Ecological site R107XB006MO
Calcareous Loess Exposed Backslope Prairie

Last updated: 5/21/2020
Accessed: 05/17/2024

General information

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

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 107X–Iowa and Missouri Deep Loess Hills

The Iowa and Missouri Deep Loess Hills 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 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, to 200 to 300 feet in the loess bluffs 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): Central Tallgrass Prairie (4214210)

Ecological Systems (National Vegetation Classification System, Nature Serve 2015): Central Tallgrass Prairie (CES205.683)

Eilers and Roosa (1994): Loess Hills

Iowa Department of Natural Resources: Loess Hills Prairie

Missouri Natural Heritage Program (Nelson 2010): Dry Loess/Glacial Till Prairie

Nebraska Game and Parks Commission (Steinauer and Rolfsmeier 2010): Northern Loess/Shale Bluff Prairie

Plant Associations (National Vegetation Classification System, Nature Serve 2015): Schizachyrium scoparium – Bouteloua curtipendula – *Bouteloua hirsuta* – (*Yucca glauca*) Herbaceous Vegetation (CEGL002035)

Rosburg (1994): Dry Mid-Grass Community

White (1983): Gravel Hill

Ecological site concept

Calcareous Loess Exposed Prairies are mapped in complex with Calcareous Loess Protected Backslope Savannas and are located within the green areas on the map (Figure 1). They occur on south- and west-facing shoulders with slopes greater than fifteen percent. Soils are Entisols that are well-drained and very deep to bedrock. These sites are developed from loess with a significant component of carbonates at or near the surface, resulting in an alkaline (increased pH) environment. These fine-silty, fertile soils have high soil uniformity resulting in increased nutrient-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 adapted to dry habitats. The site is a relatively even mixture of tall and midgrass species where the tallgrass species represent the greatest relative biomass and the midgrasses support the highest relative frequency. Little bluestem (Schizachyrium scoparium (Michx.) Nash) and sideoats grama (Bouteloua curtipendula (Michx.) Torr.) represent the dominant midgrass species, big bluestem (Andropogon gerardii Vitman) is the dominant tallgrass species, and prairie sandreed (Calamovilfa longifolia (Hook.) Scribn.) is a diagnostic component (Rosburg 1994; Nelson 2010). Forb species typical of an undisturbed habitat associated with this ecological site include tall false foxglove (Agalinis aspera (Douglas ex Benth.) Britton), lotus milkvetch (Astragalus lotiflorus Hook.), aromatic aster (Symphyotrichum oblongifolium (Nutt.) G.L. Nesom), and western silver aster (Symphyotrichum sericeum (Vent.) G.L. Nesom) (Drobney et al. 2001). Leadplant (Amorpha canescens Pursh) and prairie rose (Rosa arkansana Porter) are common shrubs that can be found lightly scattered throughout the prairie. Fire was the primary disturbance factor that maintained this site, while drought and native, large mammal grazing were secondary factors (LANDFIRE 2009; Nelson 2010).

Relative to other calcareous loess prairie communities in the MLRA, the south- and west-facing slopes of Calcareous Loess Exposed Backslope Prairies are generally warmer and drier due to the greater exposure to solar radiation and increased evapotranspiration, resulting in a plant community dominated by xerophytic species. The steeper slopes also allow for increased runoff, thus limiting the amount of infiltration within the ecological site. Herbaceous production and forb diversity are less on this ecological site compared to that of prairies found on calcareous till sites. Lastly, unlike similar loess prairie ecological sites with a higher clay content, this ecological site has a lower soil moisture and higher coefficient of wetness as evidenced by the presence of mostly obligate upland species (Drobney et al. 2001).

Associated sites

R107XB003MO	**Deep Loess Exposed Backslope Savanna** Calcareous loess soils on slopes greater than fifteen percent on north and east slopes, including Dow and Ida

R107XB012MO	**Calcareous Loess Upland Prairie** Calcareous loess soils on slopes less than fifteen percent, including Dow and Ida

Similar sites

R107XB027IA	**Calcareous Till Upland Prairie** Calcareous Till Upland Prairies are similar in landscape position but parent material is glacial till
R107XB007MO	**Loess Upland Prairie** Loess Upland Prairies are similar in supporting a prairie plant community but parent material contains no carbonates and a higher clay content
R107XB012MO	**Calcareous Loess Upland Prairie** Calcareous Loess Upland Prairies are similar in composition but frequency and production of tallgrasses are greater in this ecological site; occurs only on summits
R107XB002MO	**Deep Loess Upland Prairie** Deep Loess Upland Prairies are similar in supporting a prairie plant community but parent material contains no carbonates and a higher clay content

Table 1. Dominant plant species

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

Physiographic features

Calcareous Loess Exposed Backslope Prairies 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 1,100 to 1,500 feet ASL. This site does not experience flooding but rather generates runoff to adjacent, downslope ecological sites.

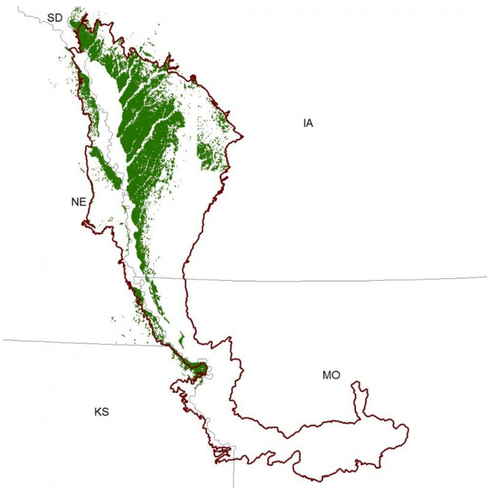


Figure 2. Figure 1. Location of Calcareous Loess Exposed Backslope Prairie ecological site within MLRA 107B.

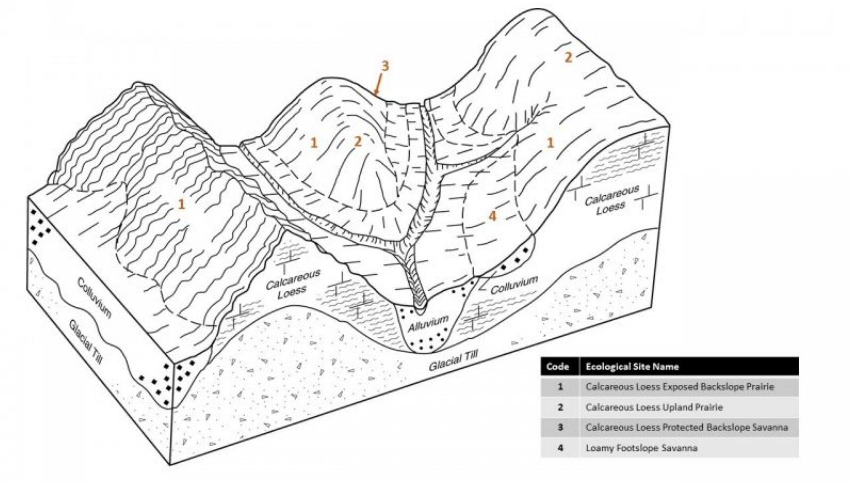


Figure 3. Figure 2. Representative block diagram of Calcareous Loess Exposed Backslope Prairie and associated ecological sites.

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 m
Slope	15–90%
Water table depth	203 cm
Aspect	W, NW, S, SW

Climatic features

The Iowa and Missouri Deep Loess Hills fall 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 will 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 one travels. 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)	787-864 mm
Frost-free period (actual range)	132-154 days
Freeze-free period (actual range)	156-184 days
Precipitation total (actual range)	711-864 mm
Frost-free period (average)	140 days
Freeze-free period (average)	165 days
Precipitation total (average)	813 mm

Climate stations used

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

Influencing water features

Calcareous Loess Exposed Backslope Prairies 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).

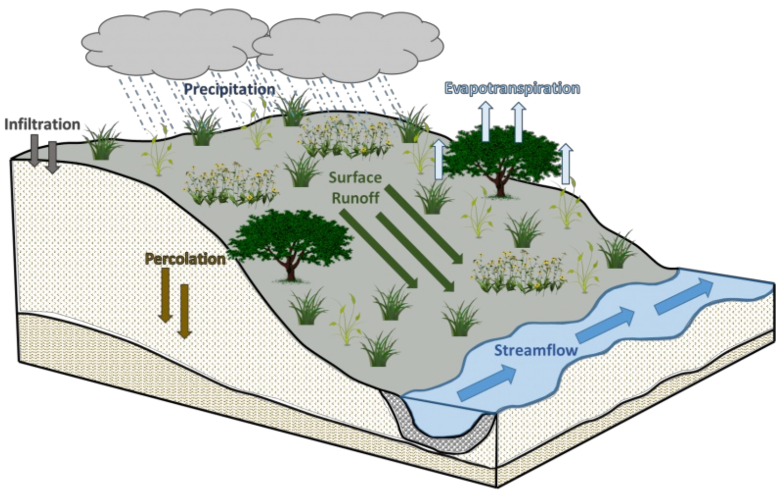


Figure 10. Figure 5. Hydrologic cycling in Calcareous Loess Exposed Backslope Prairie ecological site.

Soil features

Soils of Calcareous Loess Exposed Backslope Prairies 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 naturally high surface runoff rates, higher erosion rates, and dry environmental conditions. The soil series associated with this site includes Dow, Hamburg, 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 very high.

Figure 11. Ida series (from Young, 1994)

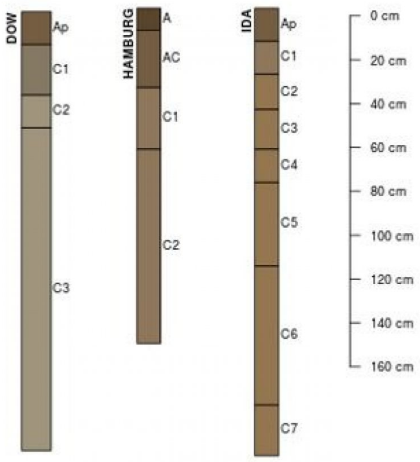


Figure 12. Figure 6. Profile sketches of soil series associated with Calcareous Loess Exposed Backslope Prairie.

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
Permeability class	Slow to moderate
Soil depth	203 cm
Available water capacity (0-101.6cm)	20.32–22.86 cm
Calcium carbonate equivalent (0-101.6cm)	0–30%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	6.6–8.2

Ecological dynamics

Prairie ecosystems are regarded as the most endangered ecosystem in North America where an estimated four percent of the tallgrass prairie habitat remains (Steinauer and Collins 1996). The Loess Hills region of MLRA 107B was once dominated by tall- and midgrass prairies, extending across more than 90 percent of the area (Rosburg 1994; Farnsworth 2009). However, by the early twenty-first century much of the land had been converted to agriculture, leaving an estimated 20 percent of the region to be classified as "grassland" and another three percent classified as "remnant prairie" (Farnsworth 2009).

Calcareous Loess Exposed Backslope Prairies form a vegetative continuum throughout the Loess Hills, where soil moisture serves as the primary influence on community composition (White 1983; White and Glenn-Lewin 1984). This ecological site occurs on steep south- and west-facing shoulder slopes in the Loess Hills. Species characteristic of this ecological site are sun-loving, fire- and drought-adapted plants.

Fire is the most important ecosystem driver for maintaining this ecological site (Vogl 1974; Anderson 1990; Eilers and Roosa 1994). Fire intensity 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 prairie ecosystem.

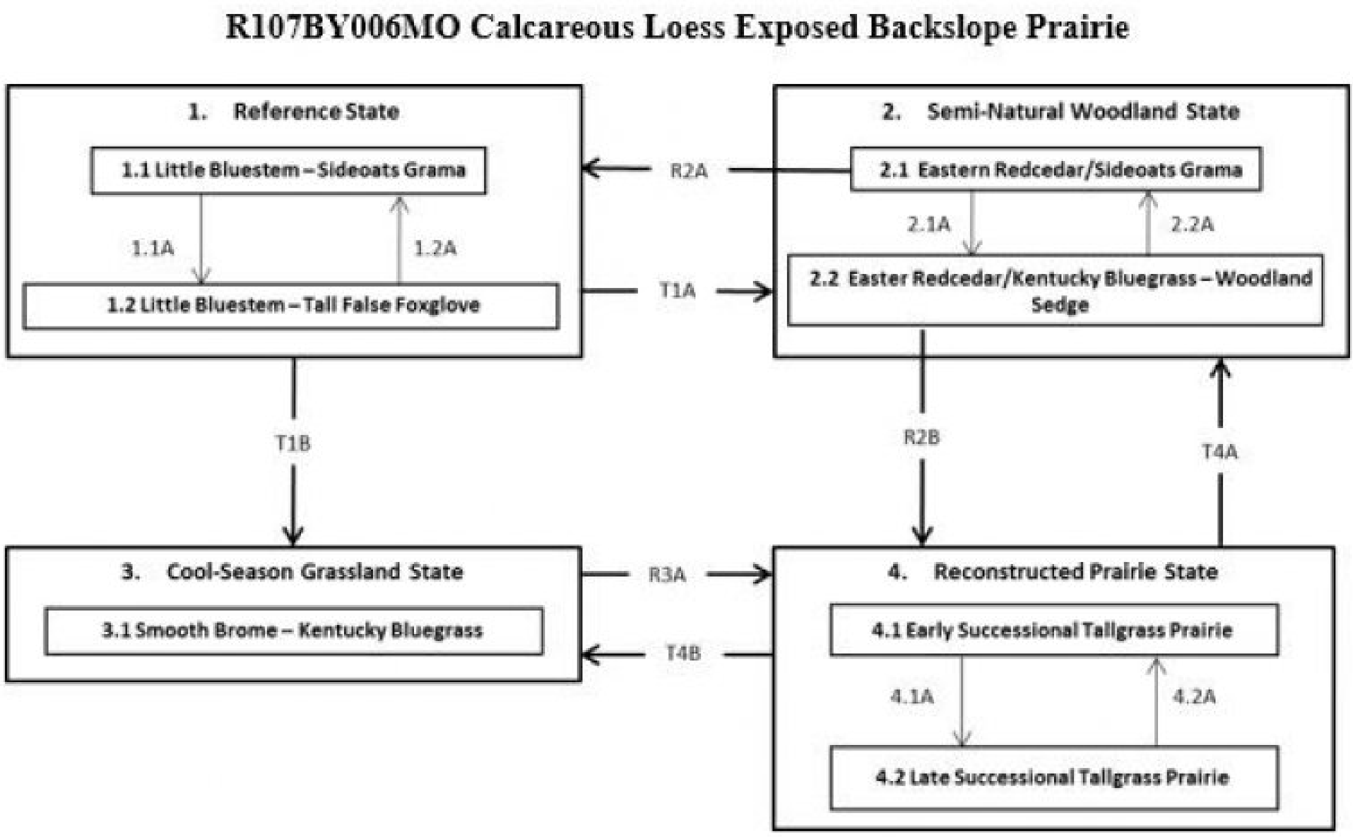
Grazing by native ungulates is often cited as an important disturbance regime of Great Plains grasslands, with bison (Bison bison), prairie elk (Cervus elaphus), and white-tailed deer (Odocoileus virginianus) serving as the dominant herbivores of the area. However, plant community succession in the Loess Hills 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). Elk and deer are believed to have had some role in keeping woody vegetation at bay in the prairies of the Loess Hills (Farnsworth 2009; LANDFIRE 2009).

Drought has also played a part in shaping the prairie ecosystems in the Loess Hills. The periodic episodes of reduced soil moisture have favored the proliferation of plant species tolerant of such conditions. 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 Exposed Backslope Prairies are limited in their extent, having been reduced as a result of eastern redcedar (*Juniperus virginiana* L.) encroachment from 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. The remnants that do exist show evidence of indirect anthropogenic influence as some non-native species (i.e., Kentucky bluegrass (*Poa pratensis* L.)) are present in the species composition. 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.

e cool-season grasses (3).

State and transition model



Code	Process
T1A, T4A	Fire suppression
T1B, T4B	Brush control, interseeding of non-native cool-season grasses, and overgrazing
1.1A	Fire-free period, 1-4 years
1.2A	Fire-free period, 4-6 years
R2A	Brush control, non-native species control and reintroduction of historic fire regime
2.1A	Fire-free period, >20 years
2.2A	Fire-free period, <20 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

State 1
Reference State

The reference plant community is categorized as a dry tall/midgrass prairie and includes an assemblage of xeric grasses, forbs, and limited components of shrubs. The two community phases within the reference state are dependent on a fire frequency of every one to six years. Shorter fire intervals maintain dominance by grasses and forbs, while less frequent intervals allow grass litter to accumulate and crowd out the native forbs. 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

- little bluestem (*Schizachyrium scoparium*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- tall false foxglove (*Agalinis aspera*), other herbaceous

Community 1.1
Little Bluestem – Sideoats Grama

Little bluestem and sideoats grama are the dominant grass species for this phase, but other species can include big bluestem, Indiangrass, prairie sandreed, hairy grama (*Bouteloua hirsuta* Lag.), and prairie junegrass (*Koeleria macrantha* (Ledeb.) Schult.) (Nelson 2010). Across this site, plant species frequencies and production vary with respect to slope angle and aspect. As slope steepness increases, drought-tolerant species are favored (e.g., plains muhly (*Muhlenbergia cuspidata* (Torr. ex Hook.) Rydb.) and soapweed yucca (*Yucca glauca* Nutt.)) (Rosburg 1994). Characteristic forbs include dotted blazing star (*Liatris punctata* Hook.), blacksamson echinacea (*Echinacea angustifolia* DC.), white heath aster (*Symphyotrichum ericoides* (L.) G.L. Nesom) prairie blue-eyed grass (*Sisyrinchium campestre* E.P. Bicknell), and rush skeletonplant (*Lygodesmia juncea* (Pursh) D. Don ex Hook.). A few shrubs – such as leadplant and prairie rose – can be scattered throughout the community.

Dominant plant species

- little bluestem (*Schizachyrium scoparium*), grass
- sideoats grama (*Bouteloua curtipendula*), grass

Community 1.2
Little Bluestem – Tall False Foxglove

This reference community phase can occur when fire return intervals occur on a one to four year cycle. The increased fire return interval reduces the grass canopy, and on the steep slopes of this site, a reduction in canopy reduces soil stability resulting in areas of limited erosion and bare soil. These conditions are highly suitable for inhabitation by annuals such as tall false foxglove, ribseed sandmat (*Chamaesyce glyptosperma* (Englem.) Small), and slickseed fuzzybean (*Strophostyles leiosperma* (Torr. & A. Gray) Piper) (Rosburg 1994).

Dominant plant species

- little bluestem (*Schizachyrium scoparium*), grass
- tall false foxglove (*Agalinis aspera*), other herbaceous

Pathway P1.1A
Community 1.1 to 1.2

Average fire return interval of one to four years.

Pathway P1.2A
Community 1.2 to 1.1

Average fire return interval of four to six years.

State 2
Semi-Natural Woodland State

Fire suppression by livestock can transition the reference prairie community into a semi-natural woodland state dominated by eastern redcedar (*Juniperus virginiana*) (Briggs et al. 2002; Anderson 2003; Steinauer and Rolfsmeier 2010). Eastern redcedar is a species native to the eastern half of North America with a range spanning from Ontario east to Nova Scotia, south across the Great Plains into eastern Texas, and east to the Atlantic coast (Lawson 1990; Lee 1996). It is a long-lived (450+ years), slow-growing, fire-intolerant dioecious conifer and historically was found in areas that were protected from fire (e.g., bluffs, rocky hillsides, sandstone cliffs, granite outcrops, etc.) (Ferguson et al. 1968; Anderson 2003). Today, however, decades of fire suppression have allowed this species to spread and it can now be found occupying sites with highly variable aspects, topography, soils, and formerly stable plant communities (Anderson 2003).

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree

Community 2.1
Easter Redcedar/Sideoats Grama

This community phase represents the early stages of eastern redcedar invasion into the prairie. Native grass species that can persist during this stage include big bluestem, little bluestem, sideoats grama, and Scribner's rosette grass (*Dichanthelium oligosanthes* (Schult.) Gould var. scribnerianum (Nash) Gould)), however sideoats grama is the only species known to increase its cover during this phase. Candle anemone (*Anemone cylindrica* A. Gray), cutleaf anemone (*Pulsatilla patens* (L.) Mill. ssp. multifida (Pritz.) Zamels), and Cuman ragweed (*Ambrosia psilostachya* DC.) comprise the persistent forb component of the plant community (Gehring and Bragg 1992; Rosburg 1994).

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- sideoats grama (*Bouteloua curtipendula*), grass

Community 2.2
Eastern Redcedar/Kentucky Bluegrass – Woodland Sedge

Sites falling into this community phase are strongly dominated by eastern red cedars as a result of over 20 years of fire suppression. As the canopies of the trees increase, light availability is greatly reduced to the ground layer and soil moisture increases, allowing more shade tolerant species, such as Kentucky bluegrass and sedges (Carex L.), to replace the heliophytic tallgrass prairie species (Gehring and Bragg 1992; Brantley and Young 2010; Pierce and Reich 2010). Over time, the diversity and productivity of the herbaceous understory is greatly reduced (Smith and Stubbendieck 1990; Gehring and Bragg 1992; Rosburg 1994). The continued absence of fire and other disturbances will allow this community to expand its range.

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- Kentucky bluegrass (*Poa pratensis*), grass
- eastern woodland sedge (*Carex blanda*), grass

Pathway P2.1A
Community 2.1 to 2.2

Fire is removed from the landscape in excess of 20 years.

Pathway P2.2A
Community 2.2 to 2.1

Fire is restored to the landscape within 20 years of initial encroachment.

State 3
Cool Season Grassland State

The cool-season grassland state occurs when the reference state has been anthropogenically-altered for livestock and/or hay 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*) and Kentucky bluegrass (*Poa pratensis*) in order to help extend the grazing season (Smith 1998). 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.

Community 3.1
Invaded Grassland

Species characteristic of this community phase include big bluestem, smooth brome (*Bromus inermis*), and Kentucky bluegrass (*Poa pratensis*). 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 Prairie State

Prairie reconstructions have become an important tool for repairing natural ecological functioning and providing habitat protection for numerous grassland-dependent species. Because the historic plant community of the tallgrass prairie was extremely diverse and complex, prairie replication is not considered to be possible once the native vegetation has been altered by past 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 prairie state is the result of a long-term commitment involving a multi-step, adaptive management process. Diverse, species-rich seed mixes are 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 grasses, forbs, and shrubs. Establishing a prescribed fire regimen 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 woody vegetation (Brudvig et al. 2007).

Community 4.1
Early Successional Reconstructed Tallgrass Prairie

This community phase represents the early community assembly from prairie reconstruction and is highly dependent on the seed mix utilized and the timing and priority of planting operations. 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 (e.g., big bluestem, little bluestem, sideoats grama, white heath aster). 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 Tallgrass Prairie

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 prairie 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 perennial bunchgrasses allows more light and nutrients to become available for forb recruitment, allowing for greater ecosystem complexity (Wilsey 2008).

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 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 and overgrazing by domestic livestock transition this site to the semi-natural woodland state (2).

Transition T1B
State 1 to 3

Interseeding non-native, cool-season grasses, overgrazing, and brush control transition this site to the cool-season grassland state (3).

Restoration pathway R2A
State 2 to 1

Mechanical or chemical control of brush 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 prairie 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 prairie state (4).

Transition T4A
State 4 to 2

Fire suppression allows red cedar encroachment and transitions this site to the semi-natural woodland state (2).

Transition T4B
State 4 to 3

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

Additional community tables

Animal community

Wildlife*

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.

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).

*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

Tier 3 Sampling Plot(s) used to develop the reference state, community phase 1.1:

State County Ownership Legal Description Easting Northing
Iowa Plymouth Broken Kettle Grasslands, The Nature Conservancy T91N R48W S19 700218 4729022

Other references

Anderson, R.C. 1990. The historic role of fire in the North American grassland. In: S.L. Collins and L.L. Wallace, eds. Fire in North American Tallgrass Prairie. University of Oklahoma Press, Norman, OK.

Anderson, M.D. 2003. *Juniperus virginiana*. In: Fire Effects Information System [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available at https://www.feis-crs.org/feis/. (Accessed 22 February 2017).

Baker, R.G., C.A. Chumbley, P.M. Witinok, and H.K. Kim. 1990. Holocene vegetational changes in eastern Iowa. Journal of the Iowa Academy of Science 97: 167-177.

Baker, R.G., L.J. Maher, C.A. Chumbley, and K.L. Van Zant. 1992. Patterns of Holocene environmental changes in the midwestern United States. Quaternary Research 37: 379-389.

Barrett, S.W. 1980. Indians and fire. Western Wildlands Spring: 17-20.

Brantley, S. and D. Young. 2010. Linking light attenuation, sunflecks, and canopy architecture in mesic shrub thickets. Plant Ecology 206: 225-236.

Briggs, J.M., A.K. Knapp, and B.L. Brock. 2002. Expansion of woody plants in tallgrass prairie: a fifteen-year study of fire and fire-grazing interactions. The American Midland Naturalist 147: 287-294.

Brudvig, L.A., C.M. Mabry, J.R. Miller, and T.A. Walker. 2007. Evaluation of central North American prairie management based on species diversity, life form, and individual species metrics. Conservation Biology 21: 864-874.

Catt, J. 2001. The agricultural importance of loess. Earth-Science Reviews 54: 213-229.

Cleland, D.T., J.A. Freeouf, J.E. Keys, G.J. Nowacki, C. Carpenter, and W.H. McNab. 2007. Ecological Subregions: Sections and Subsections of the Coterminous United States. USDA Forest Service, General Technical Report WO-76. Washington, DC. 92 pps.

Day, G. 1953. The Indian as an ecological factor in the northeastern forest. Ecology 34: 329-346.

Decker, W.L. 2017. Climate of Missouri. University of Missouri, Missouri Climate Center, College of Agriculture, Food and Natural Resources. Available at http://climate.missouri.edu/climate.php. (Accessed 24 February 2017).

Dinsmore, J.J. 1994. A Country So Full of Game: The Story of Wildlife in Iowa. University of Iowa Press, Iowa City, Iowa. 261 pps.

Drobney, P.D., G.S. Wilhelm, D. Horton, M. Leoschke, D. Lewis, J. Pearson, D. Roosa, and D. Smith. 2001. Floristic Quality Assessment for the State of Iowa. Neal Smith National Wildlife Refuge and Ada Hayden Herbarium, Iowa State University, Ames, IA.

Eilers, L. and D. Roosa. 1994. The Vascular Plants of Iowa: An Annotated Checklist and Natural History. University of Iowa Press, Iowa City, IA. 319 pps.

Farnsworth, D.A. 2009. Establishing restoration baselines for the Loess Hills region. M.S. Thesis. Iowa State University, Ames, IA. 123 pps.

Ferguson, E.R., E.R. Lawson, W.R. Maple, and C. Mesavage. 1968. Managing Eastern Redcedar. Research paper SO-37. U.S. Department of Agriculture, Forest Service, Southern Forest Experimental Station, New Orleans, LA. 14 pps.

Gehring, J.T. and T.B. Bragg. 1992. Changes in prairie vegetation under eastern redcedar (*Juniperus virginiana* L.) in an eastern Nebraska bluestem prairie. The American Midland Naturalist 128: 209-217.

LANDFIRE. 2009. Biophysical Setting 4214210 Central Tallgrass Prairie. In: LANDFIRE National Vegetation Dynamics Models. USDA Forest Service and US Department of Interior. Washington, DC.

Lawson, E.R. 1990. *Juniperus virginiana* L. eastern redcedar. In: R.M. Burns and B.H. Honkala, technical coordinators. Silvics of North America, Volume I: Conifers. Agriculture Handbook 654. Washington, DC: U.S.

Department of Agriculture, Forest Service.

Lee, S.A. 1996. Propagation of Juniperus for conservation plantings in the Great Plains. M.S. Thesis. University of Nebraska, Lincoln, NE. 91 pps.

Martin, L.M. and B.J. Wilsey. 2006. Assessing grassland restoration success: relative roles of seed additions and native ungulate activities. Journal of Applied Ecology 43: 1098-1110.

Martin, L.M. and B.J. Wilsey. 2012. Assembly history alters alpha and beta diversity, exotic-native proportions and functioning of restored prairie plant communities. Journal of Applied Ecology 49: 1436-1445.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1 NatureServe, Arlington, VA. Available at http://explorer.natureserve.org. (Accessed 13 February 2017).

Nelson, P. 2010. The Terrestrial Natural Communities of Missouri, Revised Edition. Missouri Natural Areas Committee, Department of Natural Resources and the Department of Conservation, Jefferson City, MO. 500 pps.

Nigh, T.A. and W.A. Schroeder. 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation, Jefferson City, Missouri.

Peel, M.C., B.L. Finlayson, and T.A. McMahon. 2007. Updated world map of the Köppen-Geiger climate classification. Hydrology and Earth System Sciences 11: 1633-1644.

Pierce, A.M. and P.B. Reich. 2010. The effects of eastern redcedar (*Juniperus virginiana*) invasion and removal on a dry bluff prairie ecosystem. Biological Invasions 12: 241-252.

Prior, J.C. 1991. Landforms of Iowa. University of Iowa Press for the Iowa Department of Natural Resources, Iowa City, IA. 153 pps.

Prior, J.C., J.L. Boekhoff, M.R. Howes, R.D. Libra, and P.E. VanDorpe. 2003. Iowa's Groundwater Basics: A Geological Guide to the Occurrence, Use, & Vulnerability of Iowa's Aquifers. Iowa Department of Natural Resources, Iowa Geological Survey Educational Series 6. 92 pps.

Pyne, S.J., P.L. Andrews, and R.D. Laven. 1996. Introduction to Wildland Fire, Second Edition. John Wiley and Sons, Inc. New York, New York. 808 pps.

Rosburg, T. 1994. Community and Physiological Ecology of Native Grasslands in the Loess Hills of Western Iowa. PhD Dissertation. Iowa State University, Ames, IA. 228 pps.

Smith, D.D. 1998. Iowa prairie: original extent and loss, preservation, and recovery attempts. The Journal of the Iowa Academy of Sciences 105: 94-108.

Smith, D.D., D. Williams, G. Houseal, and K. Henderson. 2010. The Tallgrass Prairie Center Guide to Prairie Restoration in the Upper Midwest. University of Iowa Press, Iowa City, IA. 338 pps.

Smith, J.D. and J. Stubbendieck. 1990. Production of tall-grass prairie herbs below eastern red cedar. Prairie Naturalist 22: 13-18.

Society for Ecological Restoration [SER] Science & Policy Working Group. 2002. The SER Primer on Ecological Restoration. Available at http://www.ser.org/. (Accessed 28 February 2017).

Stambaugh, M.C., R.P. Guyette, E.R. McMurry, and D.C. Dey. 2006. Fire history at the Eastern Great Plains Margin, Missouri River Loess Hills. Great Plains Research 16: 149-59.

Steinauer, E.M. and L. Collins. 1996. Prairie ecology: the tallgrass prairie. In: Samson, F.B. and F.L. Knopf, eds. Prairie Conservation: Preserving North America's Most Endangered Ecosystem. Island Press, Washington, D.C. 351 pps.

Steinauer, G. and S. Rolfsmeier. 2010. Terrestrial Natural Communities of Nebraska, Version IV. Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pps.

Stockton, C.W. and D.M. Meko. 1983. Drought recurrence in the Great Plains as reconstructed from long-term tree-ring records. Journal of Climate and Applied Meteorology 22: 17-29.

United States Department of Agriculture – Natural Resource Conservation Service (USDA-NRCS). 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. 682 pps.

U.S. Environmental Protection Agency [EPA]. 2013. Level III and Level IV Ecoregions of the Continental United States. Corvallis, OR, U.S. EPA, National Health and Environmental Effects Research Laboratory, map scale 1:3,000,000. Available at http://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states. (Accessed 1 March 2017).

Vogl, R.J. 1974. Effects of fire on grasslands. In: T.T. Kozlowski and C.E. Ahlgren, eds. Fire and Ecosystems. Academic Press, New York, New York.

White, J.A. 1983. Regional and Local Variation in Composition and Structure of the Tallgrass Prairie Vegetation of Iowa and Eastern Nebraska. M.S. Thesis. Iowa State University, Ames, IA. 168 pps.

White, J. 1994. How the terms savanna, barrens, and oak openings were used in early Illinois. In: J. Fralisch, ed. Proceedings of the North American Conference on Barrens and Savannas. Illinois State University, Normal, IL.

White, J.A. and S.C. Glenn-Lewin. 1984. Regional and local variation in tallgrass prairie remnants of Iowa and eastern Nebraska. Vegetatio 57: 65-78.

Williams, D.A., L.L. Jackson, and D.D Smith. 2007. Effects of frequent mowing on survival and persistence of forbs seeded into a species-poor grassland. Restoration Ecology 15: 24-33.

Wilsey, B.J. 2008. Productivity and subordinate species response to dominant grass species and seed source during restoration. Restoration Ecology 18: 628-637.

Approval

Chris Tecklenburg, 5/21/2020

Acknowledgments

This project could not have been completed without the dedication and commitment from a variety of partners and staff (Table 6). Team members supported the project by serving on the technical team, assisting with the development of state and community phases of the state-and-transition model, providing peer review and technical editing, and conducting quality control and quality assurance reviews.

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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	05/17/2024
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:

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

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

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

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

17. **Perennial plant reproductive capability:**