USDA Natural Resources Conservation Service

Ecological site F107XB009MO
Calcareous Loess Upland Woodland

Last updated: 5/21/2020
Accessed: 05/13/2025

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.

Figure 1. Mapped extent

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

MLRA notes

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

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

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

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), Rolling Loess Prairies (47f), Nebraska/Kansas Loess Hills (47h) (USEPA 2013)

Biophysical Setting (LANDFIRE 2009): North-Central Interior Dry-Mesic Oak Forest and Woodland (4213100)

Ecological Systems (National Vegetation Classification System, Nature Serve 2015): North-Central Interior Dry-Mesic Oak Forest and Woodland (CES202.046)

Eilers and Roosa (1994): Upland Woods

Iowa Department of Natural Resources (INAI nd): Bur Oak Woodland

Lauver et al. (1999): Quercus macrocarpa/Andropogon gerardii – Stipa spartea Woodland

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

Nebraska Game and Parks Commission (Steinauer and Rolfsmeier 2010): Dry Upland Bur Oak Woodland

Plant Associations (National Vegetation Classification System, Nature Serve 2015): Quercus macrocarpa/Andropogon gerardii – Hesperostipa spartea Woodland (CEGL002053)

Ecological site concept

Calcareous Loess Upland Woodlands occur within the green areas on the map (Figure 1). They occur on summits and shoulders with slopes less than fifteen percent that are upslope from and adjacent to other calcareous wooded ecological sites. Soils are Inceptisols that are well-drained and very deep. 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- and water-holding capacity, increased organic matter retention, and good soil aeration that allows deep penetration by plant roots, which generally results in high plant productivity (Catt 2001).

The historic pre-European settlement vegetation on this site was dominated by open oak woodlands. Bur oak (Quercus macrocarpa Michx.) and chinquapin oak (Quercus muehlenbergii Engelm.) are associated with calcareous soils and form the dominant oak component (Gucker 2011). However, other oak species can occur on the site and include white oak (Quercus alba L.) and black oak (Quercus velutina Lam.). Leadplant (Amorpha canescens Pursh) and prairie willow (Salix humilis Marshall) are characteristic of the plant community, but New Jersey tea (Ceanothus americanus L.) and fragrant sumac (Rhus aromatica Aiton) are dominants. Diagnostic species in the herbaceous layer included big bluestem (Andropogon gerardii Vitman) and pale purple coneflower (Echinacea pallida (Nutt.) Nutt.). Other herbaceous species associated with an undisturbed community included sky blue aster (Symphyotrichum oolentangiense (Riddell) G.L. Nesom), longbract wild indigo (Baptisia bracteata Muhl. ex Elliott), and buffalo clover (Trifolium reflexum L.) (Nelson 2010; Ladd and Thomas 2015). Fire was the primary disturbance factor that maintained this site, while drought, ice damage, native grazing, and periodic insect defoliation were likely secondary factors (LANDFIRE 2009).

Associated sites

F107XB011MO	**Calcareous Loess Exposed Backslope Woodland** Calcareous loess soils on slopes greater than 15 percent with south and west aspects, including Pohocco and Timula
F107XB010MO	**Calcareous Loess Protected Backslope Forest** Calcareous loess soils on slopes greater than 15 percent with north and east aspects, including Pohocco and Timula

Similar sites

F107XB004MO	**Deep Loess Protected Backslope Woodland** Deep Loess Protected Backslope Woodlands support a similar community, but the dominant oak is northern red oak
F107XB011MO	**Calcareous Loess Exposed Backslope Woodland** Calcareous Loess Exposed Backslope Woodlands support a similar oak-hickory community, but landscape position results in a drier environment and less productive bur oak component

Table 1. Dominant plant species

Tree	(1) *Quercus macrocarpa* (2) *Quercus muehlenbergii*
Shrub	(1) *Amorpha canescens* (2) *Salix humilis*
Herbaceous	(1) *Andropogon gerardii* (2) *Echinacea pallida*

Physiographic features

Calcareous Loess Upland Woodlands occur on uplands on summits and shoulders with slopes less than fifteen percent (Figure 2). This ecological site is unique to the Loess Hills landform situated on elevations ranging from approximately 500 to 1,500 feet ASL. This site does not experience flooding but rather generates runoff to adjacent, downslope ecological sites.

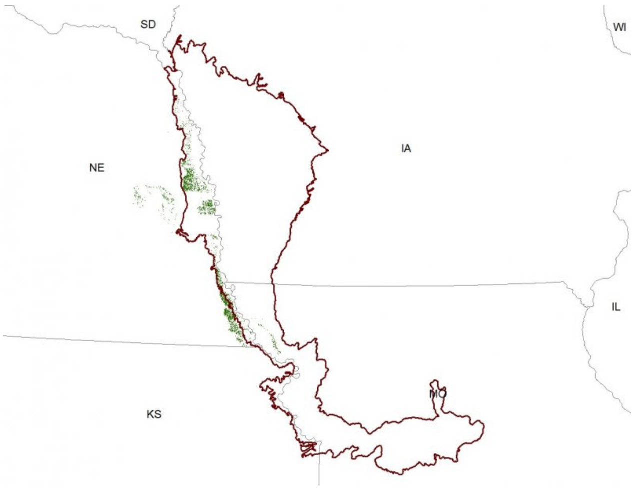


Figure 2. Figure 1. Location of Calcareous Loess Upland Woodland ecological site within MLRA 107B.

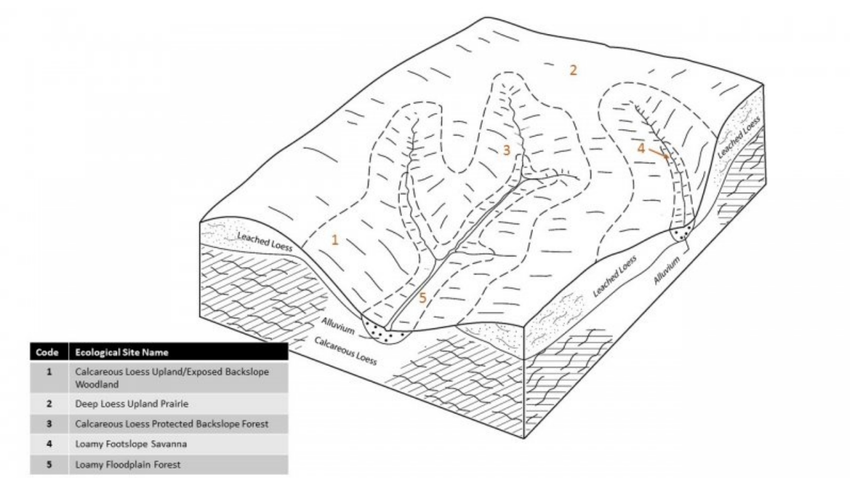


Figure 3. Figure 2. Representative block diagram of Calcareous Loess Upland Woodland and associated ecological sites.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit
Slope shape across	(1) Linear (2) Convex
Slope shape up-down	(1) Concave (2) Convex

Landforms	(1) Ridge (2) Interfluve (3) Hill
Flooding frequency	None
Ponding frequency	None
Elevation	499–1,499 ft
Slope	0–15%
Water table depth	80 in
Aspect	Aspect is not a significant factor

Climatic features

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

The soil temperature regime of MLRA 107B is classified as mesic, where the mean annual soil temperature is between 46 and 59°F (USDA-NRCS 2006). Temperature and precipitation occur along a north-south gradient, where temperature and precipitation increase the further south you travel. The average freeze-free period of this ecological site is about 189 days, while the frost-free period is about 160 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 30 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 41 and 62°F, respectively.

Climate data and analyses are derived from 30-year average 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)	140-151 days
Freeze-free period (characteristic range)	169-186 days
Precipitation total (characteristic range)	31-36 in
Frost-free period (actual range)	136-155 days
Freeze-free period (actual range)	164-192 days
Precipitation total (actual range)	31-37 in
Frost-free period (average)	146 days
Freeze-free period (average)	178 days
Precipitation total (average)	33 in

Climate stations used

- (1) TROY 3N [USC00148250], Troy, KS
- (2) TEKAMAH [USC00258480], Tekamah, NE
- (3) OREGON [USC00236357], Oregon, MO
- (4) AUBURN 5 ESE [USC00250435], Auburn, NE

Influencing water features

Calcareous Loess Upland Woodlands 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 low to 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).

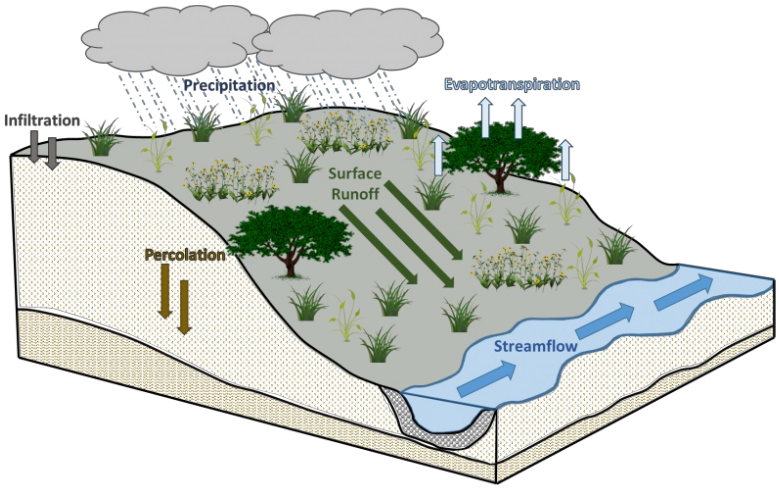


Figure 10. Figure 5. Hydrologic cycling in Calcareous Loess Upland Woodland ecological site.

Soil features

Soils of Calcareous Loess Upland Woodlands are in the Inceptisol order, further classified as Typic Eutrochrepts and Typic Eutrudepts, with moderate infiltration and low to high runoff potential. The soil series associated with this site includes Pohocco and Timula. The parent material is calcareous loess, and the soils are well-drained and very deep with no coarse fragments. Soil pH classes are slightly to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site. Average clay content is low limiting compaction susceptibility, but erosion from wind and water can be high.

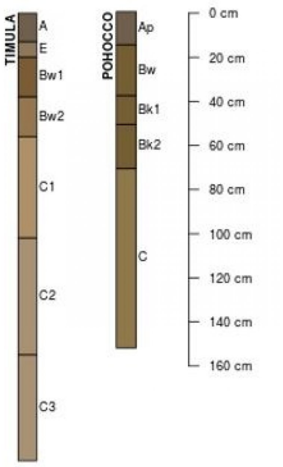


Figure 11. Figure 6. Profile sketches of soil series associated with Calcareous Loess Upland Woodland.

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	Moderately slow to slow
Soil depth	80 in
Available water capacity (0-40in)	8 in
Calcium carbonate equivalent (0-40in)	0–30%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	7.4–8.4

Ecological dynamics

The Loess Hills region lies within the transition zone between the eastern deciduous forests and the Great Plains. 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 (Novacek et al. 1985; Nelson 2010). Calcareous Loess Upland Woodlands form an aspect of this vegetative continuum. This ecological site occurs on summits on calcareous soils. Species characteristic of this ecological site consist of oaks and tallgrass prairie species.

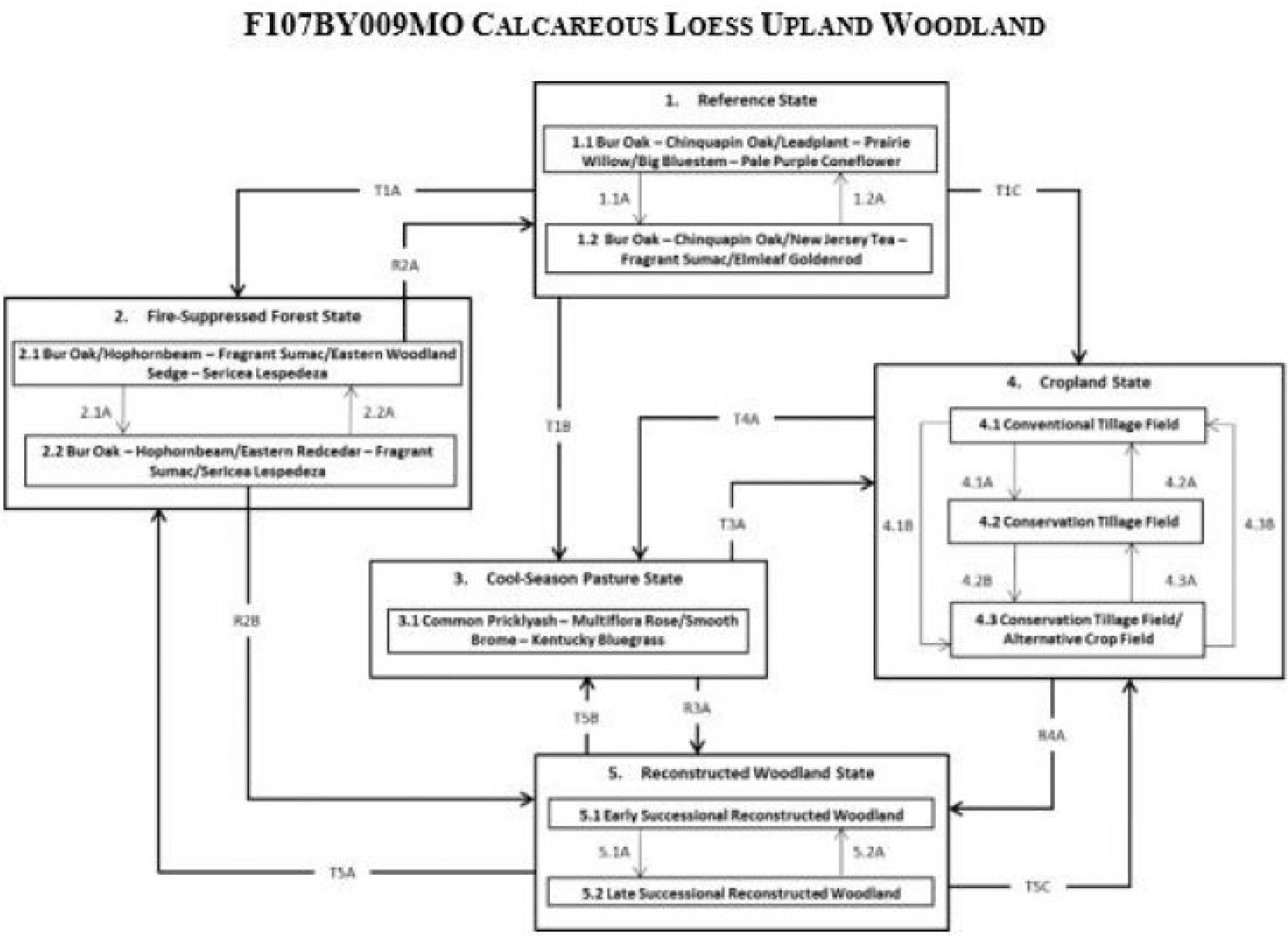
Fire is the most important ecosystem driver for maintaining this ecological site (Dey and Kabrick 2015). Fire intensity typically consisted of periodic, low-to-moderate severity surface fires (LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human 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). Historic fire frequency has been estimated to occur on average every 6.6 years in the Loess Hills region (Stambaugh et al. 2006).

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

Grazing by native ungulates, ice storms, and periodic insect pest damage serve as an important secondary disturbance factors in wooded ecosystems, helping to shape stand composition, structure, condition, and functional complexity (Irland 2000; Briggs et al. 2002; LANDFIRE 2009). Grazing from native ungulates, such as bison (Bison bison), encourages the growth of woody plants by reducing understory species as well as reducing fine fuels that help carry fire into the woodlands (Briggs et al. 2002). Damage to stands from storms and pests can vary from minor, patchy effects of individual trees to major stand effects that could shift overstory composition (Irland 2000). In the case of Calcareous Loess Upland Woodlands, periodic canopy openings from ice storms and insect defoliation as well as reduced competition from grasses and sedges can provide opportunities for the shade-intolerant oaks to regenerate.

Today, many Calcareous Loess Upland Woodland sites have been converted to row-crop agriculture or pasture and are likely to remain as such for the foreseeable future. In addition, grazing and fire suppression have reduced the integrity of remaining woodlands. Sites where remnant woodlands occur have experienced a shift in species composition and cover, and the current woodlands exhibit a more-closed canopy plant community. In addition, invasion by non-native species (e.g., sericea lespedeza (*Lespedeza cuneata* (Dum. Cours.) G. Don)) is rapidly threatening the remaining native community.

State and transition model



Code	Process
T1A, T5A	Fire suppression in excess of 50 years
T1B, T4A, T5B	Tree removal and interseeding of non-native cool-season grasses
T1C, T3A, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
1.1A	Fire return interval reduced to every 10-15 years
1.2A	Fire return interval increased to every 5-10 years
R2A	Selective tree thinning and prescribed fire
2.1A	Fire suppression 50-65 years
2.2A	Single fire event
R2B, R3A, R4A	Tree planting, timber stand improvement, and prescribed fire
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
5.1A	Application of stand improvement practices
5.2A	Reconstruction experiences a setback from extreme weather event or improper timing of management action

Figure 12. STM

State 1
Reference State

The reference plant community is categorized as an open oak woodland. The two community phases within the reference state are dependent on a fire frequency of every two to fifteen years. Shorter fire intervals maintain dominance by tallgrass prairie species in the understory, while less frequent intervals allow more shade-tolerant species to increase in importance. Drought, ice storm, periodic insect defoliation, and native grazing disturbances have less impact in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- chinquapin oak (*Quercus muehlenbergii*), tree
- leadplant (*Amorpha canescens*), shrub
- prairie willow (*Salix humilis*), shrub
- New Jersey tea (*Ceanothus americanus*), shrub
- fragrant sumac (*Rhus aromatica*), shrub
- big bluestem (*Andropogon gerardii*), grass
- pale purple coneflower (*Echinacea pallida*), other herbaceous

Community 1.1
Bur Oak – Chinquapin Oak/Leadplant – Prairie Willow/Big Bluestem – Pale Purple Coneflower

Bur oak and chinquapin oak are the dominant tree components of this phase with lesser components of white oak and black oak. Canopy height is moderate (30 to 60 feet) and coverage is classified as open and is estimated at approximately 30 percent (Nelson 2010). It is maintained by surface fires approximately every two to five years (LANDFIRE 2009). Leadplant and prairie willow are sun-loving shrubs and are diagnostic of the open woodland community phase. The herbaceous layer is moderately vegetated, typically with tallgrass prairie associates such as big bluestem and pale purple coneflower. Other common understory species include little bluestem (*Schizachyrium scoparium* (Michx.) Nash), pointedleaf ticktrefoil (*Desmodium glutinosum* (Muhl. ex Willd.) Alph. Wood), and wild quinine (*Parthenium integrifolium* L.) (Nelson 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- chinquapin oak (*Quercus muehlenbergii*), tree
- leadplant (*Amorpha canescens*), shrub
- prairie willow (*Salix humilis*), shrub
- big bluestem (*Andropogon gerardii*), grass
- pale purple coneflower (*Echinacea pallida*), other herbaceous

Community 1.2
Bur Oak – Chinquapin Oak/New Jersey Tea – Fragrant Sumac/Elmleaf Goldenrod

This reference community phase can occur when fire frequency is increased to approximately every five to ten years (LANDFIRE 2009). Oaks continue to serve as the dominant canopy cover (which can increase to over 80 percent), but the reduced fire interval allows the more shade-tolerant shrubs to increase in the sub-canopy such as New Jersey tea and fragrant sumac. The understory sees an increase to slightly more shade-tolerant species such as elmleaf goldenrod (*Solidago ulmifolia* Muhl. ex Willd.) and fringeleaf wild petunia (*Ruellia humilis* Nutt.) (Steinauer and Rolfsmeier 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- chinquapin oak (*Quercus muehlenbergii*), tree
- New Jersey tea (*Ceanothus americanus*), shrub
- fragrant sumac (*Rhus aromatica*), shrub
- elmleaf goldenrod (*Solidago ulmifolia*), other herbaceous

Pathway P1.1A
Community 1.1 to 1.2

Natural succession as a result of an average fire return interval of five to ten years.

Pathway P1.2A
Community 1.2 to 1.1

Natural succession as a result of surface fires within ten years.

State 2
Fire Suppressed Forest State

Fire suppression can transition the reference oak woodland community into a closed-canopy fire-suppressed forest state. This state is evidenced by a closed-canopy that is overstocked and overgrown with a sparse herbaceous understory. Invasive and exotic species, particularly Eastern redcedar (*Juniperus virginiana* L.) and sericea lespedeza, have invaded these sites and decreased the understory diversity (Nelson 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- hophornbeam (*Ostrya virginiana*), tree
- eastern redcedar (*Juniperus virginiana*), shrub
- fragrant sumac (*Rhus aromatica*), shrub
- eastern woodland sedge (*Carex blanda*), grass
- sericea lespedeza (*Lespedeza cuneata*), other herbaceous

Community 2.1
Bur Oak/Hophornbeam – Fragrant Sumac/Eastern Woodland Sedge – Sericea Lespedeza

This community phase represents a shift to a closed-canopy forest state. The fire-intolerant hophornbeam (*Ostrya virginiana* (Mill.) K. Koch) becomes dominant in the subcanopy along with the more shade-tolerant fragrant sumac. The herbaceous layer continues to shift to more shade-tolerant species such as eastern woodland sedge (*Carex blanda* Dewey) and Virginia creeper (*Parthenocissus quinquefolia* (L.) Planch). The exotic sericea lespedeza invades the most heavily-disturbed areas, and its alleopathic properties further suppress the understory (Nelson 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- hophornbeam (*Ostrya virginiana*), shrub
- fragrant sumac (*Rhus aromatica*), shrub
- eastern woodland sedge (*Carex blanda*), grass
- sericea lespedeza (*Lespedeza cuneata*), other herbaceous

Community 2.2
Bur Oak – Hophornbeam/Eastern Redcedar – Fragrant Sumac/Virginia Creeper – Sericea Lespedeza

Hophornbeam becomes co-dominant with bur oak in the overstory canopy, while Eastern redcedar becomes a co-dominant with fragrant sumac (Nelson 2010; Steinauer and Rolfsmeier 2010). As the canopy closes, the understory becomes less populous, and only the most shade-tolerant species persist. Sericea lespedeza continues to occupy sites that are disturbed (Nelson 2010).

Dominant plant species

- hophornbeam (*Ostrya virginiana*), tree
- bur oak (*Quercus macrocarpa*), tree
- fragrant sumac (*Rhus aromatica*), shrub
- eastern redcedar (*Juniperus virginiana*), shrub
- sericea lespedeza (*Lespedeza cuneata*), other herbaceous
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

Pathway P2.1A
Community 2.1 to 2.2

Fire is removed from the landscape in excess of 65 years.

Pathway P2.2A
Community 2.2 to 2.1

Fire occurs within 50 years.

State 3
Cool Season Pasture

The cool-season pasture state occurs when the reference state has been anthropogenically-altered for livestock production. Early settlers harvested the trees for timber and fuel and seeded such non-native cool-season species as smooth brome (*Bromus inermis* Leyss.) and Kentucky bluegrass (*Poa pratensis* L.), converting the woodland to pasture (Smith 1998; IDNR 2013). Over time, as lands were continually grazed by large herds of cattle, the non-native species were able to spread and expand across the site, reducing the native species diversity.

Dominant plant species

- common pricklyash (*Zanthoxylum americanum*), shrub
- multiflora rose (*Rosa multiflora*), shrub
- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

Community 3.1
Common Pricklyash – Multiflora Rose/Smooth Brome – Kentucky Bluegrass

Sites in this community phase arise from tree removal and seeding of non-native cool-season grasses. Bur oaks provided a valuable source of fuel and timber for early settlers, and many were harvested as a result, leaving widely-spaced individuals. Smooth brome and Kentucky bluegrass were common species used for pasture planting. Grazing by livestock maintains this simplified grassland state.

Dominant plant species

- common pricklyash (*Zanthoxylum americanum*), shrub
- multiflora rose (*Rosa multiflora*), shrub
- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

State 4
Cropland State

The Midwest is well-known for its highly-productive agricultural soils, and as a result, much of the MLRA has been converted to cropland, including portions of this ecological site. The continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) have effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.) are the dominant crops for the site. These areas are likely to remain in crop production for the foreseeable future.

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 impact 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).

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 system, conservation tillage methods can reduce soil erosion, increase organic matter and water availability, improve water quality, and reduce soil compaction.

Community 4.3
Conservation Tillage Field/Alternative Crop Field

This condition 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. 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 P4.1A
Community 4.1 to 4.2

Tillage operations are greatly reduced, crop rotation occurs on a regular schedule, and crop residue is allowed to remain on the soil surface.

Pathway P4.1B
Community 4.1 to 4.3

Tillage operations are greatly reduced or eliminated, crop rotation is either reduced or eliminated, and crop residue is allowed to remain on the soil surface, and cover crops are implemented to prevent soil erosion.

Pathway P4.2A
Community 4.2 to 4.1

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

Pathway P4.2B
Community 4.2 to 4.3

Implementation of cover cropping.

Pathway P4.3B
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 P4.3A
Community 4.3 to 4.2

Remove cover cropping.

State 5
Reconstructed Woodland State

The combination of natural and anthropogenic disturbances occurring today has resulted in a number of forest health issues, and restoration back to the historic reference condition may not always be feasible. Woodlands and forests are being stressed by non-native diseases and pests, habitat fragmentation, permanent changes in soil hydrology, and overabundant deer populations on top of naturally-occurring disturbances (severe weather and native pests) (Flickinger 2010). However, these habitats provide multiple ecosystem services including carbon sequestration; clean air and water; soil conservation; biodiversity support; wildlife habitat; timber, fiber, and fuel products; as well as a variety of cultural activities (e.g., hiking, camping, hunting) (Millennium Ecosystem Assessment 2005; Flickinger 2010). Therefore, conservation of forests and woodlands should still be pursued. Woodland reconstructions are an important tool for repairing natural ecological functioning and providing habitat protection for numerous species of Calcareous Loess Upland Woodlands. 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 ranges of stress and disturbance, and create and maintain positive biotic and abiotic interactions (SER 2002). The reconstructed woodland state is the result of a long-term commitment involving a multi-step, adaptive management process.

Community 5.1
Early Successional Reconstructed Woodland

This community phase represents the early community assembly from woodland reconstruction. It is highly dependent on the current condition of the woodland based on past and current land management actions, invasive species, and proximity to land populated with non-native pests and diseases. Therefore, no two sites will have the same early successional composition. Technical forestry assistance should be sought to develop suitable stewardship management plans.

Community 5.2
Late Successional Reconstructed Woodland

Appropriately timed management practices (e.g., prescribed fire, hazardous fuels management, forest stand improvement, continuing integrated pest management) applied to the early successional community phase can help increase the stand maturity, pushing the site into a late successional community phase over time. A late successional reconstructed woodland will have an uneven-aged canopy and a well-developed understory.

Pathway P5.1A
Community 5.1 to 5.2

Application of stand improvement practices in line with a developed management plan.

Pathway P5.2A
Community 5.2 to 5.1

Reconstruction experiences a setback from extreme weather event or improper timing of management actions.

Transition T1A
State 1 to 2

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

Transition T1B

State 1 to 3

Tree removal and interseeding non-native cool-season grasses transition this site to the cool-season 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).

Restoration pathway R2A
State 2 to 1

Selective tree thinning and prescribed fire is used to restore this site to the reference state (1).

Restoration pathway R2B
State 2 to 5

Site preparation, invasive species control (native and non-native), tree planting, and prescribed fire transition this site to the reconstructed woodland state (5).

Transition T3A
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 (native and non-native), tree planting, and prescribed fire transition this site to the reconstructed woodland state (5).

Transition T4A
State 4 to 3

Non-selective herbicide and seeding of non-native cool-season grasses transitions the site to the cool-season pasture state (3).

Transition R4A
State 4 to 5

Site preparation, invasive species control (native and non-native), tree planting, and prescribed fire transition this site to the reconstructed woodland state (5).

Transition T5A
State 5 to 2

Fire (or fire surrogate) suppression efforts transition this site to the fire-suppressed forest state (2).

Restoration pathway T5B
State 5 to 3

Tree removal and interseeding non-native cool-season grasses transition this site to the cool-season 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

Animal community

Wildlife

Oak acorns are an excellent hard mast species, and along with the soft mast from shrubs, high energy legume seeds and abundant browse, the community provides excellent food and cover for wildlife.

Large diameter trees of extended age provide substantial opportunity for significant tree cavities.

Bird species associated with early-successional these Woodlands include Northern Bobwhite, Bell's Vireo, Prairie Warbler, Field Sparrow, and Brown Thrasher.

Mid- to late successional birds include Indigo Bunting, Red-headed Woodpecker, Eastern Bluebird, Eastern Wood-Pewee, and Red-tailed Hawk.

Amphibian and reptile species associated with mature Woodlands include tiger salamander, small-mouthed salamander, ornate box turtle, northern fence lizard, five-lined skink, broad-headed skink, six-lined racerunner, western slender glass lizard, prairie ring-necked snake, flat-headed snake, and rough earth snake.

Other information

Forestry

Management: Site index values range from 46 to 59 for oak. Timber management opportunities are good. Create group openings of at least 2 acres. Large clearcuts should be minimized if possible to reduce impacts on wildlife and aesthetics. Uneven-aged management using single tree selection or small group selection cuttings of ½ to 1 acre are other options that can be used if clear cutting is not desired or warranted. Using prescribed fire as a management tool should be used with caution on a particular site if timber management is the primary objective. Favor white oak, post oak, chinkapin oak and black oak.

Limitations: No major equipment restrictions or limitations exist. Erosion is a hazard when slopes exceed 15 percent. On steep slopes greater than 35 percent, traction problems increase and equipment use is not recommended.

Inventory data references

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

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Approval

Chris Tecklenburg, 5/21/2020

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Rangeland health reference sheet

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

Author(s)/participant(s)	Lisa Kluesner
Contact for lead author	
Date	05/13/2025
Approved by	Chris Tecklenburg
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not**

bare ground):

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5. **Number of gullies and erosion associated with gullies:**

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6. **Extent of wind scoured, blowouts and/or depositional areas:**

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7. **Amount of litter movement (describe size and distance expected to travel):**

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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):**

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

---

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

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

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

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:**