

Ecological site R115XC004IL Loess Upland Savanna

Last updated: 12/30/2024
Accessed: 05/12/2025

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.

LRU notes

The Central Mississippi Valley Wooded Slopes, Northern part (Land Resource Unit (LRU) 115XC) encompasses the Wyaconda River Dissected Till Plains, Mississippi River Hills, and Mississippi River Alluvial Plain (Schwegman et al. 1973; Nelson 2010). It spans three states – Illinois (73 percent), Iowa (6 percent), and Missouri (21 percent) – comprising about 13,650 square miles (Figure 1). The elevation ranges from 420 feet above sea level (ASL) along the Mississippi River floodplains to 885 feet on the upland ridges. Local relief varies from 10 to 20 feet but can be as high as 50 to 100 feet along drainageways and streams and the bluffs on the major rivers reaching 250 feet above valley floors. Wisconsin-aged loess covers the uplands, while Illinoian glacial drift lies directly below. The loess and drift deposits are underlain by several bedrock systems, including the Cretaceous, Pennsylvania, Mississippian, Silurian, Devonian, and Ordovician Systems. Wisconsin outwash deposits and sandy eolian material occur along stream terraces of major tributaries (USDA-NRCS 2006).

The vegetation across the region has undergone drastic changes over time. At the end of the last glacial episode – the Wisconsin glacial episode – the evolution of vegetation began with the development of tundra habitats, followed by a phase of spruce and fir forests, and eventually spruce-pine forests. Not until approximately 9,000 years ago did the climate undergo a warming trend which prompted the development of deciduous forests dominated by oak and hickory. As the climate continued to warm and dry, prairies began to develop approximately 8,300 years ago. Another shift in climate that resulted in an increase in moisture prompted the emergence of savanna-like habitats from 8,000 to 5,000 years before present (Taft et al. 2009). During the most recent climatic shifts, forested ecosystems maintained footholds on steep valley sides and wet floodplains. Due to the physiography of the MLRA, forests were the dominant ecosystems and were affected by such natural disturbances as droughts, wind, lightning, and occasional fire (Taft et al. 2009).

Classification relationships

USFS Subregions: Central Dissected Till Plains (251C)Section; Western Mississippi River Hills (251Ce), Mississippi River and Illinois Alluvial Plains (251Cf), Eastern Mississippi River Hills (251Ci), Galesburg Dissected Till Plain (251Cj), and Wyaconda River Dissected Till Plain (251Cm) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Upper Mississippi River Alluvial Plain (72d), River Hills (72f), and Western Dissected Illinoian Till Plain (72i) (USEPA 2013)

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

National Vegetation Classification - Plant Associations: *Quercus macrocarpa* – (*Quercus alba*, *Quercus stellata*) Wooded Grassland (CEGL002159) (Nature Serve 2015)

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

Illinois Natural Areas Inventory: Mesic savanna (White and Madany 1978)

Ecological site concept

Loess Upland Savannas are located within the green areas on the map. They occur uplands. The soils are Alfisols and Mollisols that are somewhat poorly to well drained and very deep, formed in loess or loess-covered substrates.

The historic pre-European settlement vegetation on this ecological site was dominated by tallgrass prairie interspersed with trees. Bur oak (*Quercus macrocarpa* Michx.) is the dominant tree, and big bluestem (*Andropogon gerardii* Vitman) and longbract wild indigo (*Baptisia bracteata* Muhl. ex Elliott var. *leucophaea* (Nutt.) Kartesz & Gandhi) are the dominant and characteristic species on the site, respectively. Other grasses present can include little bluestem (*Schizachyrium scoparium* (Michx.) Nash), Indiangrass (*Sorghastrum nutans* (L.) Nash), and prairie dropseed (*Sporobolus heterolepis* (A. Gray) A. Gray) (White and Madany 1978; NatureServe 2018). Forbs typically associated with an undisturbed plant community associated with this ecological site can include button eryngo (*Eryngium yuccifolium* Michx.), white prairie clover (*Dalea candida* Michx. ex Willd.), and downy phlox (*Phlox pilosa* L.) (White and Madany 1978; Taft et al. 1997). Fire is the primary disturbance factor that maintains this site, while herbivory and drought are secondary factors (LANDFIRE 2009).

Associated sites

R115XC002IL	Loess Upland Prairie Loess and loess-covered substrates including Biggsville, Bold, Breeds, Edwardsville, Joslin, Joy, Keller, Marbletown, Port Byron, Richwood, Tallula, Timewell, and Wakenda soils
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Similar sites

R115XC014IL	Terrace Savanna Terrace Savannas occur on low stream terraces in river valleys and can experience rare flooding
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Table 1. Dominant plant species

Tree	(1) <i>Quercus macrocarpa</i>
Shrub	Not specified
Herbaceous	(1) <i>Andropogon gerardii</i> (2) <i>Baptisia bracteata</i> var. <i>leucophaea</i>

Physiographic features

Loess Upland Savannas occur on uplands. They are situated on elevations ranging from approximately 341 to 1063 feet ASL. The site does not experience flooding but rather generates runoff to adjacent, downslope ecological sites.

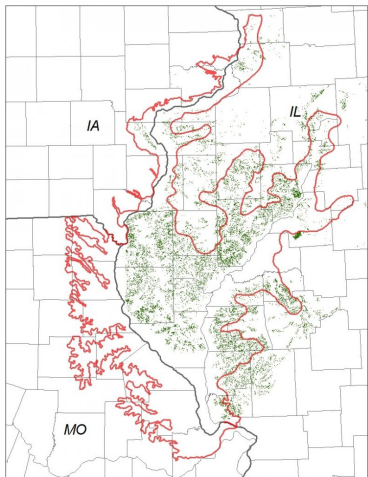


Figure 1. Location of Loess Upland Savanna ecological site within LRU

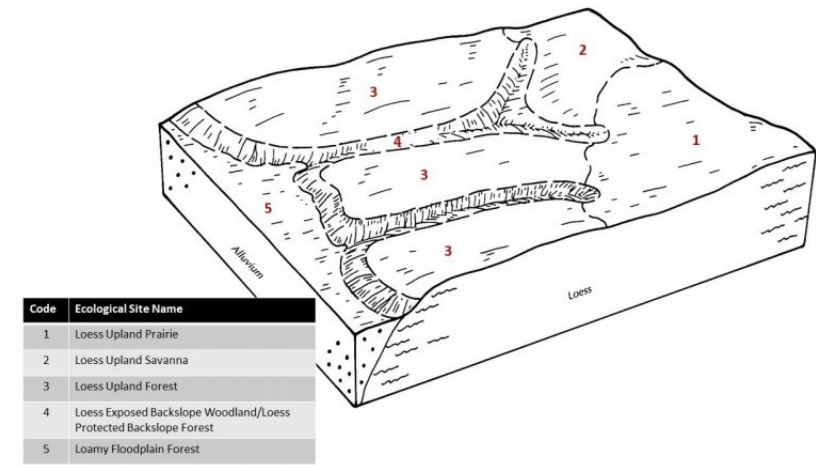


Figure 2. Representative block diagram of Loess Upland Savanna and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Convex
Slope shape up-down	(1) Convex
Landforms	(1) Upland > Upland slope
Runoff class	Low to medium
Flooding frequency	None
Ponding frequency	None
Elevation	341–1,063 ft
Slope	0–18%
Water table depth	15–80 in
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The Central Mississippi Valley Wooded Slopes, Northern Part falls into the humid subtropical (Cfa) and hot-summer humid continental climate (Dfa) Köppen-Geiger climate classifications (Peel et al. 2007). The two main factors that drive the climate of the MLRA are latitude and weather systems. Latitude, and the subsequent reflection of solar input, determines air temperatures and seasonal variations. Solar energy varies across the seasons, with summer receiving three to four times as much energy as opposed to winter. Weather systems (air masses and cyclonic storms) are responsible for daily fluctuations of weather conditions. High-pressure systems are responsible for settled weather patterns where sun and clear skies dominate. In fall, winter, and spring, the polar jet stream is responsible for the creation and movement of low-pressure systems. The clouds, winds, and precipitation associated with a low-pressure system regularly follow high-pressure systems every few days (Angel n.d.).

The soil temperature regime of LRU 115XC 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 182 days, while the frost-free period is about 146 days. The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is 39 inches, which includes rainfall plus the water equivalent from snowfall. The average annual low and high temperatures are 42 and 63°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	139-150 days
Freeze-free period (characteristic range)	169-199 days

Precipitation total (characteristic range)	38-41 in
Frost-free period (actual range)	135-162 days
Freeze-free period (actual range)	167-204 days
Precipitation total (actual range)	36-41 in
Frost-free period (average)	146 days
Freeze-free period (average)	182 days
Precipitation total (average)	39 in

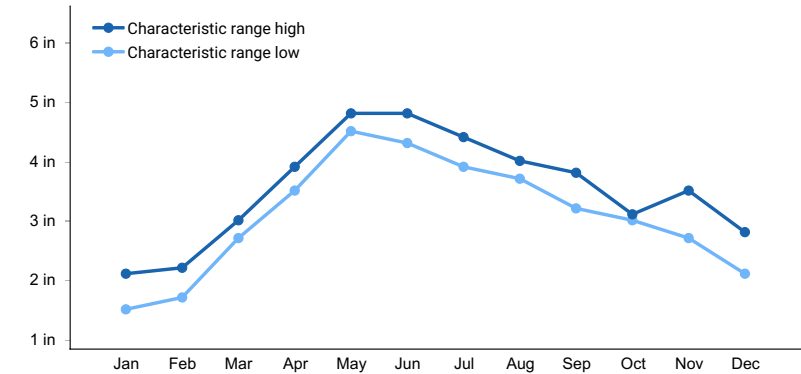


Figure 3. Monthly precipitation range

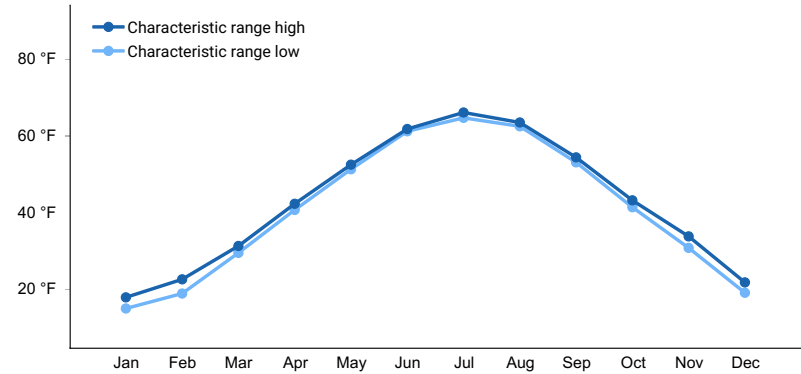


Figure 4. Monthly minimum temperature range

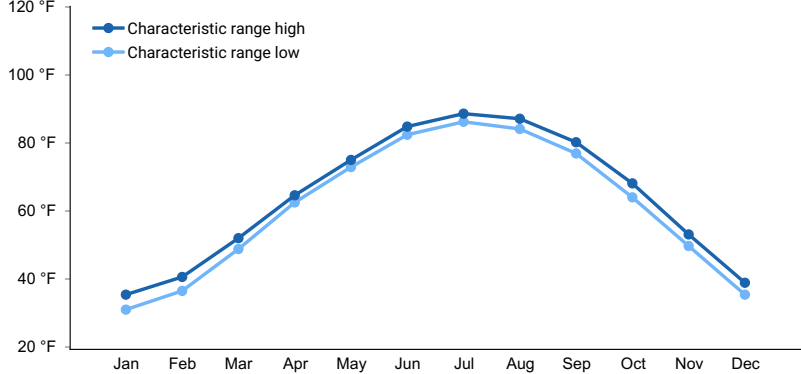


Figure 5. Monthly maximum temperature range

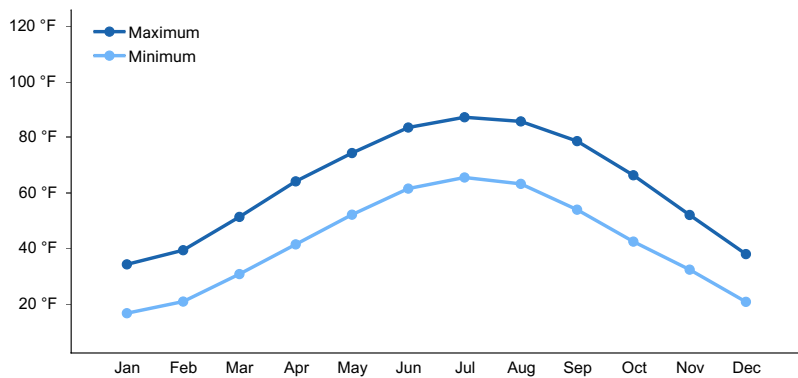


Figure 6. Monthly average minimum and maximum temperature

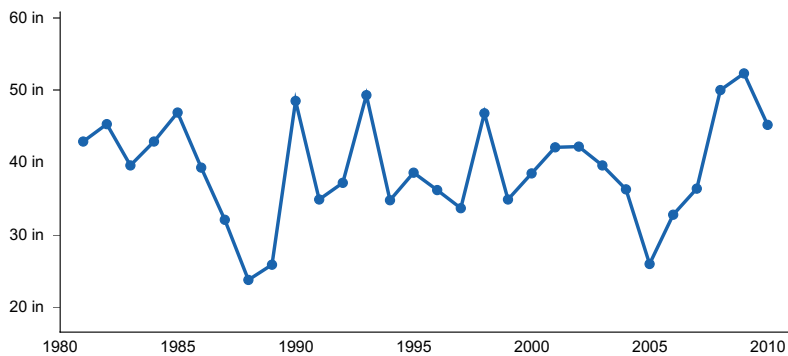


Figure 7. Annual precipitation pattern

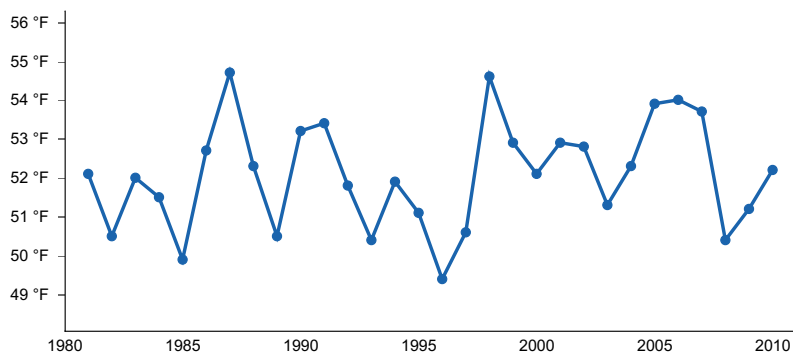


Figure 8. Annual average temperature pattern

Climate stations used

- (1) MORRISON [USC00115833], Morrison, IL
- (2) NEW BOSTON DAM 17 [USC00116080], Wapello, IL
- (3) LA HARPE [USC00114823], La Harpe, IL
- (4) HAVANA [USC00113940], Lewistown, IL
- (5) PITTSFIELD #2 [USC00116837], Pittsfield, IL
- (6) ST CHARLES CO AP [USW00053904], Portage des Sioux, MO

Influencing water features

Loess Upland Savannas are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is very slow to moderate (Hydrologic Groups B, C, and D), and surface runoff is low to medium. Surface runoff contributes some water to downslope ecological sites.

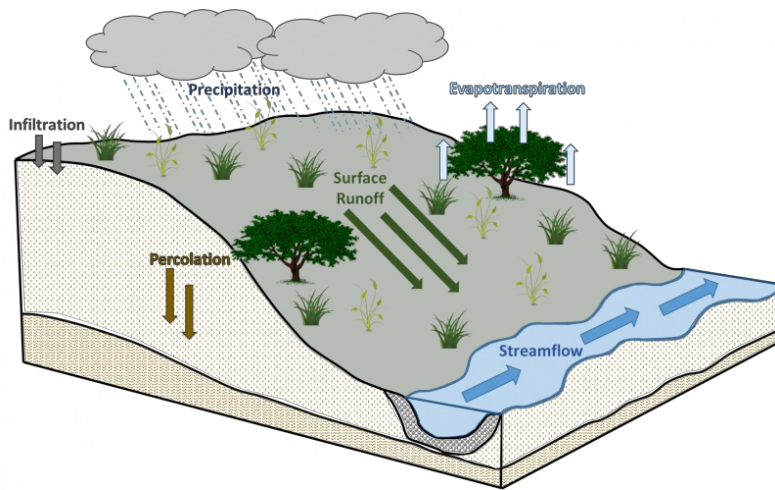


Figure 9. Hydrologic cycling in Loess Upland Savanna ecological site.

Soil features

Soils of Loess Upland Savannas are in the Alfisols and Mollisols orders, further classified as Mollic Hapludalfs, Mollic Oxyaquic Hapludalfs, Udollic Endoaqualfs, and Typic Argiudolls with very slow to moderate infiltration and low to medium runoff potential. The soil series associated with this site includes Atterberry, Bethalto, Clarksdale, Downsouth, Emery, Mannon, Mt. Carroll, Tama, and Velma. The parent material is loess and loess-covered substrates, and the soils are somewhat poorly to well drained and very deep. Soil pH classes are strongly acid to moderately alkaline. Some mapunits with strongly contrasting textural stratification are noted for this ecological site.

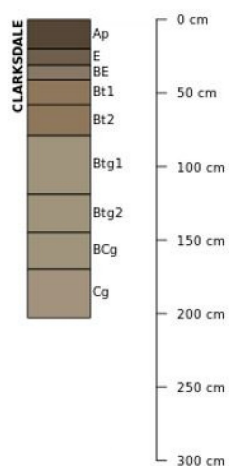


Figure 10. Profile sketches of soil series associated with Loess Upland Savanna.

Table 4. Representative soil features

Parent material	(1) Loess
Surface texture	(1) Silt loam (2) Silty clay loam
Family particle size	(1) Fine-silty
Drainage class	Somewhat poorly drained to well drained
Permeability class	Slow to moderately slow
Depth to restrictive layer	80 in
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%

Available water capacity (Depth not specified)	7–9 in
Calcium carbonate equivalent (Depth not specified)	0–30%
Electrical conductivity (Depth not specified)	0–2 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (Depth not specified)	5.1–8.4
Subsurface fragment volume ≤3" (Depth not specified)	0–7%
Subsurface fragment volume >3" (Depth not specified)	0–2%

Ecological dynamics

The MLRA lies within the tallgrass prairie ecosystem of the Midwest, but a variety of environmental and edaphic factors resulted in a landscape that historically supported upland hardwood forests, lowland mixed forests, and scattered grass and sedge meadows. Loess Upland Savannas form an aspect of this vegetative continuum. This ecological site occurs on uplands on somewhat poorly to well drained soils. Species characteristic of this ecological site consist of tallgrass herbaceous vegetation with scattered trees.

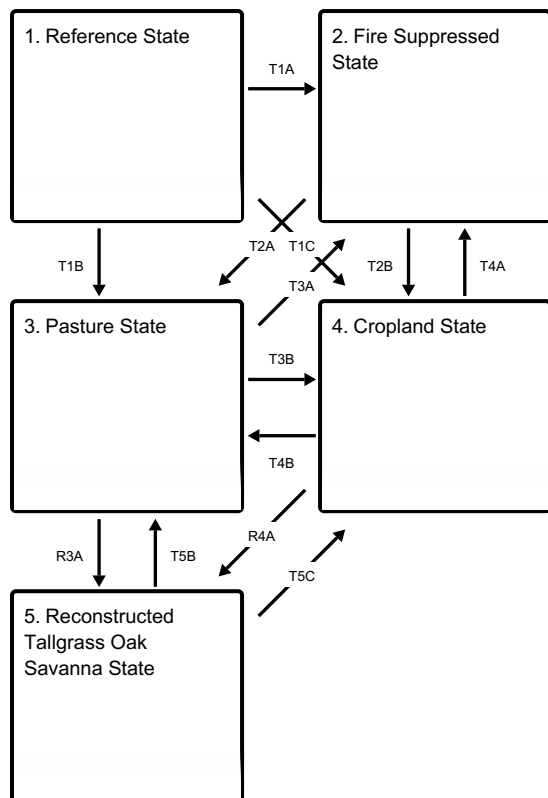
Fire is a critical disturbance factor that maintains Loess Upland Savannas. Fire intensity typically consisted of periodic fires occurring every 1 to 5 years (LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during the spring and 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 by native ungulates have also played a role in shaping this ecological site. The periodic episodes of reduced soil moisture in conjunction with the moderately well to 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).

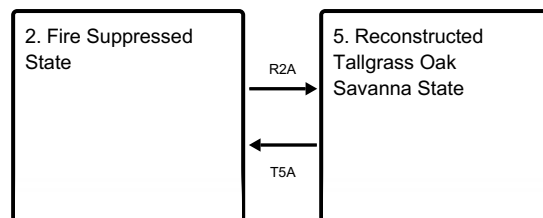
Today, Loess Upland Savannas have been greatly reduced as a result of human-driven type-conversion to agricultural production land (NatureServe 2018). Lands that have not been put into production have had fire suppressed long enough to transition the site from an open savanna to a closed woodland or forest. A return to the historic plant community may not be possible following extensive land modification, but long-term conservation agriculture or savanna reconstruction 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 and transition model

Ecosystem states



States 2 and 5 (additional transitions)



T1A - Fire suppression; land abandonment

T1B - Cultural treatments to increase forage quality and yield

T1C - Agricultural conversion

T2A - Cultural treatments to increase forage quality and yield

T2B - Agricultural conversion

R2A - Site preparation, non-native species control, native seeding

T3B - Agricultural conversion

R3A - Site preparation, non-native species control, native seeding

T4A - Fire suppression; land abandonment

T4B - Cultural treatments to increase forage quality and yield

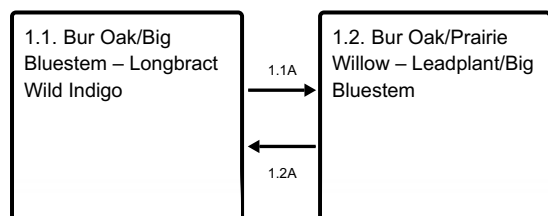
R4A - Site preparation; non-native species control, and native seeding

T5A - Fire suppression; land abandonment

T5B - Cultural treatments to increase forage quality and yield

T5C - Agricultural conversion

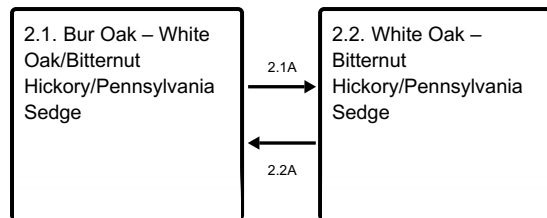
State 1 submodel, plant communities



1.1A - Fire return interval greater than 5 years

1.2A - Mixed or high intensity fire.

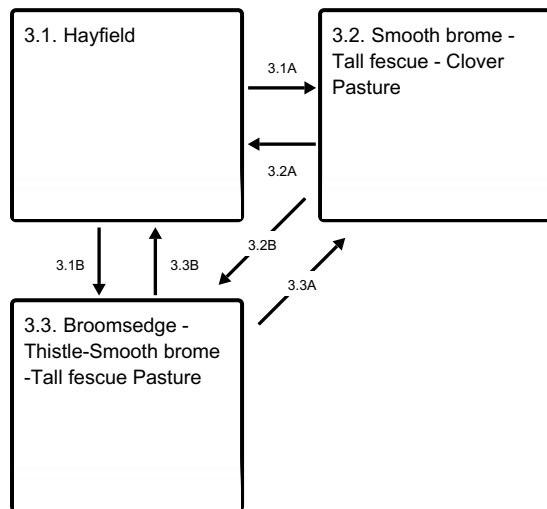
State 2 submodel, plant communities



2.1A - Continued fire suppression

2.2A - Large disturbance event; canopy reduced

State 3 submodel, plant communities



3.1A - Mechanical harvesting

3.1B - Grazing; overutilization of forage plants

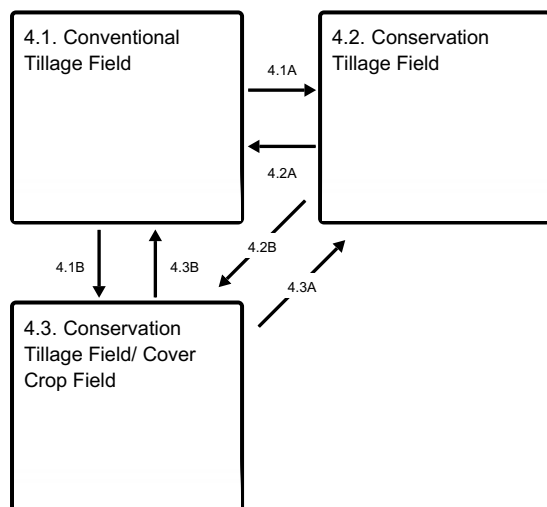
3.2A - Mechanical harvesting

3.2B - Grazing; overutilization of forage plants

3.3B - Mechanical harvesting

3.3A - Grazing; proper animal to forage plant balance

State 4 submodel, plant communities



4.1A - Less tillage, residue management

4.1B - Less tillage, residue management, and implementation of cover cropping

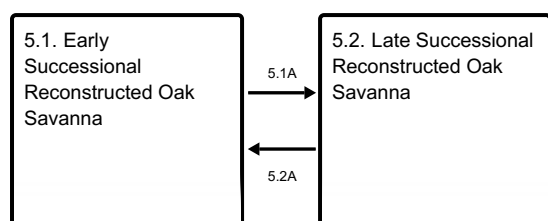
4.2A - Intensive tillage, remove residue, and reinitiate monoculture row cropping

4.2B - Implementation of cover cropping

4.3B - Intensive tillage, remove residue, and reinitiate monoculture row cropping

4.3A - Remove cover cropping

State 5 submodel, plant communities



5.1A - Invasive species control; disturbance regime

5.2A - Drought or improper timing/use of management

State 1 Reference State

The reference plant community is categorized as a mesic oak savanna, dominated by herbaceous vegetation and scattered trees. The two community phases within the reference state are dependent on periodic fires. Surface fires are the dominant fire regime, comprising approximately 96 percent of all fires and occurring every five years. Mixed and high intensity fires comprise the remaining 4 percent, occurring approximately every 3 and 1 years, respectively (LANDFIRE 2009). Fire intensity and return intervals alter species composition, cover, and extent, while regular fire intervals keep woody species from encroaching. Episodic droughts and storm damage have more localized impacts in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- big bluestem (*Andropogon gerardii*), grass
- longbract wild indigo (*Baptisia bracteata*), other herbaceous

Community 1.1 Bur Oak/Big Bluestem – Longbract Wild Indigo

Sites in this reference community phase are dominated by a mix of grasses and forbs with scattered trees. Bur oak is the dominant tree on the site, but white oak (*Quercus alba* L.) may also be present. The tree layer comprises no more than 20 percent cover and trees size class is medium (9 to 21-inch DBH). Vegetative cover is continuous (up to 100 percent) and plants can reach heights up to 3 feet tall (LANDFIRE 2009). Big bluestem, little bluestem, Indiangrass, and prairie dropseed are the dominant warm-season grasses present on the site. Characteristic forbs can include longbract wild indigo, pride of Ohio (*Dodecatheon meadia* L.), prairie blazing star (*Liatris pycnostachya* Michx.), hoary puccoon (*Lithospermum canescens* (Michx.) Lehm.), and compassplant (*Silphium laciniatum* L.) (White and Madany 1978). Surface fires every 5 years will maintain this class, but an extended fire return interval will shift the community to phase 1.2 (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- big bluestem (*Andropogon gerardii*), grass
- longbract wild indigo (*Baptisia bracteata*), other herbaceous

Community 1.2 Bur Oak/Prairie Willow – Leadplant/Big Bluestem

This reference community phase represents a successional shift as a result of an extended fire return interval. This fire-free period allows woody shrubs to establish, including prairie willow (*Salix humilis* Marshall) and leadplant (*Amorpha canescens* Pursh). Tree cover increases to as much as 60 percent, and tree size class moves from medium to large (21 to 33-inch DBH). Surface fires every 5 years will maintain this class, but mixed or high intensity

fires will shift the community back to phase 1.1 (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- leadplant (*Amorpha canescens*), shrub
- big bluestem (*Andropogon gerardii*), grass
- longbract wild indigo (*Baptisia bracteata*), other herbaceous

Pathway 1.1A

Community 1.1 to 1.2

Extended fire return interval in excess of 5 years.

Pathway 1.2A

Community 1.2 to 1.1

Mixed or high intensity fire.

State 2

Fire Suppressed 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 closed canopy state can occur in as little as 25 years from the last fire (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- white oak (*Quercus alba*), tree
- bitternut hickory (*Carya cordiformis*), tree
- Pennsylvania sedge (*Carex pensylvanica*), grass

Community 2.1

Bur Oak – White Oak/Bitternut Hickory/Pennsylvania Sedge

This community represents the early stages of long-term fire suppression. The lack of fire allows the tree canopy to close (60 to 80 percent cover) and stem density to increase. Bur oak and white oak are the dominant trees, and bitternut hickory (*Carya cordiformis* (Wangenh.) K. Koch) begins to form a scattered subcanopy (LANDFIRE 2009). The sun-loving herbaceous layer is slowly replaced by more shade-tolerant species. Rare surface fires that escape suppression efforts will maintain this phase, but a complete lack of fire for 30 years will shift the community to phase 2.2 (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- white oak (*Quercus alba*), tree
- bitternut hickory (*Carya cordiformis*), tree
- Pennsylvania sedge (*Carex pensylvanica*), grass

Community 2.2

White Oak – Bitternut Hickory/Pennsylvania Sedge

Sites falling into this community phase have transitioned into a closed canopy oak-hickory forest. Mature bur and white oaks are still present, but seedlings and saplings are generally absent as they do not establish well under the continuous canopies (Tirmenstein 1991; Gucker 2011). As fire suppression has continued, bitternut hickory saplings

have matured and now become co-dominant with the oaks (Colandonato 1992; LANDFIRE 2009). The ground layer continues to be dominated by shade-tolerant species or non-native invasive species, such as garlic mustard (*Alliaria petiolata* (M. Bieb.) Cavara & Grande). A single, large disturbance event – such as a windstorm – can create open pockets that allow the community to temporarily shift back to phase 2.1.

Dominant plant species

- white oak (*Quercus alba*), tree
- bitternut hickory (*Carya cordiformis*), tree
- Pennsylvania sedge (*Carex pensylvanica*), grass

Pathway 2.1A

Community 2.1 to 2.2

Continued fire suppression (+30 years)

Pathway 2.2A

Community 2.2 to 2.1

A large disturbance event, such as a fire.

State 3

Pasture State

The pasture state occurs when the reference state 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.), tall fescue (*Festuca arundinacea*) and Kentucky bluegrass (*Poa pratensis* L.), to help extend the grazing season. 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.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- alfalfa (*Medicago*), other herbaceous
- clover (*Trifolium*), other herbaceous

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 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). Many species may be planted depending on the landowner's objectives.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- orchardgrass (*Dactylis glomerata*), grass
- timothy (*Phleum pratense*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- alfalfa (*Medicago*), other herbaceous

- timothy (*Phleum pratense*), other herbaceous

Community 3.2

Smooth brome -Tall fescue - Clover Pasture

This community is characterized by seeded cool-season grass and forbs. Species will depend upon landowner goals and objectives and may include many different grasses and forbs. Common species include smooth brome (*Bromus inermis*), tall fescue (*Festuca arundinacea*), Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), red clover (*Trifolium pratense*) and white clover (*Trifolium repens* L.). Management inputs include control of weeds and brush. These sites are managed to ensure a proper forage/animal balance. Plants are not overutilized and have adequate rest and recovery.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- white clover (*Trifolium repens*), other herbaceous
- red clover (*Trifolium pratense*), other herbaceous

Community 3.3

Broomsedge -Thistle-Smooth brome -Tall fescue Pasture

Overutilization of the pasture will result in a shift to include more undesirable species such as thistle (*Cirsium* spp.), broomsedge (*Andropogon virginicus* L.), ironweed (*Vernonia gigantea*), buttercup (*Ranunculus* spp.), ragweed (*Ambrosia* spp.) and blackberries (*Rubus* spp.). Many woody and weed species may be present depending on seed sources and level of soil disturbance. This community reflects an improper forage-to-animal balance which will negatively impact forage productivity and reproduction, soil health, and water quality. Ecological resiliency is compromised under these conditions.

Dominant plant species

- broomsedge bluestem (*Andropogon virginicus*), grass
- crabgrass (*Digitaria*), grass
- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- thistle (*Cirsium*), other herbaceous
- ragweed (*Ambrosia*), other herbaceous
- buttercup (*Ranunculus*), other herbaceous
- ironweed (*Vernonia*), other herbaceous

Pathway 3.1A

Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock grazing.

Pathway 3.1B

Community 3.1 to 3.3

Mechanical harvesting is replaced with domestic livestock grazing. Forage plants are overutilized.

Pathway 3.2A

Community 3.2 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.2B

Community 3.2 to 3.3

Grazing of livestock with overutilization of the forage plants.

Pathway 3.3B

Community 3.3 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.3A

Community 3.3 to 3.2

Forage plants are not overutilized and the site has a proper forage-to-animal balance.

State 4

Cropland State

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.

Dominant plant species

- soybean (*Glycine max*), other herbaceous
- corn (*Zea mays*), other herbaceous

Community 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).

Dominant plant species

- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous

Community 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.

Dominant plant species

- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous

Community 4.3

Conservation Tillage Field/ 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.

Dominant plant species

- rye (*Secale*), grass
- oat (*Avena*), grass
- wheat (*Triticum*), grass
- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous
- alfalfa (*Medicago*), other herbaceous
- clover (*Trifolium*), other herbaceous

Pathway 4.1A

Community 4.1 to 4.2

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

Pathway 4.1B

Community 4.1 to 4.3

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.

Pathway 4.2A

Community 4.2 to 4.1

Intensive tillage is utilized, and monoculture row-cropping is established.

Pathway 4.2B

Community 4.2 to 4.3

Cover crops are implemented to minimize soil erosion.

Pathway 4.3B

Community 4.3 to 4.1

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

Pathway 4.3A

Community 4.3 to 4.2

Cover crop practices are abandoned.

State 5

Reconstructed Tallgrass Oak 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 will help the site progress from an early successional community dominated by annuals and some weeds to a later seral stage composed of native perennial grasses, forbs, shrubs, and eventually mature bur oaks. Establishing a prescribed fire regime that mimics natural disturbance patterns can increase native species cover and diversity while reducing cover of non-native forbs and grasses. Light grazing alone can help promote species richness, while grazing accompanied with fire can control the encroachment of undesirable woody vegetation (Brudvig et al. 2007).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- big bluestem (*Andropogon gerardii*), grass

Community 5.1

Early Successional Reconstructed Oak Savanna

This community phase represents early community assembly and is highly dependent on the timing and priority of planting and/or tree thinning operations and the herbaceous seed mix utilized. If bur oak planting is needed, acorns should be planted shortly after harvest as acorns germinate shortly after seedfall and require no cold stratification. Browse protection may need to be installed to protect newly established seedlings from animal predation (Gucker 2011). If selective tree removal is needed, canopy reduction should encompass between 16 to 45 percent of the undesirable species in a single year (Asbjornsen et al. 2005). The seed mix should look to include a diverse mix of native cool-season and warm-season annual and perennial grasses and forbs typical of the reference state. Native, cool-season annuals can help to provide litter that promotes cool, moist soil conditions to the benefit of the other species in the seed mix. The first season following site preparation and seeding will typically result in annuals and other volunteer species forming most 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 and over time close the canopy.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass

Community 5.2

Late Successional Reconstructed Oak Savanna

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

years to allow the oaks to establish and mature (Gucker 2011).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- big bluestem (*Andropogon gerardii*), grass

Pathway 5.1A

Community 5.1 to 5.2

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

Pathway 5.2A

Community 5.2 to 5.1

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

Long-term fire suppression transitions the site to the fire-suppressed state (2).

Transition T1B

State 1 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the pasture state (3).

Transition T1C

State 1 to 4

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

Transition T2A

State 2 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the pasture state (3).

Transition T2B

State 2 to 4

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

Restoration pathway R2A

State 2 to 5

Site preparation, invasive species control, and seeding native species transition this site to the reconstructed tallgrass oak savanna state (5).

Transition T3A

State 3 to 2

Land abandonment and/or fire suppression transitions the site to the fire-suppressed state (2).

Constraints to recovery. Fire suppression; land abandonment

Transition T3B

State 3 to 4

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

Restoration pathway R3A

State 3 to 5

Site preparation, invasive species control, and seeding native species transition this site to the reconstructed oak savanna state (5).

Transition T4A

State 4 to 2

Land abandonment and/or fire suppression transitions the site to the fire-suppressed state (2).

Transition T4B

State 4 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the pasture state (3).

Restoration pathway R4A

State 4 to 5

Site preparation, tree planting, invasive species control, and seeding native species transition this site to the reconstructed state (5).

Transition T5A

State 5 to 2

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

Transition T5B

State 5 to 3

Cultural treatments to enhance forage quality and yield transition the site to the pasture state (3).

Transition T5C

State 5 to 4

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

Additional community tables

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 this ecological site description.

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Acknowledgments

This project could not have been completed without the dedication and commitment from a variety of staff members. 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	05/12/2025
Approved by	Suzanne Mayne-Kinney
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:**
