Ecological site F107XB004MO
Deep Loess Protected Backslope Woodland

Last updated: 5/21/2020
Accessed: 02/08/2025

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); Deep Loess Hills (251Ca), Loess Hills (251Cb) Subsection; Nebraska Rolling Hills Section (251H), Yankton Hills and Valleys (251Ha), 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 Maple-Basswood Forest (4213140)

Ecological Systems (National Vegetation Classification System, Nature Serve 2015): North-Central Interior Maple-Basswood Forest (CES202.696)

Eilers and Roosa (1994): Upland Woods

Iowa Department of Natural Resources (INAI nd): Central Mesic Forest

Lauver et al. (1999): Acer saccharum – [Acer nigrum] – Tilia americana – Quercus rubra/Ostrya virginana Forest

Missouri Natural Heritage Program (Nelson 2010): Mesic Loess/Glacial Till Forest

Nebraska Game and Parks Commission (Steinauer and Rolfsmeier 2010): Red Oak – Basswood – Ironwood Forest

Plant Associations (National Vegetation Classification System, Nature Serve 2015): Acer saccharum – Acer nigrum – Tilia americana – Quercus rubra/Ostrya virginana Forest (CEGL002061)

Ecological site concept

Deep Loess Protected Backslope Woodlands are mapped in complex with Deep Loess Exposed Backslope Savannas and are located within the green areas on the map (Figure 1). They occur on north- and east-facing backslopes with slopes greater than fifteen percent. Soils are Alfisols, Entisols, Inceptisols, and Mollisols that are well-drained and very deep, formed from loess. 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). These sites occur adjacent to Deep Loess Upland Prairies and Deep Loess Exposed Backslope Savanna ecological sites.

The historic pre-European settlement vegetation on this site was dominated by northern red oak (Quercus rubra L.) and American basswood (Tilia americana L.). Other tree species can include bitternut hickory (Carya cordiformis (Wangenh.) K. Koch), shagbark hickory (Carya ovata (Mill.) K. Koch), and white oak (Quercus alba L.), and sugar maple (Acer saccharum Marshall) becomes an important component on the eastern side of the Missouri River. The shrub layer is typically populated with pawpaw (Asimina triloba (L.) Dunal) and slippery elm (Ulmus rubra Muhl.). Herbaceous species typical of an undisturbed plant community associated with this ecological site include narrowleaf wild leek (Allium burdickii (Hanes) A.G. Jones), American spikenard (Aralia racemosa L.), blue cohosh (Caulophyllum thalictroides (L.) Michx.), and American ginseng (Panax quinquefolius L.) (Ladd and Thomas 2015; Steinauer and Rolfsmeier 2010; Nelson 2010). Historically, catastrophic windthrow was the primary disturbance factor that maintained the composition of this site, while extreme drought, periodic pest outbreaks, browsing by native ungulates, and infrequent fires can limit woody species survival and recruitment (LANDFIRE 2009; Nelson 2010; Gucker 2011).

Compared to calcareous loess wooded ecological sites in the MLRA, Deep Loess Protected Backslope Woodlands have no soil carbonates. The resulting lower pH environment slows the mineralization of nitrogen as well as leaves other important nutrients (phosphorus, iron, manganese) more available for plant uptake making these sites slightly more productive than their calcareous counterparts (Larcher 2003). In addition, Deep Loess Protected Backslope Woodlands have a higher clay content which increases the water holding capacity.

Associated sites

F107XB009MO	**Calcareous Loess Upland Woodland** Calcareous loess soils on slopes less than 15 percent including Pohocco and Timula
F107XB011MO	**Calcareous Loess Exposed Backslope Woodland** Calcareous loess soils on slopes greater than 15 percent with south and west aspects, including Pohocco and Timula
R107XB002MO	**Deep Loess Upland Prairie** Leached soils on slopes less than 15 percent including Arents, Contrary, Deroin, Higginsville, Melia, Monona, Ponca, Sibley, Sibleyville, Strahan, Udarents, Udorthents, Wakenda

Similar sites

R107XB003MO	**Deep Loess Exposed Backslope Savanna** Deep Loess Exposed Backslope Savannas only occur on south and west aspects
F107XB009MO	**Calcareous Loess Upland Woodland** Calcareous Loess Upland Woodlands have calcareous soils and only occur on slopes less than fifteen percent and are bur oak dominated
F107XB011MO	**Calcareous Loess Exposed Backslope Woodland** Calcareous Loess Exposed Backslope Woodlands have calcareous soils and only occur on south- and west aspects and are bur oak dominated
F107XB010MO	**Calcareous Loess Protected Backslope Forest** Calcareous Loess Protected Backslope Forests are similar in landscape position but are bur oak dominated and soils are calcareous

Table 1. Dominant plant species

Tree	(1) *Quercus rubra* (2) *Tilia americana*
Shrub	(1) *Asimina triloba* (2) *Ulmus rubra*
Herbaceous	(1) *Carex jamesii* (2) *Sanguinaria canadensis*

Physiographic features

Deep Loess Protected Backslope Woodlands occur on uplands on backslopes with slopes greater than fifteen percent on north- and east-facing aspects on dissected till plains (Figure 2). This ecological site is unique to the Loess Hills landform situated on elevations ranging from approximately 400 to 1,400 feet ASL. This site does not experience flooding but rather generates runoff to adjacent, downslope ecological sites.

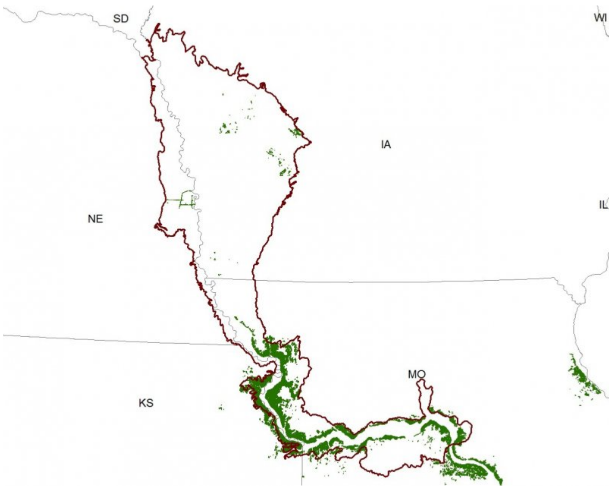


Figure 2. Figure 1. Location of Deep Loess Protected Backslope Woodland ecological site within MLRA 107B.

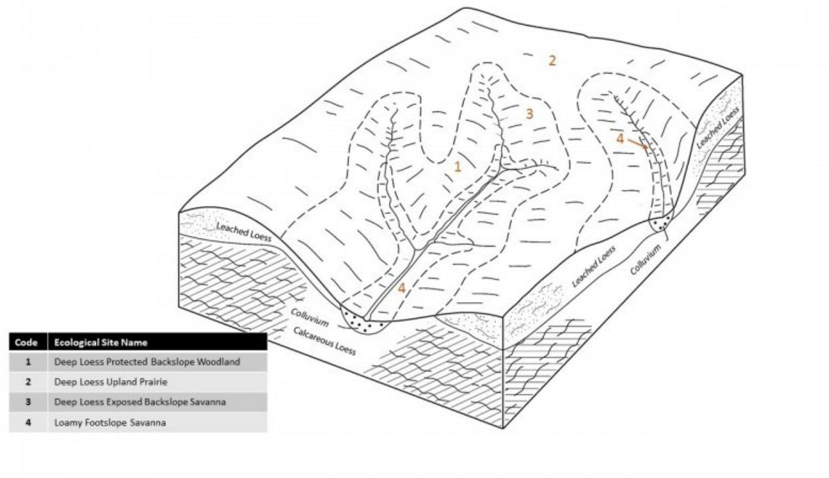


Figure 3. Figure 2. Representative block diagram of Deep Loess Protected Backslope Woodland and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Linear (2) Convex
Slope shape up-down	(1) Concave (2) Convex
Landforms	(1) Hillslope (2) Loess hill
Flooding frequency	None
Ponding frequency	None
Elevation	397–1,466 ft
Slope	15–50%
Water table depth	80 in
Aspect	N, NE, E

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 one travels. The average freeze-free period of this ecological site is about 186 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 36 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 40 and 62°F, respectively.

Climate data and analyses are derived from 30-year average gathered from seven 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)	134-156 days

Freeze-free period (characteristic range)	159-188 days
Precipitation total (characteristic range)	32-38 in
Frost-free period (actual range)	128-163 days
Freeze-free period (actual range)	153-193 days
Precipitation total (actual range)	32-41 in
Frost-free period (average)	146 days
Freeze-free period (average)	176 days
Precipitation total (average)	35 in

Climate stations used

- (1) OREGON [USC00236357], Oregon, MO
- (2) LEXINGTON 3E [USC00234904], Lexington, MO
- (3) CASTANA EXP FARM [USC00131277], Mapleton, IA
- (4) LOGAN [USC00134894], Logan, IA
- (5) MAPLETON NO.2 [USC00135123], Mapleton, IA
- (6) SIDNEY [USC00137669], Sidney, IA
- (7) KANSAS CITY INTL AP [USW00003947], Kansas City, MO

Influencing water features

Deep Loess Protected Backslope Woodlands are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is slow to moderate (Hydrologic Groups B and C), and surface runoff is low to very high. Precipitation infiltrates the soil surface and percolates 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).

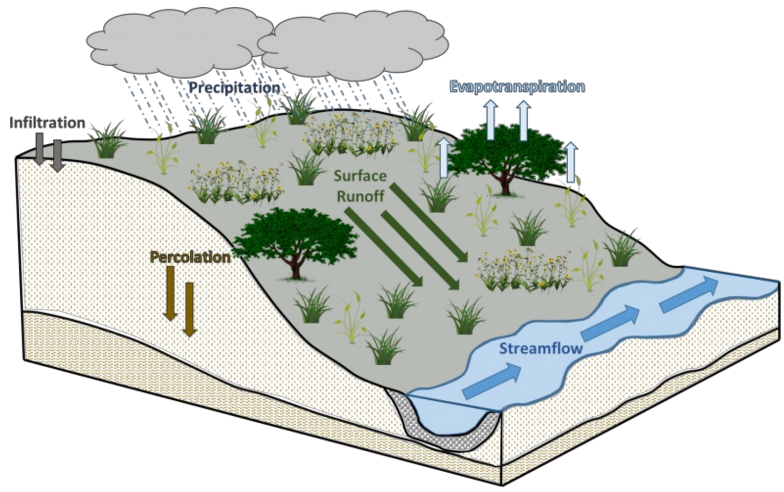


Figure 10. Figure 5. Hydrologic cycling in Deep Loess Protected Backslope Woodland.

Soil features

Soils of Deep Loess Protected Backslope Woodlands are in the Alfisol and Entisol orders, further classified as Mollic Hapludalfs and Typic Hapludalfs with slow to moderate infiltration and low to high runoff potential. The soil series associated with this site includes Knox, Menfro, Udarents, and Udorthents. The parent material is fine-silty loess, and the soils are well-drained and very deep with no coarse fragments. Soil pH classes are slightly acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site.

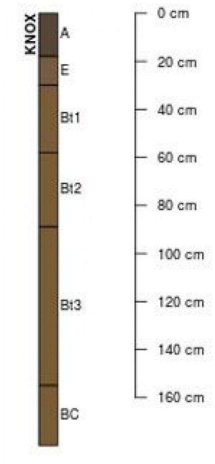


Figure 11. Figure 6. Profile sketch of soil series associated with Deep Loess Protected Backslope Woodland.

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	Well drained
Permeability class	Slow to moderately slow
Soil depth	80 in
Available water capacity (0-40in)	8 in
Calcium carbonate equivalent (0-40in)	0%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	5.6–7.3

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, or forests (Novacek et al. 1985; Nelson 2010). Deep Loess Protected Backslope Forests form an aspect of this vegetative continuum. This ecological site occurs on north- and east-facing aspects of upland backslopes on loess soils. Species characteristic of this ecological site consist of northern red oak, hickory, and basswood with a shade-tolerant understory.

Catastrophic windthrow events are a major disturbance factor in Deep Loess Protected Backslope Woodlands. Within MLRA 107B, such events are mostly caused from tornadoes and associated winds and generally occur in the early summer months. Immediate responses to high wind events can alter forest structure and species richness or evenness, thereby impacting species diversity. Composition can also shift to one containing more early-successional species (Peterson 2000). Windthrow events that maintain the reference community have been modeled to occur approximately every 10 years (LANDFIRE 2009).

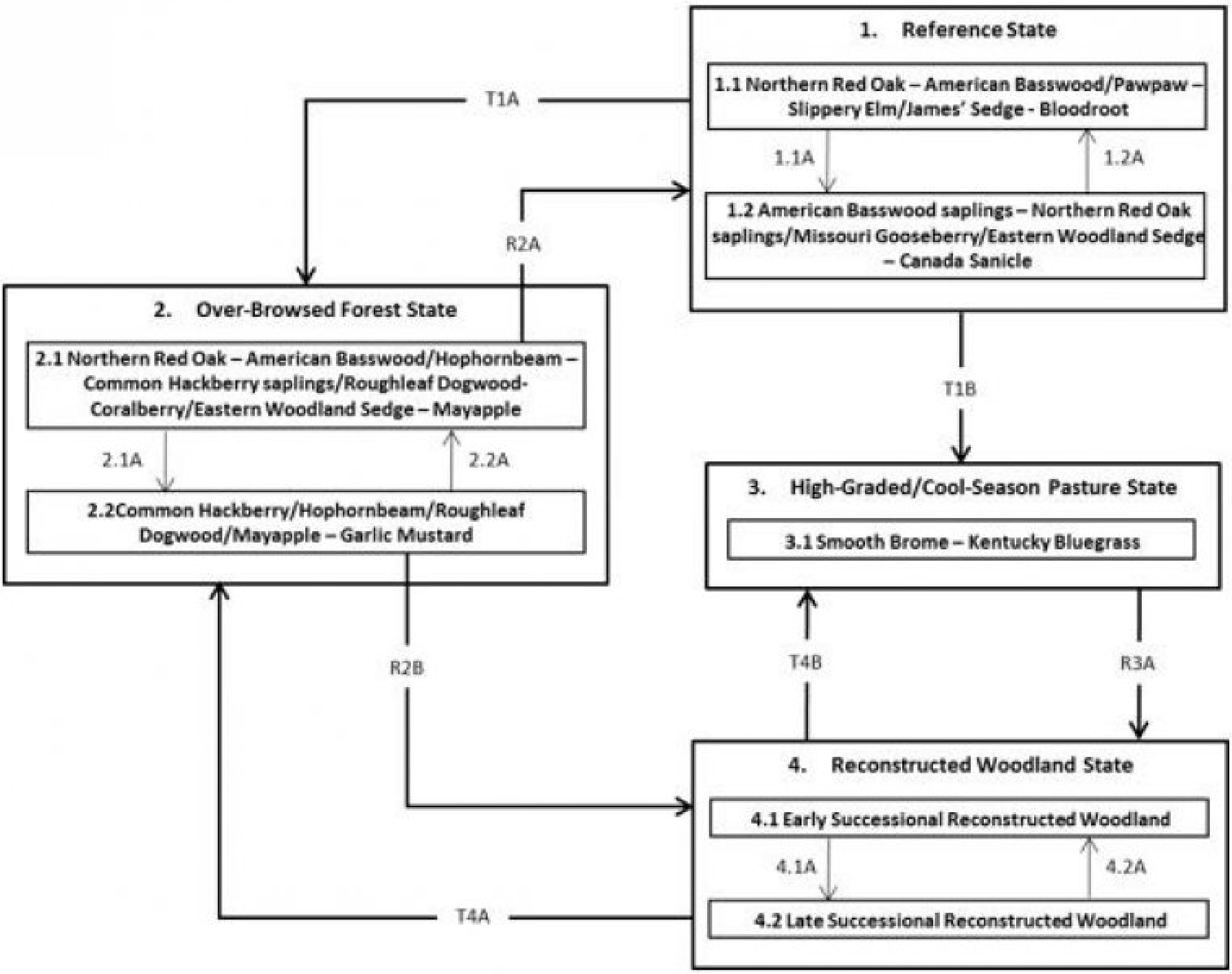
This ecological site is mostly populated with fire-sensitive species, indicating that fire was not a major disturbance factor. Rather, high-intensity, low-frequency fires typically followed catastrophic wind events or extreme periods of drought. These large stand-replacing fires were estimated to have occurred in intervals greater than 1,000 years. Periodic, light surface fires, occurring approximately on a 50-year fire-rotation interval, would help shape the composition and structure of young (<100 years of age) forest stands (LANDFIRE 2009).

Drought has also played a role in shaping the forest 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. Similarly, periodic pest outbreaks and browsing by native ungulates can have a local effect on woody species recruitment and regeneration (Gucker 2011).

Today, many original Deep Loess Protected Backslope Woodlands have been reduced as a result of conversion to cool-season pasture and will likely remain as such for the foreseeable future. However, this ecological site has expanded into areas formerly occupied by drier woodland types as a result of fire suppression and oak harvesting (LANDFIRE 2009). On steeper slopes, the community has persisted but has been degraded as a result of over-browsing by unnaturally high populations of white-tailed deer (Odocoileus virginianus). In addition, invasion by non-native species (e.g., garlic mustard (*Alliaria petiolata* (M. Bieb.) Cavara & Grande), ground ivy (*Glechoma hederacea* L.), and Amur honeysuckle (*Lonicera maackii* (Rupr.) Herder)) as well as the spread of forest pests (e.g., bur oak blight, oak tatters, emerald ash borer (Agrilus planipennis), and Japanese beetle (Popillia japonica)) are rapidly threatening the remaining native community (Nelson 2010; Steinauer and Rolfsmeier 2010).

State and transition model

F107BY004MO DEEP LOESS PROTECTED BACKSLOPE WOODLAND



Code	Process
T1A, T4A	Overbrowsing by unnaturally high deer populations
T1B, T4B	Woody removal, interseeding cool-season grasses, and continuous grazing
1.1A	Windthrow event, <10 years
1.2A	Disturbance-free period, >10 years
R2A	Deer management
2.1A	Rising deer populations
2.2A	Deer population reduction and/or browse protections installed
R2B, R3A	Tree planting, native seeding, invasive species control
4.1A	Application of stand improvement practices in line with a developed management plan
4.2A	Reconstruction experiences a setback from extreme weather event or improper timing of management actions

State 1
Reference State

The reference plant community is categorized as a mesic oak-basswood woodland. The two community phases within the reference state are dependent on catastrophic disturbance events (e.g. wind, ice, snow). A longer interval of no disturbances results in a mature overstory canopy and the presence of more disturbance-intolerant species, while recent events can reset the community to an earlier-successional status. Fire, grazing, and drought have less impact in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- American basswood (*Tilia americana*), tree
- pawpaw (*Asimina triloba*), shrub
- sedge (*Carex*), grass

Community 1.1
Northern Red Oak – American Basswood/Pawpaw – Slippery Elm/James' Sedge - Bloodroot

Northern red oak and American basswood are the diagnostic tree species for this reference community phase, while hickory, white oak, green ash (*Fraxinus pennsylvanica* Marshall), black walnut (*Juglans nigra* L.), and Kentucky coffeetree (*Gymnocladus dioicus* (L.) K. Koch) are closely associated canopy species (Nelson 2010; Steinauer and Rolfsmeier 2010). Tree heights range between 90 and 130 feet tall, tree size class is large (21 to 33 inches DBH), and the canopy closure can be 61 to 80 percent (LANDFIRE 2009; Nelson 2010). The subcanopy is dominated by pawpaw, slippery elm, and hophornbeam (*Ostrya virginiana* (Mill.) K. Koch), and the scattered shrub layer is most commonly populated by chokecherry and Missouri gooseberry. Numerous shade-tolerant sedges and forbs form a sparse to moderate herbaceous layer and include James's sedge, bloodroot, eastern waterleaf (*Hydrophyllum virginianum* L.), and Canadian white violet (*Viola canadensis* L.) (Nelson 2010, Steinauer and Rolfsmeier 2010).

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- American basswood (*Tilia americana*), tree
- pawpaw (*Asimina triloba*), shrub
- slippery elm (*Ulmus rubra*), shrub
- eastern woodland sedge (*Carex blanda*), grass
- mayapple (*Podophyllum peltatum*), other herbaceous

Community 1.2
American Basswood saplings – Northern Red Oak saplings/Missouri Gooseberry/Eastern Woodland Sedge – Canada Sanicle

This reference community phase can occur following a small-scale windthrow event. As larger trees are more vulnerable to wind events, forest structure is altered resulting in an adjustment in canopy dominance. Similarly, forest structure has shifted to a reduction in average tree height (16 to 33 feet high) and size class (medium, nine to 21 inch DBH) (LANDFIRE 2009). The understory transitions to early-successional, disturbance-tolerant species such as eastern woodland sedge (*Carex blanda* Dewey) and Canadian blacksnakeroot (*Sanicula canadensis* L.) (Steinauer and Rolfsmeier 2010).

Dominant plant species

- American basswood (*Tilia americana*), tree
- northern red oak (*Quercus rubra*), tree
- Missouri gooseberry (*Ribes missouriense*), shrub
- eastern woodland sedge (*Carex blanda*), grass
- Canadian blacksnakeroot (*Sanicula canadensis*), other herbaceous

Pathway P1.1A
Community 1.1 to 1.2

Natural succession as a result of a periodic disturbance event.

Pathway P1.2A
Community 1.2 to 1.1

Natural succession as a result of lack of natural disturbances for more than 50 years.

State 2
Over-Browsed Forest State

Overbrowsing by an unnaturally abundant white-tailed deer population can transition the reference state into an over-browsed forest state. Continuous browsing has been reported to prevent the regeneration of the historic dominant canopy, which is replaced by mid-level and invasive species (Gubanyi et al. 2008; VerCauteren and Hygnstrom 2011). White-tailed deer have been reported to prefer American basswood, which under high densities of deer can result in the reduction of seedling growth ultimately leading to a complete exclusion from the site (Tilghman 1987; Sullivan 1994). Common hackberry, on the other hand, has a greater tolerance to deer browsing thus allowing it to dominate the tree canopy under high deer browse conditions. Similarly, as small woody shrubs and plants are continuously browsed, the gaps are replaced by less palatable herbaceous species (Gubanyi et al. 2008).

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- American basswood (*Tilia americana*), tree
- hophornbeam (*Ostrya virginiana*), shrub
- roughleaf dogwood (*Cornus drummondii*), shrub
- sedge (*Carex*), grass
- mayapple (*Podophyllum peltatum*), other herbaceous

Community 2.1
Northern Red Oak – American Basswood/Hophornbeam – Common Hackberry saplings/Roughleaf Dogwood – Coralberry/Eastern Woodland Sedge – Mayapple

This community phase represents the initial impacts of browsing from an over-abundant deer population. The oak and basswood canopy component is out of browsing range from the deer and will persist in the overstory. However, recruitment of these species becomes nonexistent as seedlings and small saplings are browsed. Hophornbeam has a low palatability to deer, while common hackberry (*Celtis occidentalis* L.) is tolerant of browsing (Coladonato 1992; Gucker 2011). These species begin to dominate the midstory canopy. Roughleaf dogwood (*Cornus drummondii* C.A. Mey) and coralberry (*Symphoricarpos orbiculatus* Moench) are patchy within the shrub component. Eastern woodland sedge persists in the understory, while mayapple (*Podophyllum peltatum* L.) begins to increase as it is commonly avoided by deer (Gubanyi et al. 2008; Rawbinski 2008).

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- American basswood (*Tilia americana*), tree
- coralberry (*Symphoricarpos orbiculatus*), shrub
- roughleaf dogwood (*Cornus drummondii*), shrub
- hophornbeam (*Ostrya virginiana*), shrub
- common hackberry (*Celtis occidentalis*), shrub
- eastern woodland sedge (*Carex blanda*), grass
- mayapple (*Podophyllum peltatum*), other herbaceous

Community 2.2
Common Hackberry/Hophornbeam/Roughleaf Dogwood/Mayapple – Garlic Mustard

As deer browsing continues unabated, the overstory canopy eventually shifts away from the oaks and basswood to common hackberry. Elm (Ulmus L.) and ash (Fraxinus L.) can be co-dominants in the overstory. Hophornbeam may persist in the subcanopy, but the shrub component is heavily browsed, leaving only heavily-stunted and deformed roughleaf dogwood. Mayapple continues to dominate the herbaceous layer, and the invasive garlic mustard (*Alliaria petiolata* (M. Bieb) Vacara & Grande) can become co-dominant (Gubanyi et al. 2008; Rawbinski 2008). In addition to continued browse disturbance from the overabundant deer, garlic mustard can also suppress the re-establishment of native species as it is known to produce an antifungal chemical that disrupts beneficial mychorrhizal fungi relationships (Stinson et al. 2006).

Dominant plant species

- common hackberry (*Celtis occidentalis*), tree
- hophornbeam (*Ostrya virginiana*), shrub
- roughleaf dogwood (*Cornus drummondii*), shrub
- mayapple (*Podophyllum peltatum*), other herbaceous
- garlic mustard (*Alliaria petiolata*), other herbaceous

Pathway P2.1A
Community 2.1 to 2.2

Deer populations continue to rise and browsing rates increase.

Pathway P2.2A
Community 2.2 to 2.1

Deer populations are reduced or browse protections around vegetation less than two meters in height is installed.

State 3
High Graded/Cool Season Pasture State

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). 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

- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- mayapple (*Podophyllum peltatum*), other herbaceous

Community 3.1
Smooth Brome - Kentucky Bluegrass

Sites in this community phase arise from tree removal and seeding of non-native cool-season grasses (Steinauer and Rolfsmeier 2010). Oaks and basswoods provided a valuable source of fuel and timber for early settlers, and many were harvested from suitable slopes as a result. Smooth brome and Kentucky bluegrass were common species used for pasture planting. Grazing by livestock maintains this simplified grassland state.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

State 4
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 is likely not possible. 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 associated with Deep Loess Protected Backslope 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 4.1
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 4.2
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 P4.1A
Community 4.1 to 4.2

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

Pathway P4.2A
Community 4.2 to 4.1

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

Transition T1A
State 1 to 2

Over-browsing by unnaturally high populations of white-tailed deer transition this site to the over-browsed woodland state (2).

Transition T1B
State 1 to 3

Woody species reduction, interseeding of non-native, cool-season grasses, and continuous grazing transition this site to the high-graded, cool-season pasture state (3).

Restoration pathway R2A
State 2 to 1

Establishment of a long-term deer management program transitions this site to the reference state (1).

Restoration pathway R2B
State 2 to 4

Site preparation, tree planting, native seeding, and invasive species control transition this site to the reconstructed woodland state (4).

Restoration pathway R3A
State 3 to 4

Site preparation, tree planting, native seeding, and invasive species control transition this site to the reconstructed woodland state (4).

Transition T4A
State 4 to 2

Over-browsing by unnaturally high populations of white-tailed deer transition this site to the over-browsed woodland state (2).

Transition T4B
State 4 to 3

Woody species removal; seeding of cool season grasses; continuous management.

Additional community tables

Animal community

Wildlife

Wild turkey, white-tailed deer, and eastern gray squirrel depend on hard and soft mast food sources and are typical upland game species of this type.

Oaks provide hard mast; scattered shrubs provide soft mast; native legumes provide high-quality wildlife food;

Sedges and native cool-season grasses provide green browse; patchy native warm-season grasses provide cover and nesting habitat; and a diversity of forbs provides a diversity and abundance of insects.

Post-burn areas can provide temporary bare-ground – herbaceous cover habitat important for turkey poults and quail chicks.

Bird species associated with mature communities include Indigo Bunting, Red-headed Woodpecker, Eastern Bluebird, Northern Bobwhite, Eastern Wood-Pewee, Broad-winged Hawk, Great-Crested Flycatcher, Summer Tanager, and Red-eyed Vireo.

Reptile and amphibian species associated with this ecological site include tiger salamander, small-mouthed salamander, ornate box turtle, northern fence lizard, five-lined skink, broad-headed skink, flat-headed snake, and rough earth snake.

Other information

Forestry
Management: Site index values range from 68 to 81 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 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 could have a negative impact on timber quality, may not be fitting, or should be used with caution on a particular site if timber management is the primary objective. Favor white oak and northern red 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.

Other references

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

Baker, R.G., L.J. Maher, C.A. Chumbley, and K.L. Van Zant. 1992. Patterns of Holocene environmental changes in the midwestern United States. Quarternary Research 37: 379-389.
Catt, J. 2001. The agricultural importance of loess. Earth-Science Reviews 54: 213-229.

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

Coladonato, M. 1992. *Ostrya virginiana*. In: Fire Effects Information System [online]. U.S. Department of Agricutlure, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Available at https://www.feis-crs.org/feis/. (Accessed 17 April 2017).

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

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

Flickinger, A. 2010. Iowa Forests Today: An Assessment of the Issues and Strategies for Conserving and Managing Iowa's Forests. Iowa Department of Natural Resources. 329 pps.

Gubanyi, J., J. Savidge, S.E. Hygnstrom, K. VerCauteren, G.W. Garabrandt, and S. Korte. 2008. Deer impact on vegetation in natural areas in southeastern Nebraska. USDA National Wildlife Research Center – Staff Publications. 913. Available at http://digitalcommons.unl.edu/icwdm_usdanwrc/913. (Accessed 6 April 2017).

Gucker, C.L. 2011. Quercus macrocarpa. In: Fire Effects Information System [online]. U.S. Department of Agricutlure, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Available at https://www.feis-crs.org/feis/. (Accessed 17 April 2017).

Iowa Natural Areas Inventory [INAI]. No date. Vegetation Classification of Iowa. Iowa Natural Areas Inventory, Iowa Department of Natural Resources, Des Moines, IA.

Ladd, D. and J.R. Thomas. 2015. Ecological checklist of the Missouri Flora for Floristic Quality Assessment. Phytoneuron 12: 1-274.

LANDFIRE. 2009. Biophysical Setting 4213140 North-Central Interior Maple-Basswood. In: LANDFIRE National Vegetation Dynamics Models. USDA Forest Service and US Department of Interior. Washington, DC.

Larcher, W. 2003. Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups, 4th Edition. Spring-Verlag Berlin Heidelberg. Berlin, Germany. 514 pps.

Lauver, C.L., K. Kindscher, D. Faber-Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44: 421-443.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-Being: Current States and Trends. World Resources Institute. Island Press, Washington, D.C. 948 pages.

Nelson, P. 2010. The Terrestrial Natural Communities of Missouri, Revised Edition. Missouri Natural Areas

Committee, Department of Natural Resources and the Department of Conservation, Jefferson City, MO. 500 pps.

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

Novacek, J.M., D.M. Roosa, and W.P. Pusateri. 1985. The vegetation of the Loess Hills landform along the Missouri River. Proceedings of the Iowa Academy of Sciences 92: 199-212.

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

Peterson, C.J. 2000. Catastrophic wind damage to North American forests and the potential impact of climate change. The Science of the Total Environment 262: 287-311.

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

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

Rawbinski, T.J. 2008. Impacts of White-tailed Deer Overabundance in Forest Ecosystems: An Overview. U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry. Newton Square, PA, USA. Available at https://www.na.fs.fed.us/fhp/special_interests/White-tailed_deer.pdf (Accessed 17 April 2017).

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

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

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

Steinauer, G. and S. Rolfsmeier. 2010. Terrestrial Natural Communities of Nebraska, Version IV. Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 224 pps.

Stinson, K.A., S.A. Campbell, J.R. Powell, B.E. Wolfe, R.M. Callaway, G.C. Thelen, S.G. Hallett, D. Prati, and J.N. Klironomos. 2006. Invasive plant suppresses the growth of native tree seedlings by disrupting belowground mutualisms. PLOS Biology 4: 0727-0731.

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

Sullivan, J. 1994. Tilia americana. In: Fire Effects information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Available: http://www.fs.fed.us/database/feis/. (Accessed 6 April 2017.)

Tilghman, N.G. 1987. Deer populations and their impact on regenerating northern hardwoods. In: Nyland, R.D. (ed.). Managing Northern Hardwoods: Proceedings of a Silvicultural Symposium. 1986 June 23-25, Syracuse, NY. Faculty of Forestry Miscellaneous Publication No. 13 (ESF 87-002); Society of American Foresters Publication No. 87-03. Syracuse, NY; College of Environmental Science and Forestry, State University of New York.

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

U.S. Environmental Protection Agency [EPA]. 2013. Level III and Level IV Ecoregions of the Continental United

States. Corvallis, OR, U.S. EPA, National Health and Environmental Effects Research Laboratory, map scale 1:3,000,000. Available at http://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states. (Accessed 1 March 2017).

VerCauteren, K. and S.E. Hygnstrom. 2011. Managing white-tailed deer: Midwest North America. Papers in Natural Resources. Paper 380. Available at http://http://digitalcommons.unl.edu/natrespapers/380. (Accessed 17 April 2017).

Visher, S.S. 1954. Climatic Atlas of the United States. Harvard University Press, Cambridge, MA. 403pps.

Approval

Chris Tecklenburg, 5/21/2020

Acknowledgments

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

Organization Name Title Location
Drake University:
Dr. Tom Rosburg Professor of Ecology and Botany Des Moines, IA

Iowa Department of Natural Resources:
Lindsey Barney District Forester Oakland, IA
John Pearson Ecologist Des Moines, IA

LANDFIRE (The Nature Conservancy):
Randy Swaty Ecologist Evanston, IL

Natural Resources Conservation Service:
Rick Bednarek IA State Soil Scientist Des Moines, IA
Stacey Clark Regional Ecological Site Specialist St. Paul, MN
Tonie Endres Senior Regional Soil Scientist Indianapolis, IA
John Hammerly Soil Data Quality Specialist Indianapolis, IN
Lisa Kluesner Ecological Site Specialist Waverly, IA
Sean Kluesner Earth Team Volunteer Waverly, IA
Jeff Matthias State Grassland Specialist Des Moines, IA
Kevin Norwood Soil Survey Regional Director Indianapolis, IN
Doug Oelmann Soil Scientist Des Moines, IA
James Phillips GIS Specialist Des Moines, IA
Dan Pulido Soil Survey Leader Atlantic, IA
Melvin Simmons Soil Survey Leader Gallatin, MO
Tyler Staggs Ecological Site Specialist Indianapolis, IN
Jason Steele Area Resource Soil Scientist Fairfield, IA
Doug Wallace Ecological Site Specialist Columbia, MO

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	02/08/2025
Approved by	Chris Tecklenburg
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

---

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:**
