USDA Natural Resources Conservation Service

Ecological site R056BY094MN
Loamy

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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.

MLRA notes

Major Land Resource Area (MLRA): 056B–Glacial Lake Agassiz, Tallgrass Aspen Parklands

MLRA 56B is part of the glacial Lake Agassiz basin, which formed as the lake receded. Most of the area is glaciolacustrine sediments overlying till. This MLRA is entirely in Minnesota and makes up about 4,664 square miles (12,079 square kilometers). It is bordered by beaches and a lake plain on the west (MLRA 56A), by a till plain on the south (MLRA 102A), and by a lake plain and till plain on the east (MLRA 88). (United States Department of Agriculture, Agriculture Handbook 296)

Classification relationships

Level IV Ecoregions of the Conterminous United States: 48a Glacial Lake Agassiz Basin; 48b Beach Ridges and Sand Deltas; and 48d Lake Agassiz Plains.

MLRA 56B (United States Department of Agriculture, Agriculture Handbook 296, 2022).

Ecological site concept

The Loamy ecological site is located on flats and rises on lake plains, delta plains, and isolated areas of till plain. Representative slopes range from 0 to 2 percent. The soils are very deep; The common feature of the soils are medium and moderately fine textures through most of the root zone. Surface textures typically are loam, very fine sandy loam, fine sandy loam, sandy loam, loamy sand and loamy fine sand also occur. Soil on this site is somewhat poorly to moderately well drained.

Associated sites

R056BY084MN	**Clayey** This site typically occurs somewhat lower on the landscape. The subsoil layer forms a ribbon >2 inches long.
R056BY087MN	**Limy Subirrigated** This site occurs lower on the landscape. It is highly calcareous in the upper part of the subsoil and has redoximorphic features at a depth of 18 to 30 inches. All textures are included in this site.
R056BY088MN	**Loamy Overflow** This site occurs on lower, concave slopes on lake plains – a run-on position; it also occurs on floodplain steps. The surface and subsoil layers form a ribbon 1 to 2 inches long.
R056BY091MN	**Sandy** This site occurs on lake plains. The surface and subsoil layers from a ribbon <1 inch long.

R056BY095MN	**Subirrigated** This site occurs on concave flats and in shallow depressions which have occasional, brief ponding early in the growing season. It has redoximorphic features at a depth of 18 to 30 inches. It is >16 inches to a highly calcareous subsoil. All textures are included in this site.
R056BY102MN	**Wet Meadow** This site occurs in depressions and flats on uplands; it also occurs on floodplains. It is poorly drained - a seasonal highwater table is typically within a depth of 1.5 feet during the months of April through June; in depressions, it is frequently ponded (typically <1.5) in April and May. It typically has redoximorphic features within a depth of 18 inches. Some soils are highly calcareous. E.C. is <8 in the surface and subsoil layers. All textures are included in this site.

Similar sites

R056BY088MN	**Loamy Overflow** This site occurs on lower, concave slopes on lake plains – a run-on position; it also occurs on floodplain steps. The surface and subsoil layers form a ribbon 1 to 2 inches long.
R056BY091MN	**Sandy** This site occurs on lake plains. The surface and subsoil layers from a ribbon <1 inch long.
R056BY084MN	**Clayey** This site typically occurs somewhat lower on the landscape. The subsoil layer forms a ribbon >2 inches long.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon gerardii* (2) *Sorghastrum nutans*

Physiographic features

This site typically occurs on flats and rises on lake plains, delta plains, and isolated areas of till plain. Representative slopes range from 0 to 2 percent.

Table 2. Representative physiographic features

Landforms	(1) Lake plain (2) Delta plain (3) Till plain
Runoff class	Low to high
Flooding frequency	None
Ponding frequency	None
Elevation	229–451 m
Slope	0–2%
Water table depth	76–152 cm
Aspect	Aspect is not a significant factor

Climatic features

About 70 percent of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation accounts for about 15 percent of the annual precipitation.

Table 3. Representative climatic features

Frost-free period (characteristic range)	103-108 days

Freeze-free period (characteristic range)	133-136 days
Precipitation total (characteristic range)	559-584 mm
Frost-free period (actual range)	102-110 days
Freeze-free period (actual range)	132-137 days
Precipitation total (actual range)	559-610 mm
Frost-free period (average)	106 days
Freeze-free period (average)	135 days
Precipitation total (average)	584 mm

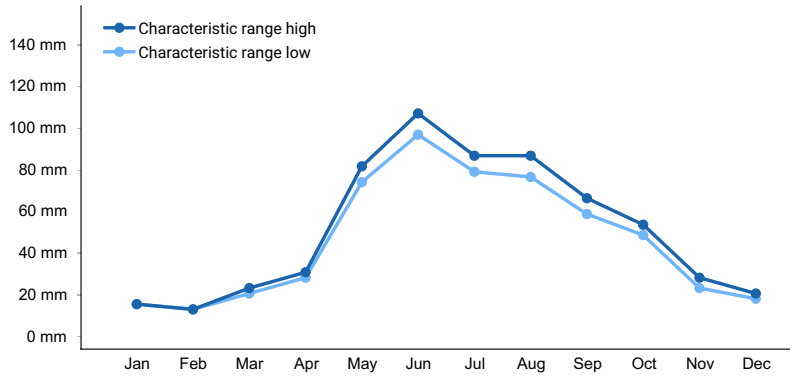


Figure 1. Monthly precipitation range

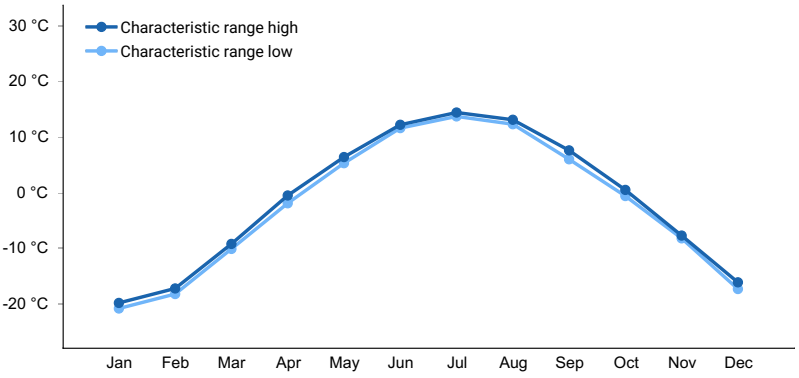


Figure 2. Monthly minimum temperature range

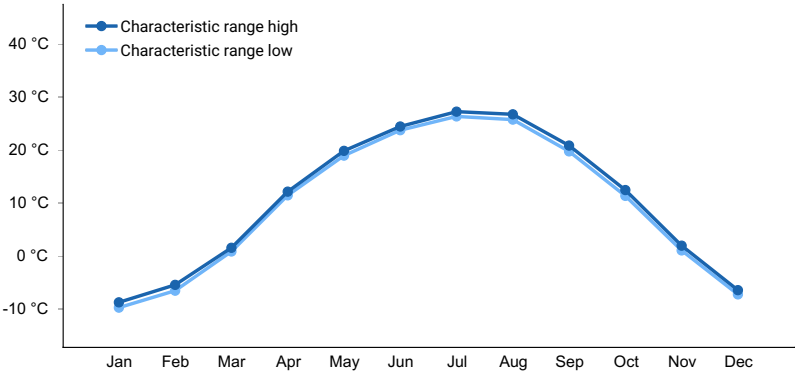


Figure 3. Monthly maximum temperature range

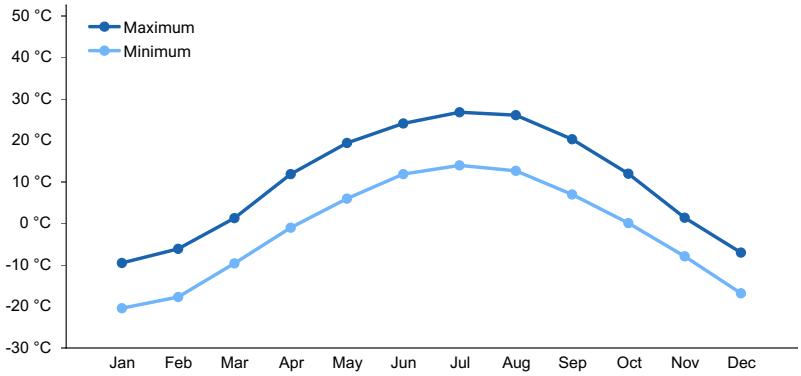


Figure 4. Monthly average minimum and maximum temperature

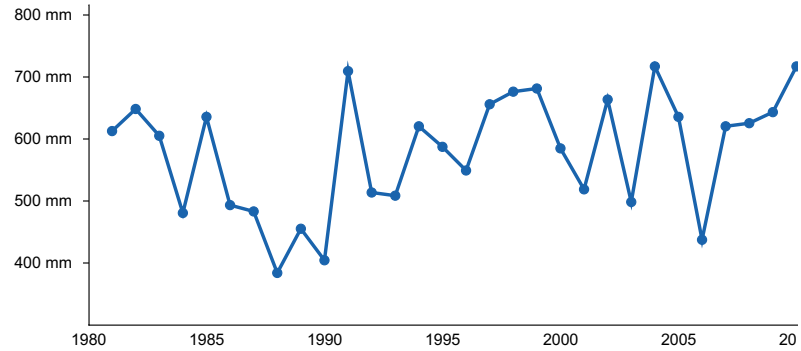


Figure 5. Annual precipitation pattern

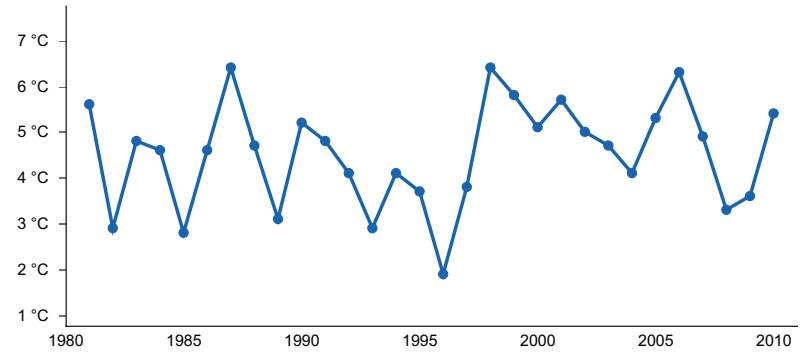


Figure 6. Annual average temperature pattern

Climate stations used

- (1) GOODRIDGE 12 NNW [USW00004994], Grygla, MN
- (2) AGASSIZ REFUGE [USC00210050], Grygla, MN
- (3) RED LAKE FALLS [USC00216787], Red Lake Falls, MN
- (4) CROOKSTON NW EXP STN [USC00211891], Crookston, MN
- (5) HALLOCK [USC00213455], Hallock, MN

Influencing water features

This site does not receive significant additional water either as runoff from adjacent slopes (it is commonly in a run-off landscape position) or from stream overflow. Neither does it receive significant additional water from a seasonal high water table. Depth to the water table typically exceeds 2.5 feet in the spring; however, in a few soils it may be as shallow as 2 feet early in the growing season. During the summer months, the depth is generally from 4 feet to more than 6 feet. Surface infiltration is moderately slow to moderately rapid. Saturated hydraulic conductivity throughout the profile typically is moderately high; however, in soils with contrasting substratum materials, it is very high where gravelly. Water loss is through evapotranspiration and percolation below the root zone. Where this site occurs on terraces, flooding frequency is none to occasional.

Wetland description

Not Applicable.

Soil features

Soils associated with Loamy ES are typically in the Mollisol order. These soils were developed under prairie vegetation. The soils in this site commonly formed in glaciolacustrine sediments, till, or alluvium.

Surface textures typically are loam, very fine sandy loam, fine sandy loam, sandy loam, loamy sand and loamy fine sand also occur. Soils in this site are somewhat poorly drained or moderately well drained - where present, redoximorphic features are deeper than 30 inches.

Major soil series correlated to the Loamy site are: Croke, Garnes, Linveldt, Marquette, Nereson, Pelan, Reiner, Skagen, Skime.

Access Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx) for specific local soils information.

Table 4. Representative soil features

Parent material	(1) Till (2) Glaciolacustrine deposits (3) Alluvium
Surface texture	(1) Fine sandy loam (2) Sandy loam (3) Loamy fine sand (4) Very fine sandy loam (5) Loamy sand (6) Loam
Drainage class	Somewhat poorly drained to moderately well drained
Permeability class	Slow to moderate
Soil depth	203 cm
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–2%
Available water capacity (0-101.6cm)	12.45–18.8 cm
Soil reaction (1:1 water) (0-101.6cm)	6.6–8.4
Subsurface fragment volume <=3" (0-101.6cm)	0–10%
Subsurface fragment volume >3" (0-101.6cm)	0–3%

Ecological dynamics

This ecological site description is based on nonequilibrium ecology and resilience theory and utilizes a State-and-Transition Model (STM) diagram to organize and communicate information about ecosystem change as a basis for management. The ecological dynamics characterized by the STM diagram reflect how changes in ecological drivers, feedback mechanisms, and controlling variables can maintain or induce changes in plant community composition (phases and/or states). The application of various management actions, coupled with weather variables, impact the ecological processes which influence the competitive interactions thereby maintaining or alter plant community structure.

Prior to European influence, the historical disturbance regime for MLRA 56 included frequent fires, both

anthropogenic and natural in origin. Most fires, however, were anthropogenic fires set by Native Americans. Native Americans set fires in all months except perhaps January. These fires occurred in two peak periods, one from March-May with the peak in April and another from July-November with the peak occurring in October. Most of these fires were scattered and of small extent and duration. The grazing history would have involved grazing and browsing by large herbivores such as American bison, elk, and whitetail deer. Herbivory by small mammals, insects, nematodes and other invertebrates are also important factors influencing the production and composition of the communities. Grazing and fire interaction, particularly when coupled with drought events, influenced the dynamics discussed and displayed in the following state and transition diagram and descriptions.

Following European influence, this ecological site generally has had a history of grazing by domestic livestock, particularly cattle, which along with other related activities (e.g. fencing, water development, fire suppression) has changed the disturbance regime of the site. Changes will occur in the plant communities due to these and other factors.

Weather fluctuations, coupled with managerial factors, may lead to changes in the plant communities and, under adverse impacts, may result in a slow decline in vegetative vigor and composition. However, under favorable conditions the botanical composition may resemble that prior to European influence.

Six vegetative states have been identified for the site (Reference, Native/Invaded, Invaded, Go-Back, Wooded, and Cropland). Within each state, one or more community phases have been identified. These community phases are named based on the more dominant and visually conspicuous species and have been determined by study of historical documents, relict areas, scientific studies, and ecological aspects of plant species and plant communities. Transitional pathways and thresholds have been determined through similar methods.

State 1: Reference State represents the natural range of variability that dominated the dynamics of this ecological site prior to European influence. Dynamics of the state were largely determined by variations in climate and weather (e.g. drought), as well as that of fire (e.g. timing, frequency) and grazing by native herbivores (e.g. frequency, intensity, selectivity). Due to those variations, the Reference State is thought to have shifted temporally and spatially between three Plant Community Phases.

Presently, the primary disturbances are due to the widespread introduction of exotic species, concentrated livestock grazing, lack of fire, and perhaps long-term non-use and no fire. Because of these changes (particularly the widespread occurrence of exotic species), as well as other environmental changes, the Reference State is considered to no longer exist. Thus, the presence of exotic species on the site precludes it from being placed in the Reference State. It must then be placed in one of the other states, most commonly State 2: Native/Invaded State. This state may transition to State 2: Native/Invaded State with the colonization of exotic cool-season species (T1A). It may also transition to State 5: Wooded State during extended periods of no use or very light grazing and no fire (T1B).

State 2: Native/Invaded State: Colonization of the site by exotic species will cause a transition from State 1: Reference State to State 2: Native/Invaded State (T1A). This transition was probably inevitable and often resulted from colonization by exotic cool-season grasses such as Kentucky bluegrass, smooth brome, and/or quackgrass which have been particularly and consistently invasive under extended periods of no use and no fire. Other exotics such as Canada thistle and leafy spurge are also known to invade the site.
Three community phases have been identified for this state and are similar to the three community phases in the Reference State but have now been invaded by exotic cool-season grasses. These exotic cool-season grasses can be expected to increase. As that increase occurs, a decline in forb diversity can be expected. Under non-use or minimal use management, mulch increases and may become a physical barrier to plant growth. It also changes the micro-climate near the soil surface and may alter infiltration, nutrient cycling, and biological activity near the soil surface. As a result, these factors, coupled with shading, cause desirable native plants to have increasing difficulty remaining viable and recruitment declines.
To slow or limit the invasion of these exotic grasses or other exotic plants, it is imperative that managerial options (e.g. prescribed grazing, prescribed burning) be carefully constructed and evaluated with respect to that objective. If management does not include measures to control or reduce these exotic plants, the transition to State 3: Invaded State should be expected (T2A). The threshold to this transition is reached when the exotic cool-season grasses exceed 30% of the plant community and native grasses represent less than 40% of the community. This state may also transition to State 5: Wooded State during extended periods of no use or very light grazing and no fire (T2B).

State 3: Invaded State. The threshold for this state is reached when the exotic cool-season grasses (e.g. Kentucky bluegrass, quackgrass, and/or smooth brome) exceed 30% of the plant community and native grasses represent less than 40% of the community. One plant community phase has been identified for this state.

The exotic cool-season grasses can be quite invasive and often form monotypic stands. As they increase, both forage quantity and quality of the annual production becomes increasingly restricted to late spring and early summer even though annual production may increase. Forb diversity often declines. Under non-use or minimal use management, mulch increases and may become a physical barrier to plant growth. It may also alter infiltration, nutrient cycling, and biological activity near the soil surface. As such, desirable native plants become increasingly displaced.

Once the state is well established, prescribed burning and prescribed grazing techniques have been largely ineffective in suppressing or eliminating the exotic cool-season grasses, even though some short-term reductions may appear successful. However, assuming there is an adequate component of native grasses to respond to treatments, a restoration pathway to State 2: Native/Invaded State (R3A) may be accomplished with the implementation of long-term prescribed grazing in conjunction with prescribed burning. This state may also transition to State 5: Wooded State during extended periods of no use or very light grazing and no fire (T3A).

State 4: Go-Back State often results following cropland abandonment and consists of only one plant community phase. This weedy assemblage may include noxious weeds that need control. Over time, the exotic cool-season grasses Kentucky bluegrass, smooth brome, and/or quackgrass will likely predominate. Initially, due to extensive bare ground and a preponderance of shallow rooted annual plants, infiltration is low and the potential for soil erosion is high. Plant species richness may be high, but overall diversity (i.e. equitability) is typically low with the site dominated by a relatively small assemblage of species. Due to the lack of native perennials and other factors, restoring the site with the associated ecological processes is difficult. However, a successful range planting may result in something approaching State 2: Native/Invaded State (R4A). Following planting, prescribed grazing, prescribed burning, haying, and the use of herbicides will generally be necessary to achieve the desired result and control weeds, some of which may be noxious weeds. A failed range planting and/or secondary succession will lead to State 3: Invaded State (R4B). This state may also transition to State 5: Wooded State during long term non-use and no disturbance (T4A).

State 5: Wooded State
This state historically existed as small patches of trees and/or shrubs scattered across the site when precipitation, fire frequency, and other factors enabled woody species to colonize or encroach on the site. This often resulted in a mosaic of patches of woody vegetation interspersed within the grass dominated vegetation. A marked increase in non-use management and active fire suppression since European influence has enabled this state to expand and become more widespread. One community phase has been identified and often results from extended periods of no use or very light grazing and no fire (T1B, T2B,T3A) or long-term non-use and no disturbance (T4A).

Prescribed burning and/or chemical/mechanical brush management followed by a successful range planting may lead to State 2: Native/Invaded State (R5A). Failure of the range planting followed by secondary succession, however, will lead to State 3: Invaded State (R5B).

State 6: Cropland State results from planting and production of annual crops. This plant community is most commonly associated with cropped fields. Soil conditions can be quite variable on the site, in part due to variations in the management/cropping history (e.g. development of tillage induced compaction, erosion, fertility, herbicide/pesticide carryover). Thus, soil conditions should be assessed when considering restoration techniques..

The following state and transition model diagram illustrates the common states, community phases, community pathways, transition and restoration pathways that can occur on the site. These are the most common plant community phases and states based on current knowledge and experience; changes may be made as more data are collected. Pathway narratives describing the site’s ecological dynamics reference various management practices (e.g. prescribed grazing, prescribed burning, brush management, herbaceous weed treatment) which, if properly designed and implemented, will positively influence plant community competitive interactions. The design of these management practices will be site specific; it should be developed by knowledgeable individuals and based upon management goals, a resource inventory, and supported by an ongoing monitoring protocol.

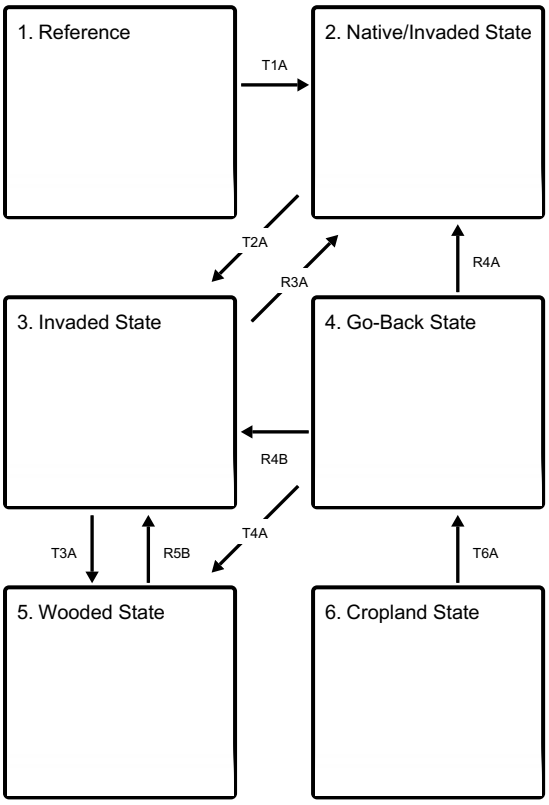
When the management goal is to maintain an existing plant community phase or restore to another phase within the

same state, modification of existing management to ensure native species have the competitive advantage may be required. To restore a previous state, the application of two or more management practices in an ongoing manner will be required. Whether using prescribed grazing, prescribed burning, or a combination of both with or without additional practices (e.g. brush management), the timing and method of application needs to favor the native species over the exotic species. Adjustments to account for variations in annual growing conditions and implementing an ongoing monitoring protocol to track changes and adjust management inputs to ensure desired outcome will be necessary.

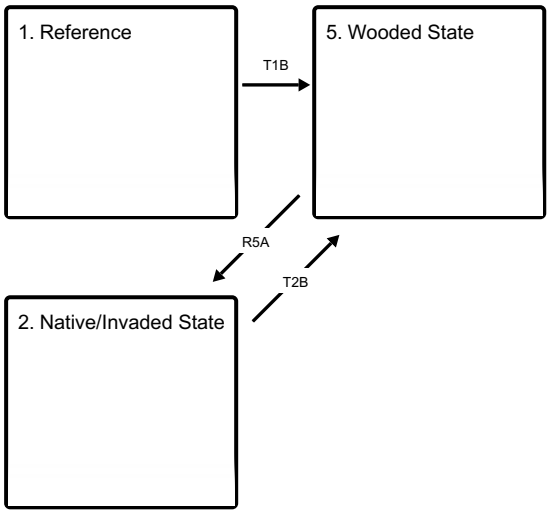
The plant community phase composition table(s) has been developed from the best available knowledge including research, historical records, clipping studies, and inventory records. As more data are collected, plant community species composition and production information may be revised.

State and transition model

Ecosystem states



States 1, 5 and 2 (additional transitions)



T1A - Introduction of exotic cool-season grasses

T1B - Extended periods of non-use or very light grazing, no fire

T2A - Extended periods of non-use or very light grazing, no fire

T2B - Extended periods of non-use or very light grazing, no fire

R3A - Long term prescribed grazing with prescribed burning

T3A - Extended periods of non-use or very light grazing, no fire

R4A - Successful range planting with prescribed grazing and prescribed burning

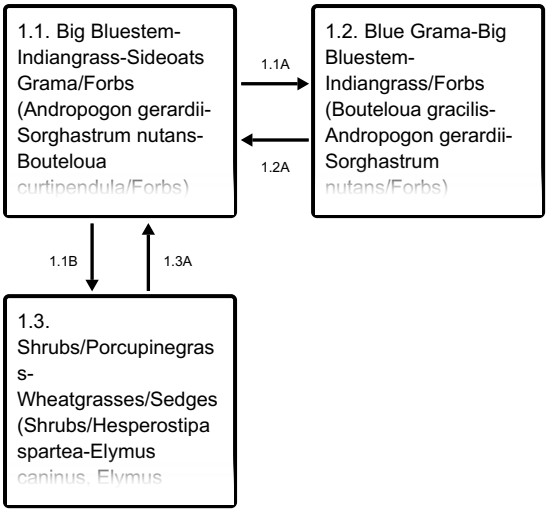
R4B - Failed range planting and/or secondary succession

R5A - Prescribed burning and/or chemical/mechanical brush management followed by successful range planting

R5B - Prescribed burning and/or chemical/mechanical brush management followed by failed range planting

T6A - Cessation of annual cropping

State 1 submodel, plant communities



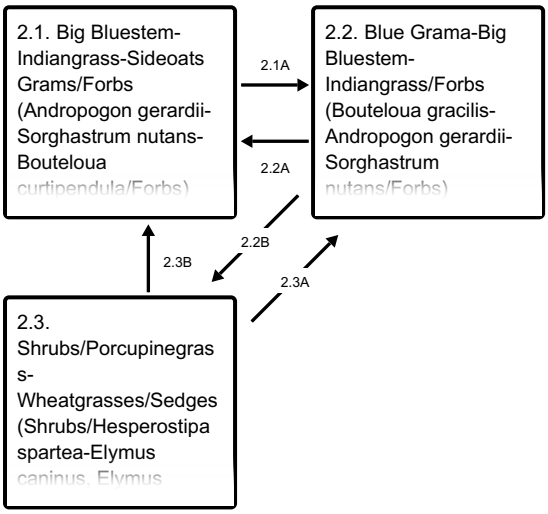
1.1A - Long-term drought with/without heavy, long-term grazing

1.1B - Above average precipitation and/or reduced grazing or fire frequency

1.2A - Return to average growing conditions and reduced grazing pressure

1.3A - Return to average growing conditions and fire frequency with/without reduced grazing pressure

State 2 submodel, plant communities



2.1A - Long-term drought with/without heavy, long-term grazing

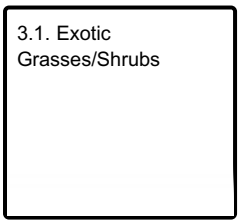
2.2A - Reduced grazing pressure and return to average precipitation

2.2B - Extended periods of non-use or very light grazing, no fire

2.3B - Prescribed grazing with prescribed burning

2.3A - Prescribed grazing with prescribed burning

State 3 submodel, plant communities



State 4 submodel, plant communities

4.1. Annual/Pioneer Perennial /Exotics

State 5 submodel, plant communities

5.1. Green Ash-Bur Oak-Quaking Aspen (Fraxinus pennsylvanica-Quercus macrocarpa-Populus tremuloides)

State 1
Reference

This state represents the natural range of variability that dominated the dynamics of this ecological site prior to European influence. The primary disturbance mechanisms for this site in the reference condition included frequent fire and grazing by large herding ungulates. Timing of fires and grazing, coupled with weather events, dictated the dynamics that occurred within the natural range of variability. These factors likely caused the community to shift both spatially and temporally between three community phases.

Characteristics and indicators. (i.e. characteristics and indicators that can be used to distinguish this state from others). Because of changes in disturbances and other environmental factors (particularly the widespread occurrence of exotic species), the Reference State is considered to no longer exist.

Resilience management. (i.e. management strategies that will sustain a state and prevent a transition). If intact, the reference state should probably be managed with current disturbance regimes which have permitted the site to remain in reference condition as well as maintaining the quality and integrity of associated ecological sites. Maintenance of the reference condition is contingent upon a monitoring protocol to guide management.

Dominant plant species

- leadplant (*Amorpha canescens*), shrub
- prairie rose (*Rosa arkansana*), shrub
- western snowberry (*Symphoricarpos occidentalis*), shrub
- prairie sagewort (*Artemisia frigida*), shrub
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- porcupinegrass (*Hesperostipa spartea*), grass
- green needlegrass (*Nassella viridula*), grass
- blazing star (*Liatris*), other herbaceous
- common yarrow (*Achillea millefolium*), other herbaceous
- purple prairie clover (*Dalea purpurea*), other herbaceous
- stiff sunflower (*Helianthus pauciflorus*), other herbaceous
- goldenrod (*Solidago*), other herbaceous

Community 1.1
Big Bluestem-Indiangrass-Sideoats Grama/Forbs (Andropogon gerardii-Sorghastrum nutans-Bouteloua curtipendula/Forbs)

This Community Phase was historically the most dominant both temporally and spatially, with warm-season grasses dominating the community. The major grasses and sedges included big bluestem, Indiangrass, switchgrass, sideoats grama, little bluestem, prairie dropseed, porcupinegrass, and green needlegrass. Other associated

grasses included needle and thread, western wheatgrass, slender wheatgrass, bearded wheatgrass, blue grama, and upland sedges. Blazing star, common yarrow, purple prairie clover, blacksamson echinacea, silverleaf Indian breadroot, upright prairie coneflower, stiff sunflower, and stiff goldenrod were among the more common forbs. Common shrubs likely included leadplant, prairie rose, western snowberry, and prairie sagewort. Annual production likely varied between about 1900-3900 pounds per acre with grasses and grass-likes, forbs, and shrubs contributing about 85%, 10%, and 5% respectively. This community represents the plant community phase upon which interpretations are primarily based and is described in the “Plant Community Composition and Group Annual Production” portion of this ecological site description.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	1810	2763	3716
Forb	213	325	443
Shrub/Vine	106	163	219
Total	**2129**	**3251**	**4378**

Community 1.2
Blue Grama-Big Bluestem-Indiangrass/Forbs (Bouteloua gracilis-Andropogon gerardii-Sorghastrum nutans/Forbs)

This Community Phase occurred with long-term drought with or without heavy long-term grazing. This resulted in an increase in blue grama with a corresponding decrease in big bluestem, Indiangrass, and sideoats grama. The forb and shrub component of this community was similar to that of Community Phase 1.1 but some species (e.g. prairie sagewort) may have markedly increased.

Community 1.3
Shrubs/Porcupinegrass-Wheatgrasses/Sedges (Shrubs/Hesperostipa spartea-Elymus caninus, Elymus trachycaulus/Carex spp.)

This Community Phase occurred during periods of above average precipitation and/or reduced grazing or fire frequency. It may be characterized as a shrub dominated community consisting of a mixture of species such as western snowberry, prairie rose, leadplant, American plum, or chokecherry. Associated grasses often included porcupinegrass, bearded wheatgrass, and slender wheatgrass, along with upland sedges. Canada goldenrod, white heath aster, wavyleaf thistle, and common yarrow were likely among the common forbs.

Pathway 1.1A
Community 1.1 to 1.2

Community Phase Pathway 1.1 to 1.2 occurred during long-term drought with or without heavy-long term grazing or other conditions that resulted in an increase in blue grama with a corresponding decrease in big bluestem, Indiangrass, and sideoats grama.

Pathway 1.1B
Community 1.1 to 1.3

Community Phase Pathway 1.1 to 1.3 occurred with above average precipitation and/or reduced grazing or fire frequency resulting in a marked increase in shrubs (e.g. western snowberry), porcupinegrass, wheatgrass, and sedges with a corresponding decrease in big bluestem, Indiangrass, and sideoats grama.

Pathway 1.2A
Community 1.2 to 1.1

Community Phase Pathway 1.2 to 1.1 occurred with the return to average growing conditions and reduced grazing pressure which led to a decrease in blue grama with a corresponding increase in big bluestem, Indiangrass, and

sideoats grama.

Pathway 1.3A
Community 1.3 to 1.1

Community Phase Pathway 1.3 to 1.1 occurred upon return to average growing conditions and fire frequency with/without reduced grazing pressure. This would have resulted in a decrease in shrubs, porcupinegrass, wheatgrasses, and sedges with a corresponding increase in big bluestem, Indiangrass, and sideoats grama

State 2
Native/Invaded State

This state is similar to State 1: Reference State but has now been colonized by the exotic cool-season grasses, commonly Kentucky bluegrass, smooth brome, and/or quackgrass which are now present in small amounts. Although the state is still dominated by native grasses, an increase in these exotic cool-season grasses can be expected. These exotic cool-season grasses can be quite invasive on the site and are particularly well adapted to heavy grazing. They also often form monotypic stands. As these exotic cool-season grasses increase, both forage quantity and quality become increasingly restricted to late spring and early summer due to the monotypic nature of the stand even though annual production may increase. Native forbs generally decrease in production, abundance, diversity, and richness compared to that of State 1: Reference State. These exotic cool-season grasses have been particularly and consistently invasive under extended periods of no use and no fire. To slow or limit the invasion of these exotic grasses, it is imperative that managerial options (e.g. prescribed grazing, prescribed burning) be carefully constructed and evaluated with respect to that objective. If management does not include measures to control or reduce these exotic cool-season grasses, the transition to State 3: Invaded State should be expected. Annual production of this state can be quite variable, in large part due to the amount of exotic cool-season grasses. Annual production may range from 1800-3800 pounds per acre.

Characteristics and indicators. The presence of trace amounts of exotic cool-season grasses indicates a transition from State 1 to State 2. The presence of exotic biennial or perennial leguminous forbs (i.e. sweet clover, black medic) may not, on their own, indicate a transition from State 1 to State 2 but may facilitate that transition.

Resilience management. To slow or limit the invasion of these exotic grasses, it is imperative that managerial options (e.g. prescribed grazing, prescribed burning) be carefully constructed and evaluated with respect to that objective. Grazing management should be applied that enhances the competitive advantage of native grass and forb species. This may include: (1) grazing when exotic cool-season grasses are actively growing and native cool-season grasses are dormant; (2) applying proper deferment periods allowing native grasses to recover and maintain or improve vigor; (3) adjusting overall grazing intensity to reduce excessive plant litter (above that needed for rangeland health indicator #14 – see Rangeland Health Reference Worksheet); (4) incorporating early heavy spring utilization which focuses grazing pressure on exotic cool-season grasses and reduces plant litter provided that livestock are moved when grazing selection shifts from exotic cool-season grasses to native grasses. Prescribed burning should be applied in a manner that maintains or enhances the competitive advantage of native grass and forb species. Prescribed burns should be applied as needed to adequately reduce/remove excessive plant litter and maintain the competitive advantage for native species. Timing of prescribed burns (spring vs. summer vs. fall) should be adjusted to account for differences in annual growing conditions and applied during windows of opportunity to best shift the competitive advantage to the native species.

Dominant plant species

- western snowberry (*Symphoricarpos occidentalis*), shrub
- prairie rose (*Rosa arkansana*), shrub
- big bluestem (*Andropogon gerardii*), grass
- silky sophora (*Sophora nuttalliana*), grass
- green needlegrass (*Nassella viridula*), grass
- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- goldenrod (*Solidago*), other herbaceous
- white sagebrush (*Artemisia ludoviciana*), other herbaceous
- stiff sunflower (*Helianthus pauciflorus*), other herbaceous

- common yarrow (*Achillea millefolium*), other herbaceous
- eastern purple coneflower (*Echinacea purpurea*), other herbaceous

Community 2.1
Big Bluestem-Indiangrass-Sideoats Grams/Forbs (Andropogon gerardii-Sorghastrum nutans-Bouteloua curtipendula/Forbs)

This Community Phase is very similar to Community Phase 1.1, but now has been colonized by exotic cool-season grasses, commonly Kentucky bluegrass, smooth brome, and/or quackgrass.

Community 2.2
Blue Grama-Big Bluestem-Indiangrass/Forbs (Bouteloua gracilis- Andropogon gerardii-Sorghastrum nutans/Forbs)

This Community Phase is similar to Community Phase 1.2 but has now been colonized by exotic cool-season grasses, often Kentucky bluegrass, smooth brome, and/or quackgrass. These exotics, however, are present in smaller amounts with the community still dominated by native grasses. This community phase is often dispersed throughout a pasture in an overgrazed/undergrazed pattern, typically referred to as patch grazing. Some overgrazed areas will exhibit the impacts of heavy use, while the ungrazed areas will have a build-up of litter and increased plant decadence. This is a typical pattern found in properly stocked pastures grazed season long. As a result, Kentucky bluegrass tends to increase more in the undergrazed areas while the more grazing tolerant short statured species such as blue grama and sedges increase in the heavily grazed areas. If present, Kentucky bluegrass may increase under heavy grazing. This Community Phase is approaching the threshold leading to a transition to State 3: Invaded State. As a result, it is an “at risk” community. If management does not include measures to control or reduce these exotic cool-season grasses, the transition to State 3: Invaded State should be expected.

Community 2.3
Shrubs/Porcupinegrass-Wheatgrasses/Sedges (Shrubs/Hesperostipa spartea-Elymus caninus, Elymus trachycaulus/Carex spp.)

This Community Phase is similar to Community Phase 1.3 but has now been colonized by exotic cool-season grasses, often Kentucky bluegrass, smooth brome, and/or quackgrass. These exotics, however, are present in smaller amounts with the community still dominated by native grasses.

Pathway 2.1A
Community 2.1 to 2.2

Community Pathway 2.1 to 2.2 occurs with heavy season-long grazing with or without drought. Blue grama increases with a corresponding decrease in big bluestem, Indiangrass, and sideoats grama

Pathway 2.2A
Community 2.2 to 2.1

Community Phase Pathway 2.2 to 2.1 occurs with reduced grazing pressure and return to average precipitation. This results in an increase in big bluestem, Indiangrass, and sideoats grama with a corresponding decrease in blue grama.

Pathway 2.2B
Community 2.2 to 2.3

Community Phase Pathway 2.2 to 2.3 occurs during extended periods of no use or very light grazing with no fire resulting in an increase in mulch accumulation along with a marked increase in shrubs, forbs, and exotic cool-season grasses.

Pathway 2.3B

Community 2.3 to 2.1

Community Phase Pathway 2.3 to 2.1 occurs with the implementation of long-term prescribed grazing with prescribed burning which results in a reduction of the shrub component and corresponding increase in native grasses. Prescribed burning will likely require repeated treatments to complete the pathway because many of the shrubs (e.g. western snowberry) sprout profusely following one burn.

Pathway 2.3A
Community 2.3 to 2.2

Community Phase Pathway 2.3 to 2.2 occurs with prescribed grazing and prescribed burning. Prescribed grazing incorporates heavy early spring and/or late fall grazing cool-season exotic grasses when cool-season exotic grass is most vulnerable, shifting the competitive advantage to the remaining native species. Prescribed burning will likely require repeated treatments to complete the pathway in order to target exotic cool-season grass invasion and because many of the shrubs (e.g., western snowberry) sprout profusely following one burn.

State 3
Invaded State

This state is the result of invasion and dominance by the exotic cool-season grasses, commonly Kentucky bluegrass, smooth brome, and/or quackgrass. These exotic cool-season grasses can be quite invasive on the site and are particularly well adapted to heavy grazing. They also often form monotypic stands. As these exotic cool-season grasses increase, both forage quantity and quality become increasingly restricted to late spring and early summer due to the monotypic nature of the stand even though annual production may increase. Native forbs generally decrease in production, abundance, diversity, and richness compared to that of State 1: Reference State. Common forbs often include white heath aster, goldenrod, common yarrow, and white sagebrush. Shrubs such as western snowberry and prairie rose, however, may increase. Once the state is well established, prescribed burning and grazing techniques have been largely ineffective in suppressing or eliminating these three species even though some short-term reductions may appear successful. Annual production of this state may vary widely, in part due to variations in the extent of invasion by exotic cool-season grasses. However, annual production may be in the range of 1300-3700 pounds per acre.

Characteristics and indicators. This site is characterized by exotic cool-season grasses constituting greater than 30 percent of the annual production and native grasses constituting less than 40 percent of the annual production.

Resilience management. Light or moderately stocked continuous, season-long grazing or a prescribed grazing system which incorporates adequate deferment periods between grazing events and proper stocking rate levels will maintain this State. Application of herbaceous weed treatment, occasional prescribed burning and/or brush management may be needed to manage noxious weeds and increasing shrub (e.g. western snowberry) populations.

Dominant plant species

- western snowberry (*Symphoricarpos occidentalis*), shrub
- prairie rose (*Rosa arkansana*), shrub
- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- purple threeawn (*Aristida purpurea*), grass
- white heath aster (*Symphyotrichum ericoides*), other herbaceous
- goldenrod (*Solidago*), other herbaceous
- common yarrow (*Achillea millefolium*), other herbaceous
- white sagebrush (*Artemisia ludoviciana*), other herbaceous
- sweetclover (*Melilotus officinalis*), other herbaceous

Community 3.1
Exotic Grasses/Shrubs

This Community Phase is dominated by exotic, cool-season sodgrasses, such as Kentucky bluegrass, smooth brome, and/or quackgrass, often with a reduced forb component. Excessive accumulation of mulch may also be

present, particularly when dominated by Kentucky bluegrass. Common forbs and shrubs often include white heath aster, goldenrod, common yarrow, and white sagebrush. Shrubs such as western snowberry and prairie rose may increase. Total production may be in the range of 3000 pounds per acre with over 60% of total production attributable to the exotic cool-season grasses. The longer this community phase exists, the more resilient it becomes. Natural or management disturbances that reduce the cover of Kentucky bluegrass or smooth brome are typically short-lived.

State 4
Go-Back State

This state is highly variable depending on the level and duration of disturbance related to the T6A transitional pathway. In this MLRA, the most probable origin of this state is plant succession following cropland abandonment. This plant community will initially include a variety of annual forbs and grasses, some of which may be noxious weeds needing control. Over time, the exotic cool-season grasses Kentucky bluegrass, smooth brome, and/or quackgrass will likely predominate.

Characteristics and indicators. Tillage has destroyed the native plant community, altered soil structure and biology, reduced soil organic matter, and resulted in the formation of a tillage induced compacted layer which is restrictive to root growth. Noxious weeds, if present, will need to be managed.

Dominant plant species

- bristlegrass (*Setaria*), grass
- cheatgrass (*Bromus tectorum*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- leafy spurge (*Euphorbia esula*), other herbaceous
- sweetclover (*Melilotus officinalis*), other herbaceous
- Canada thistle (*Cirsium arvense*), other herbaceous

Community 4.1
Annual/Pioneer Perennial /Exotics

This Community Phase is highly variable depending on the level and duration of disturbance related to the T6A transitional pathway. In this MLRA, the most probable origin of this phase is secondary succession following cropland abandonment. This plant community will initially include a variety of annual forbs and grasses, including noxious weeds (e.g. Canada thistle) which may need control. Over time, the exotic cool-season grasses Kentucky bluegrass, smooth brome, and/or quackgrass will likely predominate.

State 5
Wooded State

This state historically existed as small patches of trees and/or shrubs scattered across the site, where trees and shrubs could have encroached onto the site vegetatively (e.g. rhizomes, root sprouts) or provided a seed source for colonization of the site. Variations in fire frequency enabled woody plant species in some areas (i.e. period of infrequent fire) to grow large enough to escape the next fire event. As trees increased in size, canopy cover increased which altered micro-climate and reduced fine fuel amounts resulting in reduced fire intensity and frequency. This would have been the primary pathway under the historic disturbance regime and would have resulted in a mosaic pattern of small wooded patches interspersed within herbaceous plant community phases. A marked increase in non-use management and active fire suppression since European influence has enabled this state to expand and become more widespread. Common woody species often include bur oak, green ash, and small patches of quaking aspen clones with an understory of smaller trees and shrubs, often including western snowberry, prairie rose, and chokecherry. An herbaceous component of smooth brome, wildrye, and/or Kentucky bluegrass is often present, particularly when the canopy is more open. Under more closed canopies, the herbaceous understory is predominantly shade tolerant sedges (e.g. Sprengel’s sedge).

Dominant plant species

- green ash (*Fraxinus pennsylvanica*), tree

- bur oak (*Quercus macrocarpa*), tree
- quaking aspen (*Populus tremuloides*), tree
- chokecherry (*Prunus virginiana*), shrub
- prairie rose (*Rosa arkansana*), shrub
- western snowberry (*Symphoricarpos occidentalis*), shrub
- wildrye (*Elymus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- sedge (*Carex*), other herbaceous
- white heath aster (*Symphyotrichum ericoides*), other herbaceous
- common yarrow (*Achillea millefolium*), other herbaceous

Community 5.1
Green Ash-Bur Oak-Quaking Aspen (Fraxinus pennsylvanica-Quercus macrocarpa-Populus tremuloides)

This plant community phase is often characterized by a dominance of green ash, bur oak, and quaking aspen with lesser amounts of American plum, boxelder, and perhaps ironwood. Shrubs include chokecherry, prairie rose, and western snowberry. An herbaceous understory of sedges, wildrye, and assorted forbs may also be present. Regardless of how this community phase originated, the exotic cool-season grasses Kentucky bluegrass, smooth brome, and/or quackgrass will generally be prominent components. As the trees mature and canopy cover increases, herbaceous production declines and shrubs/vines associated with mature woodlands may begin to occupy the understory.

State 6
Cropland State

Cropland State results from planting and production of annual crops. This plant community is most commonly associated with cropped fields. Soil conditions can be quite variable on the site, in part due to variations in the management/cropping history (e.g. development of tillage induced compaction, erosion, fertility, herbicide/pesticide carryover). Thus, soil conditions should be assessed when considering restoration techniques..

Dominant plant species

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

Transition T1A
State 1 to 2

This is the transition from the State 1: Reference State to the State 2: Native/Invaded State due to the introduction and establishment of exotic cool-season grasses, typically Kentucky bluegrass, smooth brome, and/or quackgrass. This transition was probably inevitable and corresponded to a decline in native warm-season and cool-season grasses. This transition may have been exacerbated by chronic season-long or heavy late season grazing. Complete rest from grazing and suppression of fire could also have hastened the transition. The threshold between states was crossed when Kentucky bluegrass, smooth bromegrass, quackgrass, or other exotic species became established on the site.

Constraints to recovery. (i.e. variables or processes that preclude recovery of the former state). Current knowledge and technology will not facilitate a successful restoration to Reference State.

Transition T1B
State 1 to 5

This transition from State 1: Reference State to State 5: Wooded State occurred over extended periods of no use or very light grazing and no fire. Adjacent or nearby stands of woody species would have encroached onto the site vegetatively (e.g. rhizomes, root sprouts) or provided a seed source for colonization of the site. Common woody species often include western snowberry, chokecherry, American plum, prairie rose, and green ash.

Constraints to recovery. Current knowledge and technology will not facilitate a successful restoration to Reference State.

Transition T2A
State 2 to 3

This transition from the State 2: Native/Invaded State to State 3: Invaded State generally occurs with extended periods of no use or very light grazing, and no fire. Exotic cool-season grasses such as quackgrass, Kentucky bluegrass, and/or smooth brome become the dominant graminoids. Studies indicate that a threshold may exist in this transition when Kentucky bluegrass exceeds 30% of the plant community and native grasses represent less than 40% of the plant community composition. Similar thresholds may exist for smooth brome and quackgrass. This transition may occur under a wide range of managerial conditions ranging from non-use and no fire to heavy season-long grazing (primarily Kentucky bluegrass).

Constraints to recovery. Variations in growing conditions (e.g. cool, wet spring) will influence effects of various management activities on exotic cool-season grass populations.

Transition T2B
State 2 to 5

This transition from the State 2: Native/Invaded to State 5: Wooded State generally occurs with extended periods of no use or very light grazing and no fire. It frequently occurs when the site is in close proximity to wooded areas where the woodland vegetation may encroach vegetatively and/or serve as a seed source for these species to colonize the site. The Wooded State has become more frequent following European settlement since the historic fire regime has been markedly reduced.

Restoration pathway R3A
State 3 to 2

This restoration pathway from the State 3: Invaded State 2: Native/Invaded State may be initiated with the implementation of long-term prescribed burning with prescribed grazing, assuming there is an adequate component of native grasses to respond to the treatments. Both prescribed grazing and prescribed burning are likely necessary to successfully initiate this restoration pathway, the success of which depends upon the presence of a remnant population of native grasses in Community Phase 3.1. That remnant population, however, may not be readily apparent without close inspection. The application of several prescribed burns may be needed at relatively short intervals in the early phases of this restoration process, in part because many of the shrubs (e.g. western snowberry) sprout profusely following one burn. Early season prescribed burns have been successful; however, fall burning may also be an effective technique. Common forb and shrub associates include northern bedstraw, common dandelion, Canada goldenrod, common yarrow, Canada thistle, western snowberry, and prairie rose. If the site is adjacent to woodlands, sprouts and seeds from the woodland species may begin to encroach and colonize the site.

Context dependence. Grazing management should be applied in a manner that enhances/maximizes the competitive advantage of native grass and forb species over the exotic species. This may include the use of prescribed grazing to reduce excessive plant litter accumulations above that needed for rangeland health indicator #14 (see Rangeland Health Reference Worksheet). Increasing livestock densities may facilitate the reduction in plant litter provided length and timing of grazing periods are adjusted to favor native species. Grazing prescriptions designed to address exotic grass invasion and favor native species may involve earlier, short, intense grazing periods with proper deferment to improve native species health and vigor. Fall (e.g. September, October) prescribed burning followed by an intensive, early spring graze period with adequate deferment for native grass recovery may shift the competitive advantage to the native species, facilitating the restoration to State 2: Native/Invaded. Prescribed burning should be applied in a manner that enhances the competitive advantage of native grass and forb species over the exotic species. Prescribed burns should be applied at a frequency which mimics the natural disturbance regime, or more frequently as is ecologically (e.g. available fuel load) and economically feasible. Burn prescriptions may need adjustment to: (1) account for change in fine fuel orientation (e.g. “flopped” Kentucky bluegrass); (2) fire intensity and duration by adjusting ignition pattern (e.g. backing fires vs head fires); (3) account for plant phenological stages to maximize stress on exotic species while favoring native species (both cool- and

warm-season grasses).

Transition T3A
State 3 to 5

This transition pathway from State 3: Invaded State to State 5: Wooded State may be initiated by extended periods of no use or very light grazing and no fire. This frequently occurs when the site is in close proximity to wooded areas where the woodland vegetation may encroach vegetatively and/or serve as a seed source for these species to colonize the site. It has also become more frequent following European settlement since the historic fire regime has been markedly reduced.

Restoration pathway R4A
State 4 to 2

The restoration pathway from State 4: Go-Back State to State 2: Native/Invaded State may result from a successful range planting with prescribed grazing and prescribed burning. Following planting, prescribed grazing, prescribed burning, haying, or use of herbicides will generally be necessary to achieve the desired result and control any noxious weeds. It may be possible using selected plant materials and agronomic practices to approach something very near the functioning of State 2: Native/Invaded State. Application of chemical herbicides and the use of mechanical seeding methods using adapted varieties of the dominant native grasses are possible and can be successful. After establishment of the native plant species, prescribed grazing should include adequate recovery periods following each grazing event and stocking levels which match the available resources; management objectives must include the maintenance of those species, the associated reference state functions, and continued treatment of exotic grasses.

Context dependence. A successful range planting will include proper seedbed preparation, weed control (both prior to and after the planting), selection of adapted native species representing functional/structural groups inherent to the State 1, and proper seeding technique. Management (e.g. prescribed grazing, prescribed burning) during and after establishment must be applied in a manner that maintains the competitive advantage for the seeded native species. Adding non-native species can impact the above and below ground biota. Elevated soil nitrogen levels have been shown to benefit smooth brome and Kentucky bluegrass more than some native grasses. As a result, fertilization, exotic legumes in the seeding mix, and other techniques that increase soil nitrogen may promote smooth brome and Kentucky bluegrass invasion. The method or methods of herbaceous weed treatment will be site specific to each situation but, generally, the goal would be to apply the pesticide, mechanical control, or biological control (either singularly or in combination) in a manner that shifts the competitive advantage from the targeted species to the native grasses and forbs. The control method(s) should be as specific to the targeted species as possible to minimize impacts to non-target species.

Restoration pathway R4B
State 4 to 3

A failed range planting and/or secondary succession will lead to State 3: Invaded State.

Context dependence. Failed range plantings can result from many causes, both singularly and in combination, including: drought, poor seedbed preparation, improper seeding methods, seeded species not adapted to the site, insufficient weed control, herbicide carryover, poor seed quality (purity & germination), improper management.

Transition T4A
State 4 to 5

The transition from State 4: Go-Back State to State 5: Wooded State may occur with long-term non-use and no disturbances. This frequently occurs when the site is in close proximity to wooded areas where the woodland vegetation may encroach vegetatively and/or serve as a seed source for these species to colonize the site. It has also become more frequent following European settlement since the historic fire regime has been markedly reduced.

Context dependence. Long term non-use and no disturbances

Restoration pathway R5A
State 5 to 2

Restoration Pathway from State 5: Wooded State to State 2: Native/Invaded State occurs with the implementation of prescribed burning and/or chemical/mechanical brush management followed by successful range planting. A combination of mechanical brush management, chemical treatment, and prescribed burning is necessary to remove the woody vegetation and prepare the seedbed for a successful range planting. It may be possible using selected plant materials and agronomic practices to approach something very near the functioning of State 2: Native/Invaded State. Application of chemical herbicides and the use of mechanical seeding methods using adapted varieties of the dominant native grasses are possible and can be successful. Following the establishment of the native plant species, prescribed grazing should include adequate recovery periods following each grazing event and stocking levels which match the available resources; management objectives must include the maintenance of those species, the associated reference state functions, and continued treatment of exotic grasses.

Context dependence. Prescribed burning should be applied in a manner that enhances the competitive advantage of native grass and forb species over the exotic species. Prescribed burns should be applied at a frequency which mimics the natural disturbance regime or more frequently as is ecologically (e.g. available fuel load) and economically feasible. Burn prescriptions may need adjustment to: (1) account for change in fuel type (herbaceous vs. shrub vs. tree), fine fuel amount and orientation (e.g. “flopped” Kentucky bluegrass); (2) fire intensity and duration by adjusting ignition pattern (e.g. backing fires vs head fires); (3) account for plant phenological stages to maximize stress on exotic species while favoring native species (both cool- and warm-season grasses). The method of brush management will be site specific but generally the goal would be to apply the pesticide, mechanical control, or biological control - either singularly or in combination - in a manner that shifts the competitive advantage from the targeted species to the native grasses and forbs. The control method(s) should be as specific to the targeted species as possible to minimize impacts to non-target species. A successful range planting will include proper seedbed preparation, weed control (both prior to and after the planting), selection of adapted native species representing functional/structural groups inherent to the State 1, and proper seeding technique. Management (e.g. prescribed grazing, prescribed burning) during and after establishment must be applied in a manner that maintains the competitive advantage for the seeded native species. Adding non-native species can impact the above and below ground biota. Elevated soil nitrogen levels have been shown to benefit smooth brome and Kentucky bluegrass more than some native grasses. As a result, fertilization, exotic legumes in the seeding mix, and other techniques that increase soil nitrogen may promote smooth brome and Kentucky bluegrass invasion.

Restoration pathway R5B
State 5 to 3

Restoration Pathway from State 5: Wooded State to State 3: Invaded State occurs with the implementation of prescribed burning and/or chemical/mechanical brush management followed by a failed range planting.

Context dependence. Failed range plantings can result from many causes, both singularly and in combination, including: drought, poor seedbed preparation, improper seeding methods, seeded species not adapted to the site, insufficient weed control, herbicide carryover, poor seed quality (purity & germination), improper management.

Transition T6A
State 6 to 4

This is the Transition from any plant community to State 4: Go-Back State. It is most commonly associated with the cessation of cropping without the benefit of range planting, resulting in a “go-back” situation. Soil conditions can be quite variable on the site, in part due to variations in the management/cropping history (e.g. development of tillage induced compaction, erosion, fertility, herbicide/pesticide carryover). Thus, soil conditions should be assessed when considering restoration techniques.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					

1	**Tall Warm-Season Grasses**			325–650	
	big bluestem	ANGE	*Andropogon gerardii*	325–650	–
	Indiangrass	SONU2	*Sorghastrum nutans*	163–325	–
	switchgrass	PAVI2	*Panicum virgatum*	163–325	–
2	**Needlegrasses**			488–813	
	porcupinegrass	HESP11	*Hesperostipa spartea*	163–650	–
	green needlegrass	NAVI4	*Nassella viridula*	163–325	–
	needle and thread	HECO26	*Hesperostipa comata*	0–163	–
3	**Mid Warm-Season Grasses**			325–650	
	little bluestem	SCSC	*Schizachyrium scoparium*	163–325	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	65–325	–
	prairie dropseed	SPHE	*Sporobolus heterolepis*	65–325	–
4	**Wheatgrasses**			163–325	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–163	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	33–163	–
	bearded wheatgrass	ELCA11	*Elymus caninus*	33–163	–
5	**Other Native Grasses**			33–163	
	Graminoid (grass or grass-like)	2GRAM	*Graminoid (grass or grass-like)*	33–163	–
	slimstalk spiderling	BOGR	*Boerhavia gracillima*	33–98	–
	mat muhly	MURI	*Muhlenbergia richardsonis*	0–98	–
	Leiberg's panicum	DILE2	*Dichanthelium leibergii*	0–98	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–33	–
6	**Grass-likes**			33–163	
	needleleaf sedge	CADU6	*Carex duriuscula*	33–163	–
	long-stolon sedge	CAIN9	*Carex inops*	33–163	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–163	–
Forb					
7	**Forbs**			163–325	
	Forb (herbaceous, not grass nor grass-like)	2FORB	*Forb (herbaceous, not grass nor grass-like)*	33–163	–
	blazing star	LIATR	*Liatris*	33–98	–
	common yarrow	ACMI2	*Achillea millefolium*	33–65	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	33–65	–
	field sagewort	ARCA12	*Artemisia campestris*	33–65	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	33–65	–
	false boneset	BREU	*Brickellia eupatorioides*	0–65	–
	wavyleaf thistle	CIUN	*Cirsium undulatum*	0–65	–
	purple prairie clover	DAPU5	*Dalea purpurea*	33–65	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	33–65	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	33–65	–
	stiff goldenrod	OLRI	*Oligoneuron rigidum*	33–65	–
	soft-hair marbleseed	ONBEB	*Onosmodium bejariense var. bejariense*	33–65	–
	silverleaf Indian breadroot	PEAR6	*Pediomelum argophyllum*	33–65	–

	upright prairie coneflower	RACO3	*Ratibida columnifera*	33–65	–
	compassplant	SILA3	*Silphium laciniatum*	0–65	–
	Canada goldenrod	SOCA6	*Solidago canadensis*	33–65	–
	white heath aster	SYER	*Symphyotrichum ericoides*	33–65	–
	aromatic aster	SYOB	*Symphyotrichum oblongifolium*	0–65	–
	American vetch	VIAM	*Vicia americana*	33–65	–
	rush skeletonplant	LYJU	*Lygodesmia juncea*	0–33	–
	Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	0–33	–
	cutleaf anemone	PUPAM	*Pulsatilla patens ssp. multifida*	0–33	–
	Missouri goldenrod	SOMI2	*Solidago missouriensis*	0–33	–
	hoary verbena	VEST	*Verbena stricta*	0–33	–
Shrub/Vine					
8	**Shrubs**			33–163	
	leadplant	AMCA6	*Amorpha canescens*	33–130	–
	prairie rose	ROAR3	*Rosa arkansana*	33–98	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	33–98	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–33	–

Inventory data references

This is a provisional ecological site, and as such no field plots were inventoried for this project. MLRA 56 was split into 2 MLRAs 56A and 56B with Agricultural Handbook 296 (2022). All information was taken from original MLRA 56 ecological site descriptions in which MLRA 56B was part of. Future field verification is needed to refine the plant communities and ecological dynamics described in this ecological site description.

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	09/27/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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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:**