn (*Crataegus punctata* Jacq.) may occur rarely and is an indicator of the calcareous soils (Delong and Hooper 1996). The native prairie grasses continue to form the dominant herbaceous component.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- little bluestem (*Schizachyrium*), grass
- sideoats grama (*Bouteloua curtipendula*), grass

Community 1.2
Bur Oak/Leadplant - Prairie Rose/Little Bluestem - Sideoats

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- leadplant (*Amorpha canescens*), shrub
- prairie rose (*Rosa arkansana*), shrub
- little bluestem (*Schizachyrium*), other herbaceous
- sideoats grama (*Bouteloua curtipendula*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Reduced fire interval

Pathway 1.2A
Community 1.2 to 1.1

Increased fire return interval

State 2
Fire-Suppressed Forested State

Fire suppression can transition the reference plant community from an open savanna to a closed canopy forest. As the natural fire regime is removed from the landscape, encroachment and dominance by shade-tolerant, fire-intolerant species ensues (Asbjornsen et al. 2005). This results in a positive feedback loop of mesophication whereby plant community succession continuously creates cool, damp shaded conditions that perpetuate a closed canopy ecosystem (Nowacki and Abrams 2008). Succession to this forested state can occur in as little as 25 years from the last fire (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- northern red oak (*Quercus rubra*), tree
- American basswood (*Tilia americana*), tree
- Missouri gooseberry (*Ribes missouriense*), shrub
- eastern bottlebrush grass (*Elymus hystrix*), other herbaceous
- zigzag goldenrod (*Solidago flexicaulis*), other herbaceous
- bloodroot (*Sanguinaria*), other herbaceous

Community 2.1
Bur Oak-Northern Red Oak/American Basswood/Eastern Bottlebrush Grass - Zigzag Goldenrod

This community phase represents the early stages of long-term fire suppression of the native savanna. The canopy is still somewhat open (60 to 80 percent closure) and the stem density is greatly increased from the reference state (LANDFIRE 2009). Bur oak is the dominant canopy component, but midseral species, such as northern red oak (*Quercus rubra* L.), begin to co-dominate. The fire intolerant American basswood (*Tilia americana* L.) arises in the subcanopy in the continued absence of fire (Tirmenstein 1991). The understory begins to shift from sun-loving tallgrass prairie species to species tolerant of partially shaded conditions, including eastern bottlebrush grass (*Elymus hystrix* L. var. hystrix) and zigzag goldenrod (*Solidago flexicaulis* L.).

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- American basswood (*Tilia americana*), tree
- eastern bottlebrush grass (*Elymus hystrix*), other herbaceous
- zigzag goldenrod (*Solidago flexicaulis*), other herbaceous

Community 2.2
Northern Red Oak - American Basswood/Missouri Gooseberry/Virginia Waterleaf - Bloodroot

Sites falling into this community phase are a closed canopy northern red oak – American basswood forest. Canopy coverage ranges from 80 to 100 percent, and trees are large (21 to 33-inch DBH) (LANDFIRE 2009). Missouri gooseberry (*Ribes missouriense* Nutt.) is the dominant shrub, but other species that may occur include chokecherry (*Prunus virginiana* L.) and black raspberry (*Rubus occidentalis* L.). The understory is dominated by shade-tolerant species such as Virginia waterleaf (Hydrophyllum virginanum L.). Spring ephemerals, e.g. bloodroot (*Sanguinaria canadensis* L.), Greek valerian (*Polemonium reptans* L.), and wild blue phlox (*Phlox divaricata* L.), are a characteristic component of this phase.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- American basswood (*Tilia americana*), tree
- Missouri gooseberry (*Ribes missouriense*), shrub
- bloodroot (*Sanguinaria*), grass

Pathway 2.1A
Community 2.1 to 2.2

Forest succession from lack of disturbances, +30 years

Pathway 2.2A
Community 2.2 to 2.1

Recent disturbance event

State 3

Forage State

The forage state occurs when the site is converted to a farming system that emphasizes domestic livestock production, known as grassland agriculture. Fire suppression, periodic cultural treatments (e.g., clipping, drainage, soil amendment applications, planting new species and/or cultivars, mechanical harvesting) and grazing by domesticated livestock transition and maintain this state (USDA-NRCS 2003). Early settlers seeded non-native species, such as smooth brome (*Bromus inermis* Leyss.) and Kentucky bluegrass (*Poa pratensis* L.), to help extend the grazing season (Smith 1998). Over time, as lands were continuously harvested or grazed by herds of cattle, these species were able to spread and expand across the prairie ecosystem, reducing the native species diversity and ecological function.

Community 3.1
Hayfield

Sites in this community phase consist of forage plants that are planted and mechanically harvested. Mechanical harvesting removes much of the aboveground biomass and nutrients that feed the soil ecosystem (Franzluebbers et al. 2000; USDA-NRCS 2003). As a result, soil biology is reduced leading to decreases in nutrient uptake by plants, soil organic matter, and soil aggregation. Frequent biomass removal can in turn reduce the site's carbon sequestration capacity (Skinner 2008).

Community 3.2
Continuous Pastured Grazing System

This community phase is characterized by continuous grazing where domestic livestock graze a pasture for the entire season. Depending on stocking density, this can result in lower forage quality and productivity, weed invasions, and uneven pasture use. Continuous grazing can also increase the amount of bare ground and erosion and reduce soil organic matter, cation exchange capacity, water-holding capacity, and nutrient availability and retention (Bharati et al. 2002; Leake et al. 2004; Teague et al. 2011). Smooth brome, Kentucky bluegrass, and white clover (*Trifolium repens* L.) are common pasture species used in this phase. Their tolerance to continuous grazing has allowed these species to dominate, sometimes completely excluding the native vegetation.

Community 3.3
Rest-Rotation Pastured Grazing System

This community phase is characterized by rotational grazing where the pasture has been subdivided into several smaller paddocks. Through the development of a grazing plan, livestock utilize one or a few paddocks, while the remaining area is rested allowing plants to restore vigor and energy reserves, deepen root systems, develop seeds, as well as allow seedling establishment (Undersander et al. 2002; USDA-NRCS 2003). Rest-rotation pastured grazing systems include deferred rotation, rest rotation, high intensity – low frequency, and short duration methods. Vegetation is generally more diverse and can include orchargrass (*Dactylis glomerata* L.), timothy (Phleum pretense L.), red clover (*Trifolium pratense* L.), and alfalfa (*Medicago sativa* L.). The addition of native prairie species can further bolster plant diversity and, in turn, soil function. This community phase promotes numerous ecosystem benefits including increasing biodiversity, preventing soil erosion, maintaining and enhancing soil quality, sequestering atmospheric carbon, and improving water yield and quality (USDA-NRCS 2003).

Pathway 3.1A
Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock and continuous grazing

Pathway 3.1B
Community 3.1 to 3.3

Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing

Pathway 3.2A
Community 3.2 to 3.1

Domestic livestock grazing is replaced by mechanical harvesting

Pathway 3.2B
Community 3.2 to 3.3

Implementation of rest-rotational grazing

Pathway 3.3B
Community 3.3 to 3.1

Domestic livestock grazing is replaced by mechanical harvesting

Pathway 3.3A
Community 3.3 to 3.2

Implementation of continuous grazing

State 4
Reconstructed Savanna State

Savanna reconstructions have become an important tool for repairing natural ecological functions and providing habitat protection for numerous grassland dependent species. Because the historic plant and soil biota communities of the tallgrass prairie were highly diverse with complex interrelationships, historic savanna replication cannot be guaranteed on landscapes that have been so extensively manipulated for extended timeframes (Kardol and Wardle 2010; Fierer et al. 2013). 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 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 can 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).

Transition T1A
State 1 to 2

Long-term fire suppression, land abandonment and/or overgrazing

Transition T1B
State 1 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition R2A
State 2 to 4

Site preparation, selective tree thinning, invasive species control, and native seeding

Restoration pathway T3A
State 3 to 2

Long-term fire suppression, land abandonment, and/or overgrazing

Transition R3A
State 3 to 4

Site preparation, selective tree thinning, invasive species control, and native seeding

Restoration pathway T4A
State 4 to 2

Long-term fire suppression, land abandonment, and/or overgrazing

Restoration pathway T4B
State 4 to 3

Cultural treatments are implemented to increase forage quality and yield

Additional community tables

Inventory data references

Tier 3 Sampling Plot used to develop alternative state, community phase 2.2:
State County Ownership Legal Description Easting Northing
Iowa O'Brien Waterman Prairie Wildlife Area – Iowa Department of Natural Resources T94N R39W S14 303102 4758477

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	05/11/2025
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):**

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:**
