Ecological site R108XC509IA
Till Backslope Prairie

Last updated: 7/01/2019
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): 108X–Illinois and Iowa Deep Loess and Drift

The Illinois and Iowa Deep Loess and Drift, West-Central Part (MLRA 108C) encompasses the eastern portion of the Southern Iowa Drift Plain and the Lake Calvin basin of the Mississippi Alluvial Plain landforms (Prior 1991). It lies entirely in one state (Iowa), containing approximately 9,805 square miles (Figure 1). The elevation ranges from approximately 1,110 feet above sea level (ASL) on the highest ridges to about 505 feet ASL in the lowest valleys. Local elevation difference is mainly 10 to 20 feet. However, some valley floors can range from 80 to 200 feet, while some upland flats and valley floors only range between 3 and 6 feet. The MLRA is underlain by Pre-Illinoian glacial till, deposited more than 500,000 years ago and since undergone extensive erosion and dissection. In the northern half of the area the till thickness ranges from 150 to 350 feet and grades to less than 150 feet thick in the southern half. The till is covered by a mantle of Peoria Loess on the hillslopes and Holocene alluvium in the drainageways. Paleozoic bedrock, comprised of limestone, shale, and mudstones, 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

USFS Subregions: Central Dissected Till Plains (251C) Section, Central Dissected Till and Loess Plain (251Cc), Mississippi River and Illinois Alluvial Plains (51Cf), Southeast Iowa Rolling Loess Hills (251Ch) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Rolling Loess Prairies (47f), Upper Mississippi Alluvial Plain (72d) (USEPA 2013)

National Vegetation Classification – Ecological Systems: Central Tallgrass Prairie (CES205.683) (NatureServe 2015)

National Vegetation Classification - Plant Associations: Schizachyrium scoparium – Sorghastrum nutans – Bouteloua curtipendula Loess Hill Grassland (CEGL002203) (Nature Serve 2015)

Biophysical Settings: Central Tallgrass Prairie (BpS 4214210) (LANDFIRE 2009)

Natural Resources Conservation Service – Iowa Plant Community Species List: Prairie, Central Mesic Tallgrass (USDA-NRCS 2007)

Iowa Department of Natural Resources: Clay Loam Tallgrass Prairie (INAI 1984)

Ecological site concept

Till Backslope Prairies are located within the green areas on the map (Figure 1). They occur on mid to lower upland hillslopes on slopes ranging 9 to 40 percent. The soils are Mollisols that are somewhat poorly to well-drained and deep, formed in glacial till. Some soils are formed in shallow loess or erosional sediments over a red paleosol and may be affected by seasonal wetness in the spring.

The historic pre-European settlement vegetation on this ecological site was dominated by warm-season grasses and prairie forbs. Little bluestem (Schizachyrium scoparium (Michx.) Nash) and hoary puccoon (Lithospermum canescens (Michx.) Lehm.) are the dominant and characteristic species of the site, respectively. Other grasses present can include Indiangrass (Sorghastrum nutans (L.) Nash) and big bluestem (Andropogon gerardii Vitman). Common forbs associated with this site include gray goldenrod (Solidago nemoralis Aiton), bastard toadflax (Comandra umbellata (L.) Nutt.), wholeleaf rosinweed (Silphium integrifolium Michx.), slender lespedeza (lespedeza virginica (L.) Britton), and flowering spurge (Euphorbia corollata L.) (Owens and Ebinger 2008; McClain et al. 2012; NatureServe 2015). Fire is the primary disturbance factor that maintains this site, while herbivory, drought, and erosion on steep slopes are secondary factors (Owens and Ebinger 2008; LANDFIRE 2009; McClain et al. 2012).

Associated sites

R108XC510IA	**Till Backslope Seepage Meadow** Paleosol formed in glacial till that is shallow to a perched water table including Clarinda, Clearfield, and Lamoni soils
R108XC511IA	**Till Backslope Savanna** Glacial till parent material that classifies as a Mollic subgroup of an Alfisol including Armstrong, Caleb, Gara, Mystic, and Waubeek soils
R108XC503IA	**Loess Upland Prairie** Loess parent material on upper to mid backslopes including Killduff, Nira, Osco, Otley, Port Byron, Tallula, and Tama soilsl
F108XC521IA	**Colluvial Woodland** Colluvial parent material in river valleys including Coppock, Ely, Judson, Martinsburg, Moingona, Moingona variant, Olmitz, and Olmitz variant soils

Similar sites

R108XC503IA	**Loess Upland Prairie** Loess Upland Prairies occur higher on the landscape, and parent material is loess
R108XC506IA	**Sandy Upland Prairie** Sandy Upland Savannas occur in similar and higher landscape positions, and parent material is sandy eolian deposits

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium* (2) *Lithospermum canescens*

Physiographic features

Till Backslope Prairies occur on mid to lower upland hillslopes on slopes ranging 9 to 40 percent (Figure 2). They are situated on elevations ranging from approximately 623 to 1499 feet ASL. The site does not experience flooding, but rather generates runoff to adjacent, downslope ecological sites.

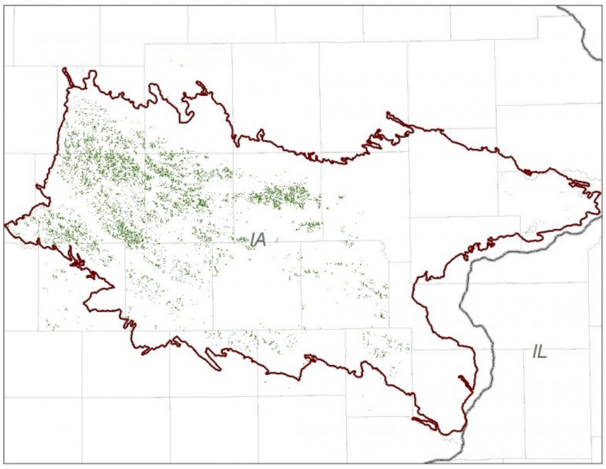


Figure 2. Figure 1. Location of Till Backslope Prairie ecological site within MLRA 108C.

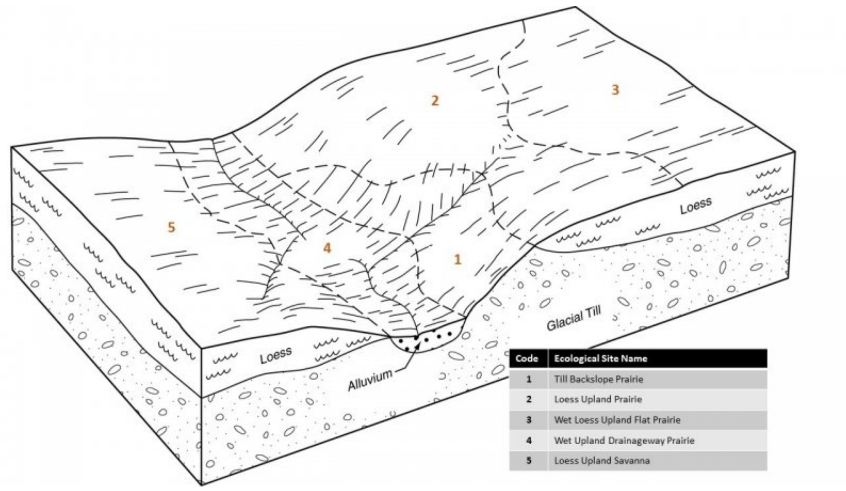


Figure 3. Figure 2. Representative block diagram of Till Backslope Prairie and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Convex (2) Linear
Slope shape up-down	(1) Convex (2) Linear
Landforms	(1) Upland > Hillslope
Runoff class	Medium to very high
Elevation	190–457 m
Slope	9–40%
Water table depth	30–203 cm
Aspect	Aspect is not a significant factor

Climatic features

The Illinois and Iowa Deep Loess and Drift, West-Central Part 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 108C 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 178 days, while the frost-free period is about 159 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 38 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 37 and 59°F, respectively.

Climate data and analyses are derived from 30-year averages gathered from four 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)	130-145 days
Freeze-free period (characteristic range)	157-173 days
Precipitation total (characteristic range)	914-965 mm
Frost-free period (actual range)	126-151 days
Freeze-free period (actual range)	147-179 days
Precipitation total (actual range)	914-965 mm
Frost-free period (average)	138 days
Freeze-free period (average)	165 days
Precipitation total (average)	940 mm

Climate stations used

- (1) GRINNELL 3 SW [USC00133473], Grinnell, IA
- (2) NEWTON [USC00135992], Newton, IA
- (3) WILLIAMSBURG 3SE [USC00139067], Williamsburg, IA
- (4) OSKALOOSA [USC00136327], Oskaloosa, IA

Influencing water features

Till Backslope Prairies are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is slow (Hydrologic Groups C), and surface runoff is medium to very high. Precipitation infiltrates the soil surface and percolates downward through the horizons unimpeded by any restrictive layer. The underlying Mississippian bedrock aquifer has few creviced openings throughout the MLRA, restricting recharge from this ecological site. However, there are numerous surficial aquifers that are shallow and allow recharge via percolation (Prior et al. 2003). Surface runoff contributes some water to downslope ecological sites (Figure 5).

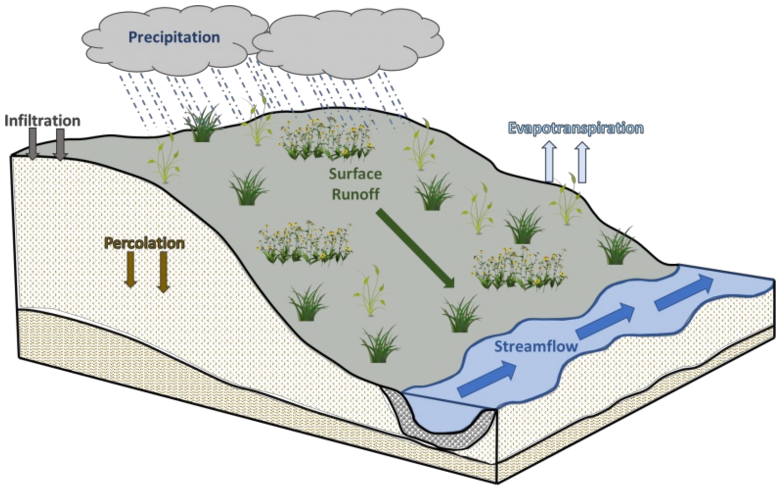


Figure 8. Figure 5. Hydrologic cycling in Till Backslope Prairie ecological site.

Soil features

Soils of Till Backslope Prairies are in the Mollisols order, further classified as Aquertic Argiudolls and Typic Argiudolls with slow infiltration and medium to very high runoff potential. The soil series associated with this site includes Adair and Shelby (Figure 6). The parent material is glacial till, and the soils are somewhat poor to well-drained and deep. Some soils are formed in shallow loess or erosional sediments over a red paleosol and may be affected by seasonal wetness in the spring. Soil pH classes are strongly acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site (Table 5).

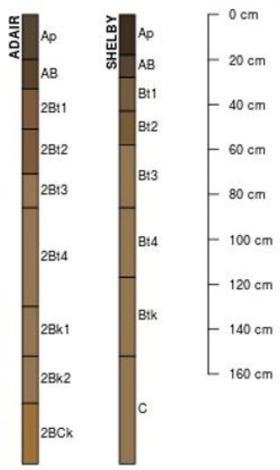


Figure 9. Figure 6. Profile sketches of soil series associated with Till Backslope Prairie.

Table 4. Representative soil features

Parent material	(1) Till
Family particle size	(1) Fine-loamy (2) Fine
Drainage class	Somewhat poorly drained to well drained
Permeability class	Slow
Soil depth	203 cm
Surface fragment cover <=3"	0–2%
Surface fragment cover >3"	0–1%

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.

The MLRA lies within the transition zone between the eastern deciduous forests and the tallgrass prairies. The heterogeneous topography of the area results in variable microclimates and fuel matrices that in turn are able to support prairies, savannas, woodlands, and forests. Till Backslope Prairies form an aspect of this vegetative continuum. This ecological site occurs on mid to lower upland hillslopes on somewhat poor to well-drained soils. Species characteristic of this ecological site consist of sun-loving, fire-adapted herbaceous vegetation.

Fire is a critical disturbance factor that maintains Till Backslope Prairies. Fire intensity typically consisted of periodic, low-intensity surface fires occurring every 1 to 3 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).

Drought and herbivory by native ungulates 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. Bison (Bos bison) grazing, while present, served a more limited role in community composition and structure than lands further west. Prairie elk (Cervus elaphus) and white-tailed deer (Odocoileus virginianus) likely contributed to woody species reduction but are also considered to be of a lesser impact compared to the west (LANDFIRE 2009). When coupled with fire, periods of drought and herbivory can further delay the establishment of woody vegetation (Pyne et al. 1996). Lastly, some Till Backslope Prairies occur on steeply sloping sites. The steep slopes naturally allow for high surface runoff, making erosion from water an important disturbance factor.

Today, Till Backslope Prairies are limited in their extent, having been type-converted to agricultural or forage production land. Remnants that do exist show evidence of indirect anthropogenic influences from fire suppression and non-native species invasion. A return to the historic plant community may not be possible following extensive land modification, but long-term conservation agriculture or prairie reconstruction efforts can help to restore some biotic 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 1 – REFERENCE STATE

The reference plant community is categorized as a prairie community, dominated by patchy herbaceous vegetation. The two community phases within the reference state are dependent on periodic fires. The intensity and frequency alter species composition, cover, and extent, while regular fire intervals keep woody species from encroaching. Drought, herbivory, and slope erosion have more localized impacts in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Community Phase 1.1 Little Bluestem – Hoary Puccoon – Sites in this reference community phase are dominated by a matrix of grasses and forbs. Vegetative cover is patchy (50 to 80 percent) with prevalent patches of bare ground. Little bluestem and Indiangrass are the dominant grasses during this phase, but big bluestem can be present. Species richness is negatively correlated with slope steepness and disturbance frequency, but forb diversity is still generally high and typically includes hoary puccoon, gray goldenrod, bastard toadflax, wholeleaf rosinweed, slender lespedeza, and flowering spurge (Owens and Ebinger 2008; McClain et al. 2012). Low intensity fires or frequent soil slumping will maintain this community phase, but an extended fire return interval or soil stabilization will shift the site to community phase 1.2 (LANDFIRE 2009; McClain et al. 2012).

Pathway 1.1A – Extended fire return interval.

Community Phase 1.2 Carolina Rose/Little Bluestem – Big Bluestem – This reference community phase represents natural succession following a reduced fire return interval or site stabilization from little to no soil erosion. Little bluestem and Indiangrass are still important grasses, but big bluestem becomes a dominant component and forb diversity can increase. The lack of fire allows woody species – such as Carolina rose (*Rosa carolina* L.) – to establish on the site. A single fire event or soil slumping will shift the site back to community phase 1.1 (LANDFIRE 2009; McClain et al. 2012).

Pathway 1.2A – Single fire event or soil slumping.

Transition 1A – Long-term fire suppression transitions the site to the fire-suppressed scrub state (2).

Transition 1B – Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Transition 1C – Tillage, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

STATE 2 – FIRE-SUPPRESSED SCRUB STATE

Long-term fire suppression can transition the reference prairie community into a woody-invaded shrub-prairie state. This state is evidenced by a well-developed shrub layer and sparse trees (Owens and Ebinger 2008; LANDFIRE 2009). Proximity to lands that have been altered provide opportunities for non-native invasive species to readily colonize this state, thereby reducing the native biodiversity and changing the vegetative community.

Community Phase 2.1 Eastern Redcedar – Roughleaf Dogwood/Indiangrass – Sweetclover – This community phase represents the early stages of fire-suppression. In as little as six years without fire, the prairie is disrupted and succeeded by woody shrubs. Eastern redcedar (*Juniperus virginiana* L.) and roughleaf dogwood (*Cornus drummondii* C.A. Mey) can form dense thickets with cover reaching up to 30 percent and shrub heights as tall as 9 feet (LANDFIRE 2009). Some native prairie plants will persist, but non-native herbaceous species can encroach on the site including sweetclover (*Melilotus officinalis* (L.) Lam.) and Canada bluegrass (*Poa compressa* L.) (Owens and Cole 2003; Owens and Ebinger 2008; McClain et al. 2012).

Pathway 2.1A – Continued fire suppression.

Community Phase 2.2 Eastern Redcedar/Rough Dogwood – Smooth Sumac/Indiangrass – Sweetclover – Sites falling into this community phase have a well-established shrub layer, and the eastern redcedars begin to develop in the tree layer in the continued absence of fire. Other woody species that may encroach on the site can include smooth sumac (*Rhus glabra* L.), white oak (*Quercus alba* L.), and non-native honeysuckles (Lonicera L.) (Owens and Cole 2003; Tucker et al. 2006; Owens and Ebinger 2008).

Pathway 2.2A – Single large disturbance event.

Transition 2A – Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Transition 2B – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Restoration 2A – Site preparation, invasive species control, and seeding native species transition this site to the reconstructed prairie state (5).

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, the non-native species were able to spread and expand across the landscape, reducing the native species diversity and ecological function. This state is dominant on the steeper slopes.

Community Phase 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 microorganisms (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 also reduce the site's carbon sequestration capacity (Skinner 2008).

Pathway 3.1A – Mechanical harvesting is replaced with domestic livestock utilizing continuous grazing.

Pathway 3.1B – Mechanical harvesting is replaced with domestic livestock utilizing rotational grazing.

Community Phase 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.

Pathway 3.2A – Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.2B – Rotational grazing replaces continuous grazing.

Community Phase 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 orchardgrass (*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 3.3A – Continuous grazing replaces rotational grazing.

Pathway 3.3B – Domestic livestock are removed, and mechanical harvesting is implemented.

Transition 3A – Land abandonment transitions the site to the fire-suppressed scrub state (2).

Transition 3B – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Restoration 3A – Site preparation, invasive species control, and seeding native species transition this site to the reconstructed prairie state (5).

STATE 4 – CROPLAND STATE

The low topographic relief across the MLRA has resulted in nearly the entire area being converted to agriculture (Eilers and Roosa 1994). The continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) has effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn and soybeans are the dominant crops for the site, and oats (Avena L.) and alfalfa (*Medicago sativa* L.) may be rotated periodically. These areas are likely to remain in crop production for the foreseeable future. This state is dominant on the shallower slopes.

Community Phase 4.1 Conventional Tillage Field – Sites in this community phase typically consist of monoculture row-cropping maintained by conventional tillage practices. They are cropped in either continuous corn or corn-soybean rotations. The frequent use of deep tillage, low crop diversity, and bare soil conditions during the non-growing season negatively impacts soil health. Under these practices, soil aggregation is reduced or destroyed, soil organic matter is reduced, erosion and runoff are increased, and infiltration is decreased, which can ultimately lead to undesirable changes in the hydrology of the watershed (Tomer et al. 2005).

Pathway 4.1A – Tillage operations are greatly reduced, crop rotation occurs on a regular interval, and crop residue remains on the soil surface.

Pathway 4.1B – Tillage operations are greatly reduced or eliminated, crop rotation occurs on a regular interval, crop residue remains on the soil surface, and cover crops are planted following crop harvest.

Community Phase 4.2 Conservation Tillage Field – This community phase is characterized by rotational crop production that utilizes various conservation tillage methods to promote soil health and reduce erosion. Conservation tillage methods include strip-till, ridge-till, vertical-till, or no-till planting systems. Strip-till keeps seedbed preparation to narrow bands less than one-third the width of the row where crop residue and soil consolidation are left undisturbed in-between seedbed areas. Strip-till planting may be completed in the fall and nutrient application either occurs simultaneously or at the time of planting. Ridge-till uses specialized equipment to create ridges in the seedbed and vegetative residue is left on the surface in between the ridges. Weeds are controlled with herbicides and/or cultivation, seedbed ridges are rebuilt during cultivation, and soils are left undisturbed from harvest to planting. Vertical-till systems employ machinery that lightly tills the soil and cuts up crop residue, mixing some of the residue into the top few inches of the soil while leaving a large portion on the surface. No-till management is the most conservative, disturbing soils only at the time of planting and fertilizer application. Compared to conventional tillage systems, conservation tillage methods can improve soil ecosystem function by reducing soil erosion, increasing organic matter and water availability, improving water quality, and reducing soil compaction.

Pathway 4.2A – Intensive tillage is utilized, and monoculture row-cropping is established.

Pathway 4.2B – Cover crops are implemented to minimize soil erosion.

Community Phase 4.3 Conservation Tillage with Cover Crop Field – This community phase applies conservation tillage methods as described above as well as adds cover crop practices. Cover crops typically include nitrogen-fixing species (e.g., legumes), small grains (e.g., rye, wheat, oats), or forage covers (e.g., turnips, radishes, rapeseed). The addition of cover crops not only adds plant diversity but also promotes soil health by reducing soil erosion, limiting nitrogen leaching, suppressing weeds, increasing soil organic matter, and improving the overall soil ecosystem. In the case of small grain cover crops, surface cover and water infiltration are increased, while forage covers can be used to graze livestock or support local wildlife. Of the three community phases for this state, this phase promotes the greatest soil sustainability and improves ecological functioning within a cropland system.

Pathway 4.3A – Cover crop practices are abandoned.

Pathway 4.3B – Intensive tillage is utilized, cover crops practices are abandoned, monoculture row-cropping is established, and crop rotation is reduced or eliminated.

Transition 4A – Land abandonment transitions the site to the fire-suppressed scrub state (2).

Transition 4B – Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Restoration 4A – Site preparation, invasive species control, and seeding native species transition this site to the reconstructed prairie state (5).

STATE 5 – RECONSTRUCTED PRAIRIE STATE

Prairie 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 prairie 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 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 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, and a few 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 Phase 5.1 Early Successional Reconstructed 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 cool-season and warm-season annual and perennial grasses and forbs typical of the reference state (e.g., little bluestem, Indiangrass, big bluestem, hoary puccoon). Cool-season annuals can help 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 a majority of the vegetative cover. Control of non-native species, particularly perennial species, is crucial at this point 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.

Pathway 5.1A – Selective herbicides are used to control non-native species, and prescribed fire and/or light grazing helps to increase the native species diversity and control woody vegetation.

Community Phase 5.2 Late Successional Reconstructed 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 function (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 greater ecosystem complexity (Wilsey 2008).

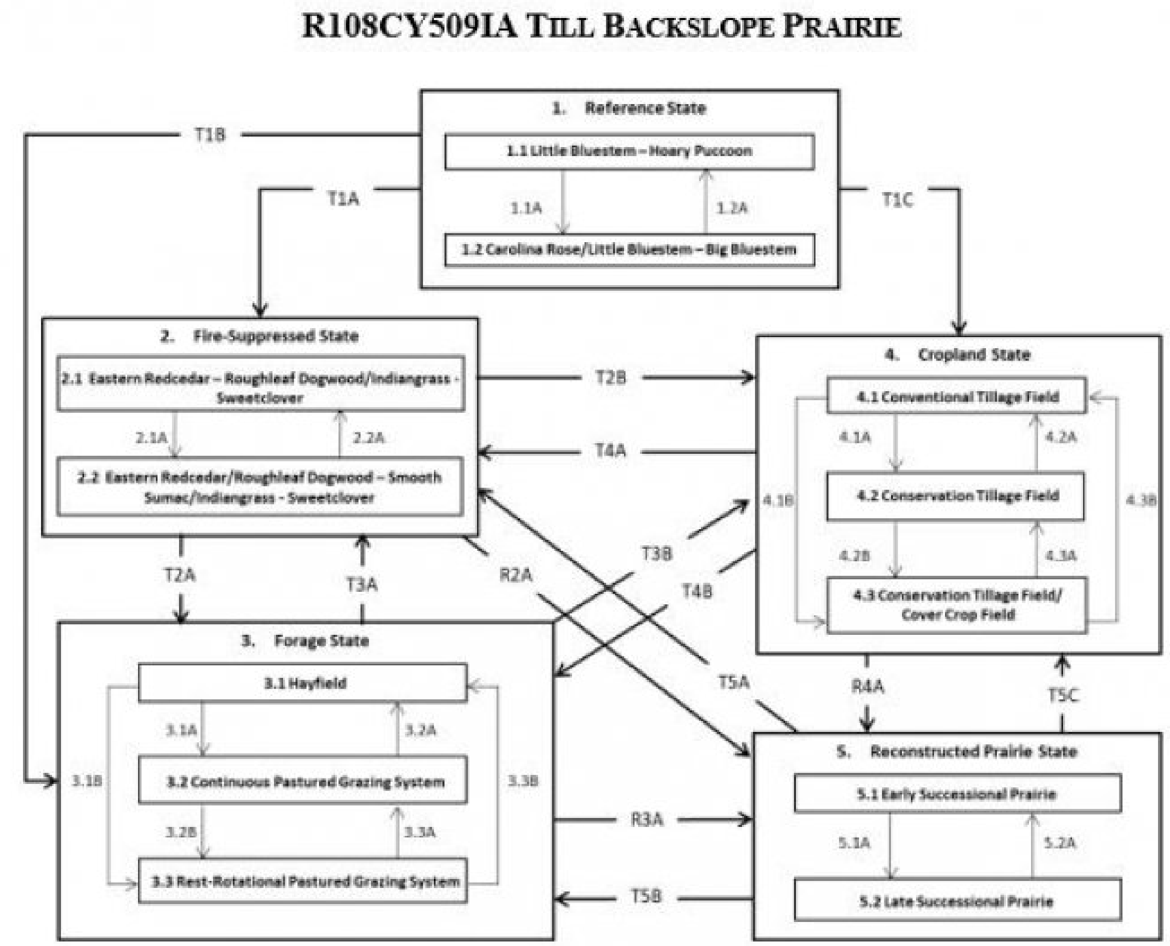
Pathway 5.2A – Reconstruction experiences a decrease in native species diversity from drought or improper timing of management actions (e.g., reduced fire frequency, use of non-selective herbicides).

Transition 5A – Land abandonment transitions the site to the fire-suppressed scrub state (2).

Transition 5B – Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition 5B – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

State and transition model



Code	Process
1.1A	Extended fire return interval
1.2A	Single fire event or soil slumping
T1A, T3A, T4A, T5A	Long-term fire suppression and/or land abandonment
2.1A	Continued fire suppression
2.2A	Single large disturbance event
T1B, T2A, T4B, T5B	Cultural treatments are implemented to increase forage quality and yield
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
T1C, T2B, T3B, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
4.1A	Less tillage, residue management
4.1B	Less tillage, residue management, and implementation of cover cropping
4.2B	Implementation of cover cropping
4.2A, 4.3B	Intensive tillage, remove residue, and reinitiate monoculture row cropping
4.3A	Remove cover cropping
R2A, R3A, R4A	Site preparation, non-native species control, and native seeding
5.1A	Invasive species control and implementation of disturbance regimes
5.2A	Drought or improper timing/use of management actions

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

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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)	
Contact for lead author	
Date	
Approved by	
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:**