USDA Natural Resources Conservation Service

Ecological site R056BY087MN
Limy Subirrigated

Last updated: 9/04/2024
Accessed: 09/27/2024

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

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 Limy Subirrigated ecological site is located on low-relief areas of lake plains, till-floored lake plains - on flats and on slightly convex slopes adjacent to shallow depressions. The soils are very deep. The dark-colored surface soil is more than 7 inches thick. The soils are somewhat poorly drained – redoximorphic features typically occur at a depth between 18 and 42 inches. Slope is typically less than 2 percent.

Associated sites

R056BY095MN	**Subirrigated** This site occurs on concave flats and in shallow depressions which have occasional, brief ponding early in the growing season. It is >16 inches to a highly calcareous subsoil. All textures are included in this site.
R056BY101MN	**Shallow Marsh** This site occurs in deep depressions which have frequent ponding through most of the growing season. All textures are included in this site.
R056BY102MN	**Wet Meadow** This site occurs in depressions and slightly below Limy Subirrigated on flats. It is poorly drained - a seasonal high water 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. It is non-saline to slightly saline (E.C. <8) in the surface and subsoil layers. All textures are included in this site.
R056BY096MN	**Subirrigated Sands** This site occurs on slightly higher, better drained positions on sand plains and outwash plains. It is not highly calcareous in the surface or upper subsoil layers.

R056BY091MN	**Sandy** This site occurs on higher, better drained positions on lake plains. The surface and upper subsoil are non-calcareous. The surface layer and subsoil form a ribbon <1 inches long. It is >30 inches to redoximorphic features.

Similar sites

R056BY095MN	**Subirrigated** This site occurs on concave flats and in shallow depressions which have occasional, brief ponding early in the growing season. It is >16 inches to a highly calcareous subsoil. All textures are included in this site.

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 till-floored lake plains where they are on flats and on slightly convex slopes adjacent to shallow depressions. The subsurface hydrology of this site has been considered more determinative of the plant community than landform or soils variability; further investigation and documentation of the landform/soils/hydrology/plant relationship is needed. Slopes typically are less than 2 percent.

Table 2. Representative physiographic features

Landforms	(1) Flat (2) Till-floored lake plain
Runoff class	Medium
Flooding frequency	None
Ponding frequency	None
Elevation	750–1,480 ft
Slope	0–2%
Ponding depth	0 in
Water table depth	18–42 in
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)	22-23 in
Frost-free period (actual range)	102-110 days
Freeze-free period (actual range)	132-137 days
Precipitation total (actual range)	22-24 in
Frost-free period (average)	106 days

Freeze-free period (average)	135 days
Precipitation total (average)	23 in

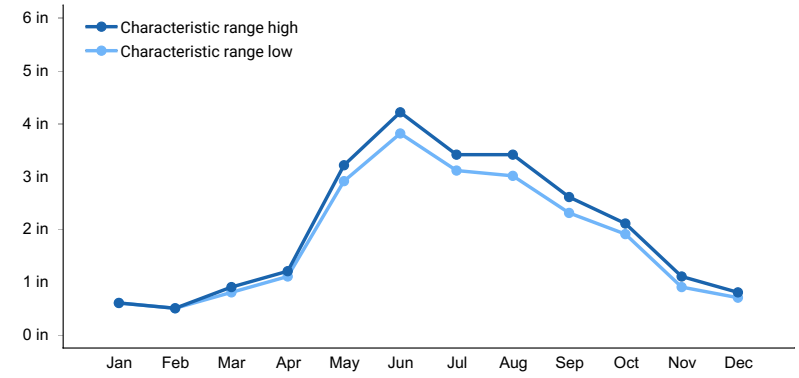


Figure 1. Monthly precipitation range

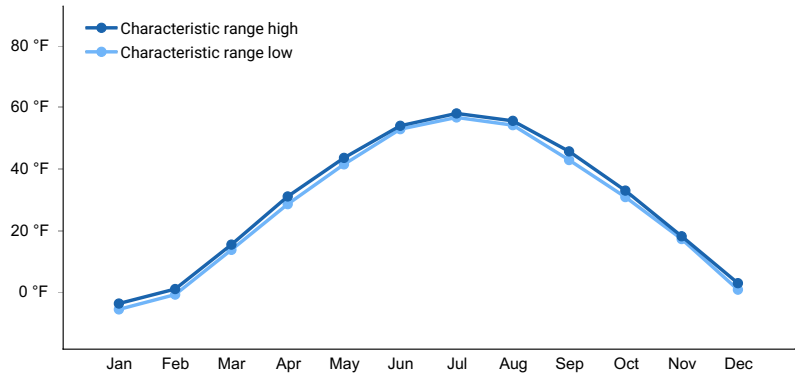


Figure 2. Monthly minimum temperature range

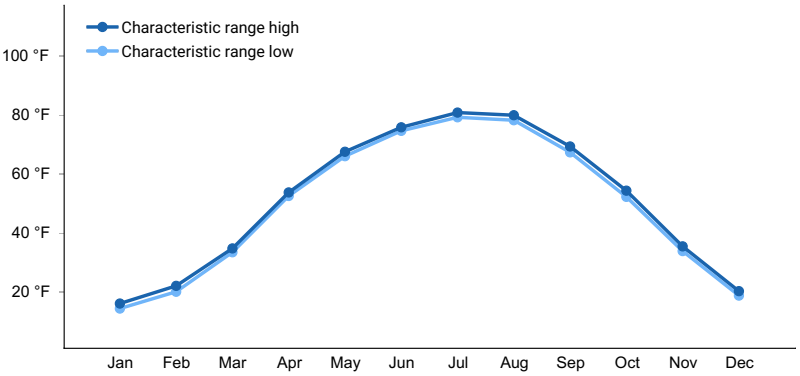


Figure 3. Monthly maximum temperature range

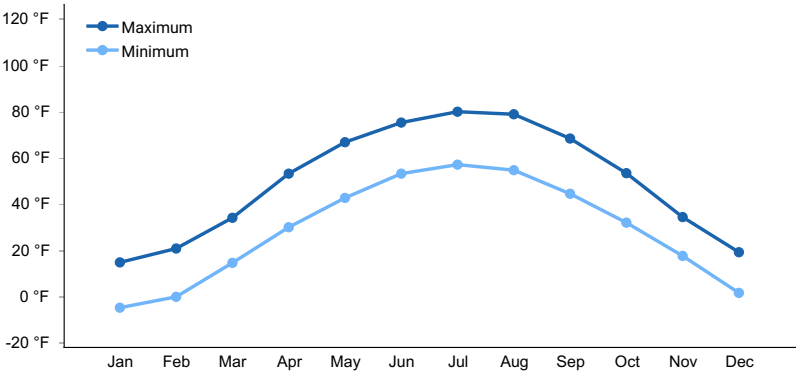


Figure 4. Monthly average minimum and maximum temperature

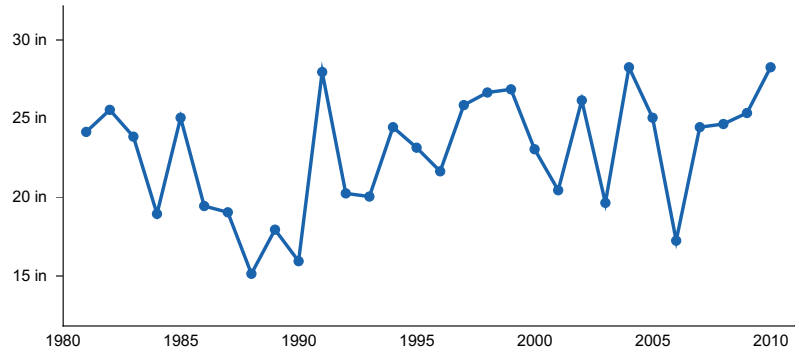


Figure 5. Annual precipitation pattern

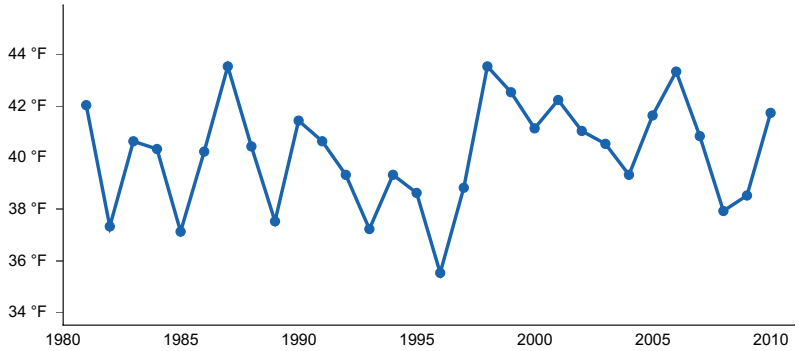


Figure 6. Annual average temperature pattern

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 Limy Subirrigated site does receive additional water from a seasonal high water table. The high level of carbonates near the surface indicates that the soils formed with a dominantly upward direction of water movement through the soil. During the growing season, water table depths typically are 1.5 to 3.5 feet during April through June. As a result of evapotranspiration and reduced precipitation, the water table lowers to 4 to 6 feet during July and August. It commonly starts to rise again in the fall (commonly at 2.5 to 5 feet during September through November). Surface infiltration rates range from moderately slow to moderately rapid. Water loss on this site is through evapotranspiration.

Wetland description

Not Applicable.

Soil features

Soils associated with this site formed in glaciolacustrine sediments, glaciofluvial deposits, or deltaic deposits; a few formed in alluvium along drainageways.

This site is somewhat poorly drained to somewhat excessively drained – redoximorphic features typically occur at a depth between 18 and 42 inches. These soils are very deep.
Soil reaction typically is neutral to moderately alkaline (pH 7.4 to 8.4) below.

Major soil series correlated to the Limy Subirrigated site are: Bearden, Fram, Glyndon, Grimstad, Gunclub, Hamerly,

Karlsruhe, Ulen, and Wheatville.

.

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) Glaciolacustrine deposits (2) Glaciofluvial deposits (3) Alluvium
Surface texture	(1) Loamy fine sand (2) Silty clay
Family particle size	(1) Sandy
Drainage class	Somewhat poorly drained to somewhat excessively drained
Permeability class	Moderately slow to moderately rapid
Depth to restrictive layer	80 in
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	4.4–6.8 in
Soil reaction (1:1 water) (0-40in)	7.4–8.4
Subsurface fragment volume <=3" (0-40in)	0–2%
Subsurface fragment volume >3" (0-40in)	0%

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 56B 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 may,

under adverse impacts, 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, Wooded, Invaded, Go-Back and Cropped). 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 two 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 (T1A).

State 2: Native/Invaded State: Colonization of the site by exotic species results in 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 non-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 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, plants more desirable to wildlife and livestock may decline. A decline in forb diversity can also be expected. Under no-use or minimal use management mulch increases and may become a physical barrier to plant growth. It also changes the micro-climate near the 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 4: Invaded State should be expected (T2B). 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. Extended periods of no-use and no fire can lead to State 3: Wooded State (T2A).

State 3: 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 non-use and no fire (T2A, T4A). Brush control can lead to State 4: Invaded State (T3A). And depending on the abundance of native species, brush control may need to be followed by a range planting to complete the restoration to State 2: Native/Invaded State (R3A).

State 4: Invaded State. The threshold for this state is reached when the exotic cool-season grasses 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 no-use or minimal use

management, mulch can increase and becomes a physical barrier to plant growth, altering nutrient cycling, infiltration, and soil biological activity. 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 (R4A) may be accomplished with the implementation of long-term prescribed grazing in conjunction with prescribed burning. This state may also transition to State 3: Wooded State during extended periods of non-use and no fire (T4A).

State 5: 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 (R5A). Following seeding, 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 4: Invaded State (R5B).

State 6: Cropland State. 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.

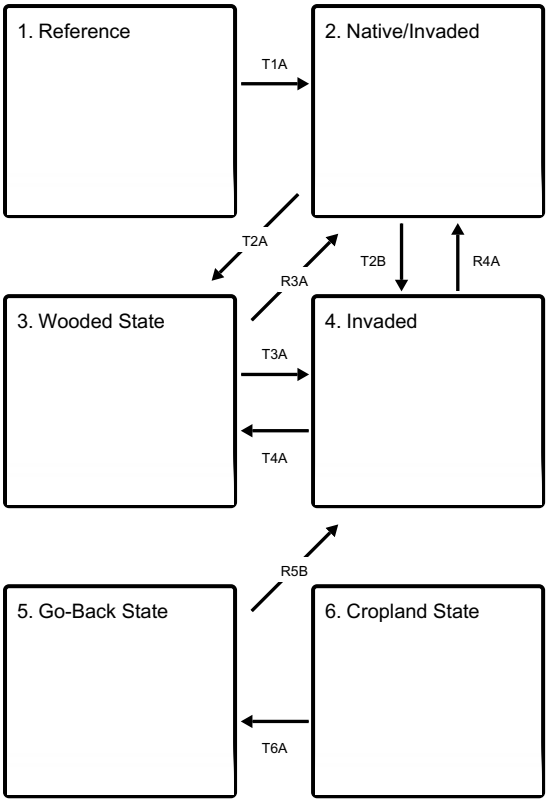
The following state and transition model diagram illustrate the common states, community phases, community pathways, transition and restoration pathways that can occur on the site. These are the most common plant community phases and states based on current knowledge and experience; changes may be made as more data are collected. Pathway narratives describing the site’s ecological dynamics reference various management practices (e.g. prescribed grazing, prescribed fire, 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 and should be developed by knowledgeable individuals, 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.

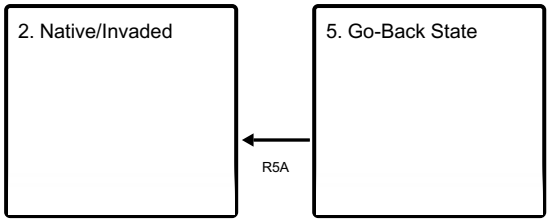
The plant community phase composition table(s) has been developed from the best available knowledge including research, historical records, clipping studies, and inventory records. As more data are collected, plant community species composition and production information may be revised.

State and transition model

Ecosystem states



States 2 and 5 (additional transitions)



T1A - Introduction of exotic species

T2A - No use, no fire

T2B - Long-term heavy grazing pressure or no-use

R3A - Brush control, perhaps followed by range planting

T3A - Brush control

R4A - Prescribed grazing and prescribed burning

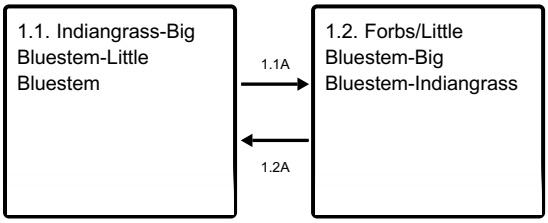
T4A - No use, no fire

R5A - Successful range planting with prescribed grazing and prescribed burning

R5B - Failed range planting

T6A - Cessation of anual cropping

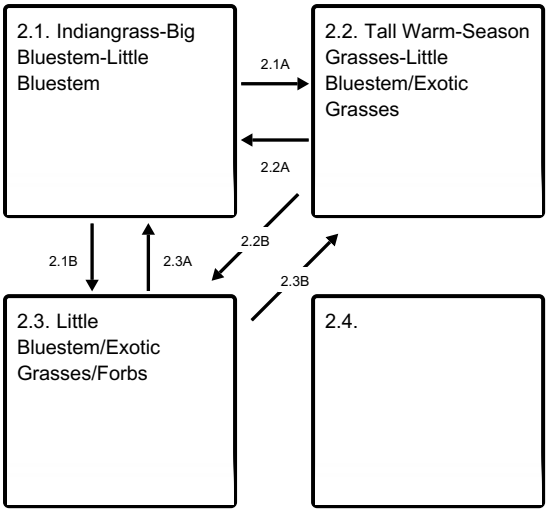
State 1 submodel, plant communities



1.1A - Periods of below average precipitation, increased disturbance

1.2A - Return to average precipitation and disturbance regime

State 2 submodel, plant communities



2.1A - No grazing, no fire

2.1B - Heavy grazing pressure without adequate recovery periods

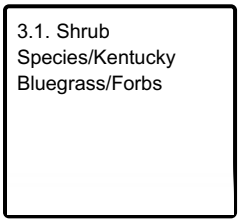
2.2A - Prescribed grazing and prescribed burning

2.2B - Long-term heavy grazing pressure

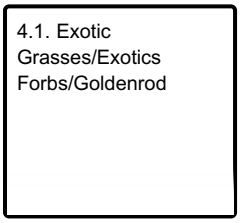
2.3A - Prescribed grazing and prescribed burning

2.3B - Prescribed grazing

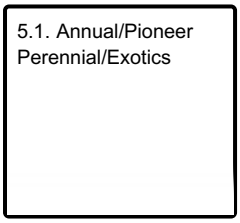
State 3 submodel, plant communities



State 4 submodel, plant communities



State 5 submodel, plant communities



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 two community phases. Both warm-season grasses and cool-season grasses were well represented in the community, and as a result production was distributed throughout the growing season.

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 found intact, the reference state should probably be managed with current disturbance regimes which has permitted the site to remain in reference condition as well as maintaining the quality and integrity of associated ecological sites. Maintenance of the reference state is contingent upon a monitoring protocol to guide management.

Dominant plant species

- prairie rose (*Rosa arkansana*), shrub
- leadplant (*Amorpha canescens*), shrub
- Indiangrass (*Sorghastrum nutans*), grass
- big bluestem (*Andropogon gerardii*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- Indianhemp (*Apocynum cannabinum*), other herbaceous
- Norwegian cinquefoil (*Potentilla norvegica*), other herbaceous
- American licorice (*Glycyrrhiza lepidota*), other herbaceous
- Canada goldenrod (*Solidago canadensis*), other herbaceous
- tall blazing star (*Liatris aspera*), other herbaceous
- upright prairie coneflower (*Ratibida columnifera*), other herbaceous
- Maximilian sunflower (*Helianthus maximiliani*), other herbaceous

Community 1.1
Indiangrass-Big Bluestem-Little Bluestem

This community phase was the most dominant both temporally and spatially. Major warm-season grasses included Indiangrass, big bluestem, little bluestem, and sideoats grams. Porcupinegrass, green needlegrass, western wheatgrass, and slender wheatgrass were the major cool-season grasses. A diverse forb component included Indianhemp, Norwegian cinquefoil, purple prairie clover, American licorice, and Canada goldenrod. Leadplant and rose were common shrubs. Annual production would have varied from about 3000-5200 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 (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	2755	3759	4535
Forb	205	315	450
Shrub/Vine	40	126	215
Total	**3000**	**4200**	**5200**

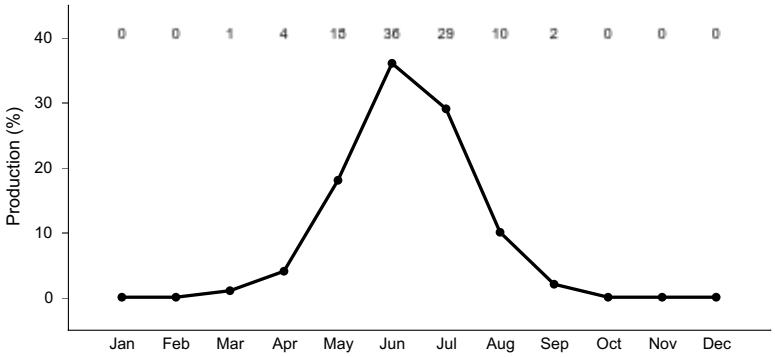


Figure 8. Plant community growth curve (percent production by month). ND5605, Red River Valley of the North, warm-season dominant.. Warm-

season dominant..

Community 1.2
Forbs/Little Bluestem-Big Bluestem-Indiangrass

This community phase could be characterized by a marked increase in forbs and little bluestem with a corresponding decrease in Indiangrass and big bluestem compared to Community Phase 1.1. Fire events followed by increased grazing pressure were prominent factors in the change. Dominant grasses would have included little bluestem, switchgrass, prairie cordgrass, big bluestem, and Indiangrass. Showy forbs such as tall gayfeather, sunflowers, showy deathcamas, black-eyed Susan, goldenrods, and American Licorice would have dominated the visual appearance of the site. Annual production would have been somewhat reduced compared to Community Phase 1.1. The contribution from forbs, however, would have increased.

Pathway 1.1A
Community 1.1 to 1.2

Community Phase Pathway 1.1 to 1.2 would have occurred during periods of below average precipitation and increased disturbance. This would have resulted in a marked increase in forbs and little bluestem with a corresponding decrease in Indiangrass and big bluestem.

Pathway 1.2A
Community 1.2 to 1.1

Community Phase Pathway 1.2A occurred with the return to average precipitation and disturbance regime leading to an increase in big bluestem and Indiangrass with a corresponding decrease in forbs and little bluestem.

State 2
Native/Invaded

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 4: 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. However, annual production may be expected to range from 3000-5200 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
- Indiangrass (*Sorghastrum nutans*), grass
- big bluestem (*Andropogon gerardii*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- American licorice (*Glycyrrhiza lepidota*), other herbaceous
- white sagebrush (*Artemisia ludoviciana*), other herbaceous
- Canada goldenrod (*Solidago canadensis*), other herbaceous
- silverleaf Indian breadroot (*Pediomelum argophyllum*), other herbaceous
- common yarrow (*Achillea millefolium*), other herbaceous

Community 2.1
Indiangrass-Big Bluestem-Little Bluestem

This Community Phase is similar to Community Phase 1.1 but has been colonized by exotic cool-season grasses, often Kentucky bluegrass, smooth brome, and/or quackgrass. However, these exotic grasses are present in smaller amounts with the community still dominated by native grasses. Annual production of this state can be quite variable, in large part due to the amount of exotic cool-season grasses. However, annual production may be expected to range from 3000-5200 pounds per acre with graminoids, forbs, and shrubs contributing 85%, 15%, and 5% respectively.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	2755	3759	4535
Forb	205	315	450
Shrub/Vine	40	126	215
Total	**3000**	**4200**	**5200**

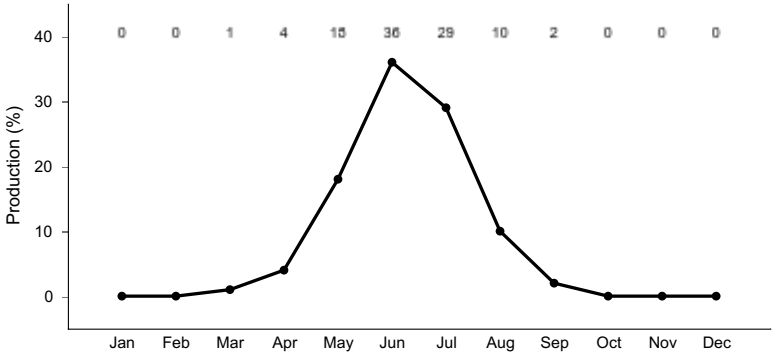


Figure 10. Plant community growth curve (percent production by month). ND5605, Red River Valley of the North, warm-season dominant.. Warm-season dominant..

Community 2.2
Tall Warm-Season Grasses-Little Bluestem/Exotic Grasses

The removal of disturbances has allowed the plant community to shift to one visually dominated by tall warm-

season species with Kentucky bluegrass invading this plant community. Tall warm-season grasses have decreased in vigor and density but are still visually dominate. This plant community is short lived and is at risk approaching the threshold which could readily transition to State 4: Invaded State. If management is significantly altered, this community phase can still be reverted back to Plant Community Phase 2.1. A combination of prescribed grazing and prescribed burning may be the most effective method to move this community phase towards a community resembling the reference plant community. Kentucky bluegrass constitutes 20 to 30 percent of the annual production with tall and mid statured warm-season native grasses such as Indiangrass, switchgrass, little bluestem, and sideoats grama constituting at least 40 percent of the annual production. Native forbs such as Maximilian sunflower, goldenrods, white heath aster, common yarrow, Cuman ragweed, and white sagebrush are present along with introduced forbs such as sweet clover and black medic. Shrubs include western snowberry and prairie rose. Annual production is similar to the reference plant community.

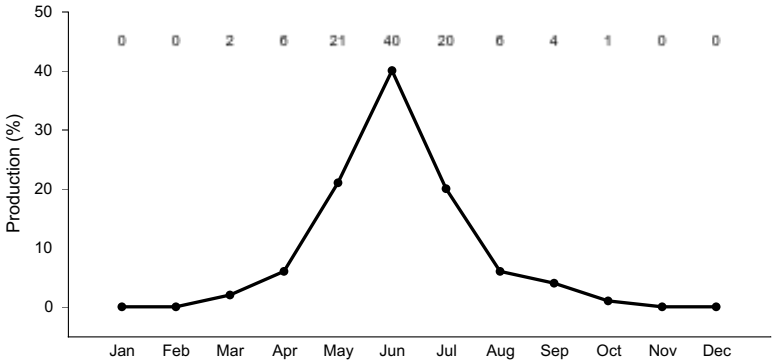


Figure 11. Plant community growth curve (percent production by month). ND5603, Red River Valley of the North, warm-season/cool-season co-dominant.. Cool-season, warm-season co-dominant..

Community 2.3
Little Bluestem/Exotic Grasses/Forbs

This community phase is characterized by a shift from the tall warm-season grasses to the more grazing tolerant mid statured warm-season bunchgrass and introduced cool-season sod formers. In the early stages of this community phase, little bluestem will initially increase along with the increase of introduced cool-season grasses. In many situations with inadequate recovery periods, the little bluestem will also begin to decline over time, facilitating the change to State 4: Invaded State. Significant grass and grass-like species include little bluestem, porcupinegrass, slender wheatgrass, switchgrass, prairie cordgrass, Kentucky bluegrass, and sedges. Other grasses present include sideoats grama, northern reedgrass, mat muhly, and scratchgrass. Indiangrass and big bluestem are still present in minor amounts. The common forbs include American licorice, cudweed sagewort, goldenrods, silverleaf Indian breadroot, and common yarrow. Western snowberry and prairie rose are the principal shrubs. This community phase is often dispersed throughout the pasture, in an overgrazed/undergrazed pattern, typically referred to as patch grazing. Some areas (overgrazed) will exhibit the impacts of heavy use, while other areas (undergrazed) will have a build-up of litter and a high amount of plant decadence. This is a typical pattern found in properly stocked pastures grazed season-long. In the undergrazed patches, litter buildup reduces plant vigor and density, and native seedling recruitment declines. Due to a lack of tiller stimulation and sunlight, native bunchgrasses typically develop dead centers and native rhizomatous grasses are limited to small colonies. In the overgrazed patches, plant vigor is reduced and the competitive advantage goes towards the grazing tolerant short statured species such as Kentucky bluegrass. This Community Phase is approaching the threshold leading to a transition to State 4: 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 4: Invaded State should be expected.

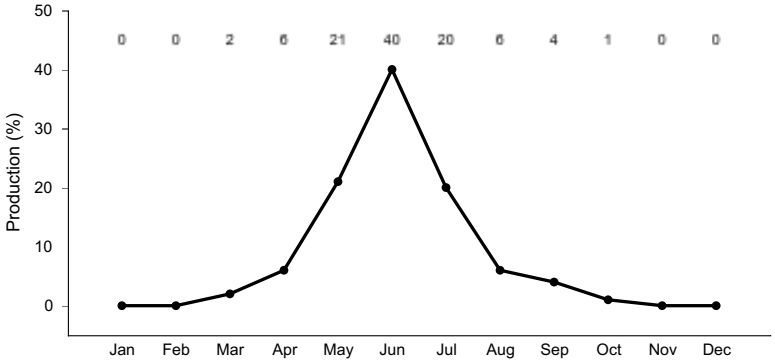


Figure 12. Plant community growth curve (percent production by month). ND5603, Red River Valley of the North, warm-season/cool-season co-dominant.. Cool-season, warm-season co-dominant..

Community 2.4

Pathway 2.1A
Community 2.1 to 2.2

Community Phase Pathway 2.1 to 2.2 results from periods of no grazing and no fire. This results in a reduction in vigor and density of the tall warm-season grasses (e.g. Indiangrass, big bluestem) and a corresponding increase in the exotic cool-season grasses, little bluestem, and forbs.

Pathway 2.1B
Community 2.1 to 2.3

Community Phase Pathway 2.1 to 2.3 results from heavy grazing pressure without adequate recovery periods. This results in an increase in little bluestem, exotic grasses, and forbs with a corresponding decrease in Indiangrass and big bluestem. The inadequate recovery periods between grazing events is especially damaging to the tall warm-season grasses. As the vigor of these dominant species is reduced, the more grazing tolerant native and introduced species gain a competitive advantage.

Pathway 2.2A
Community 2.2 to 2.1

Community Phase Pathway 2.2 to 2.1 can occur with the implementation of prescribed grazing and prescribed burning. This results in a marked increase in the density and vigor of Indiangrass and big bluestem with a corresponding decrease in the exotic cool-season grasses.

Conservation practices

Prescribed Burning
Prescribed Grazing

Pathway 2.2B
Community 2.2 to 2.3

Community Phase Pathway 2.2 to 2.3 results from long-term heavy grazing pressure without adequate recovery periods. This results in an increase in little bluestem, exotic grasses, and forbs with a corresponding decrease in Indiangrass and big bluestem. The inadequate recovery periods between grazing events is especially damaging to the tall warm-season grasses. As the vigor of these dominant species is reduced, the more grazing tolerant native and introduced species gain a competitive advantage

Pathway 2.3A
Community 2.3 to 2.1

Community Phase Pathway 2.3 to 2.1. is initiated with the implementation of prescribed grazing and prescribed burning. If properly implemented, this will shift the competitive advantage from the introduced cool-season species to the tall and mid warm-season grass species.

Conservation practices

Prescribed Burning
Prescribed Grazing

Pathway 2.3B
Community 2.3 to 2.2

Community Phase Pathway 2.3 to 2.2 is initiated with the implementation of prescribed grazing. This enables the tall warm-season grasses to increase in appearance and vigor but not density. (i.e. big bluestem, Indiangrass, switchgrass). This pathway is similar to that of Community Phase Pathway 2.3A, however, it involves prescribed grazing but not prescribed burning. The lack of prescribed burning leads to (among other things) markedly reduced vigor and production of Indiangrass compared to Community Phase Pathway 2.3A.

State 3
Wooded State

This state historically existed as small patches of shrubs (e.g. willow/dogwood species) scattered across the site, particularly during wet periods and near wooded areas where shrubs could encroach 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 shrub 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.

Dominant plant species

- willow (*Salix*), shrub
- spirea (*Spiraea*), shrub
- western snowberry (*Symphoricarpos occidentalis*), shrub
- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- Cuman ragweed (*Ambrosia psilostachya*), other herbaceous
- goldenrod (*Solidago*), other herbaceous
- white sagebrush (*Artemisia ludoviciana*), other herbaceous

Community 3.1
Shrub Species/Kentucky Bluegrass/Forbs

Visually, this community phase is characterized by a dominance of shrubs such as willow, spirea, western snowberry and an understory of introduced cool-season sod forming grass such as Kentucky bluegrass and forbs such as western ragweed, goldenrods, and cudweed sagewort. Native grasses may be still present but in greatly reduced numbers, below that which would allow for recovery. Overall annual production is reduced due to the lack of tall and mid statured warm-season grasses. Energy capture has shifted to spring and early summer. Use by domestic livestock is greatly reduced due to shrub component.

State 4
Invaded

This state is the result of invasion and dominance by the exotic cool-season grasses, commonly Kentucky bluegrass, smooth brome, and/or quackgrass. The exotic Canada thistle and leafy spurge may also invade the site.

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 rose may, however, show marked increases. 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 1700-2800 pounds per acre, with the exotic cool-season grasses contributing up to 75% or more of the total production.

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

- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- quackgrass (*Elymus repens*), grass
- tall yellow sweetclover (*Melilotus altissimus*), other herbaceous
- sweetclover (*Melilotus officinalis*), other herbaceous
- Cuman ragweed (*Ambrosia psilostachya*), other herbaceous
- goldenrod (*Solidago*), other herbaceous
- black medick (*Medicago lupulina*), other herbaceous

Community 4.1
Exotic Grasses/Exotics Forbs/Goldenrod

This community phase is dominated by Kentucky bluegrass with lesser amounts of sedge. Some native and non-native forbs can increase in production and cover as well. The dominant grass is Kentucky bluegrass, with common forbs including cudweed sagewort, goldenrod, aster, western ragweed, western yarrow, and a variety of introduced forbs such as black medic. Native warm-season species are no longer present. The longer this community phase exists the more resistant to change it becomes. Natural or management disturbances that reduce the cover of Kentucky bluegrass are very short lived due to the abundance of rhizomes of Kentucky bluegrass in the soil and the lack of propagules of other species. Production is limited to the sod forming species. Energy capture into this system is limited to one early growing species. When grazed heavily, runoff increases and is the highest of any plant community phase on this ecological site. Nutrient cycling is severely limited to the rooting depth of the Kentucky bluegrass and production is limited.

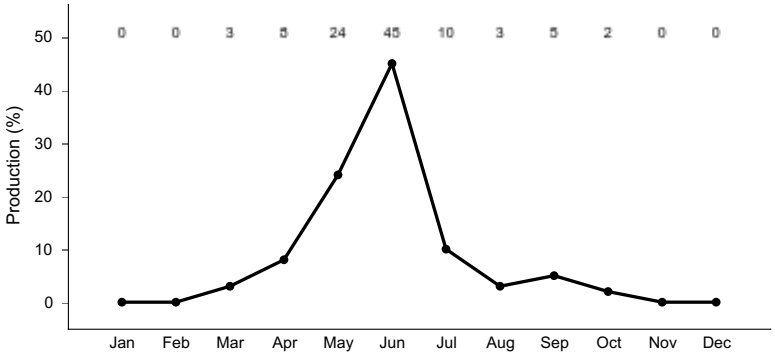


Figure 13. Plant community growth curve (percent production by month). ND5601, Red River Valley of the North, cool-season dominant.. Cool-season dominant..

State 5
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 and need control. Over time the exotic cool-season grasses Kentucky bluegrass, smooth brome, and/or quackgrass will likely predominate.

Dominant plant species

- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- quackgrass (*Elymus repens*), grass
- Canada thistle (*Cirsium arvense*), other herbaceous
- leafy spurge (*Euphorbia esula*), other herbaceous

Community 5.1
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, leafy spurge) which may need control. Over time the exotic cool-season grasses Kentucky bluegrass, smooth brome, and/or quackgrass crested wheatgrass will likely predominate, often in association with exotic forbs and goldenrods.

State 6
Cropland State

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

- soybean (*Glycine*), other herbaceous
- corn (*Zea*), 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 T2A
State 2 to 3

This transition from the State 2: Native/Invaded to State 3: Wooded State generally occurs during extended periods of non-use (or very light grazing) and no fire. It frequently occurs when the site has high density of shrubs such as willow or dogwood or is in close proximity to shrub dominated areas where woody vegetation may encroach vegetatively upon the site and/or serve as a seed source for these species to colonize the site. It has also become more frequent following European settlement when the historic fire regime was markedly reduced.

Transition T2B
State 2 to 4

This transition from the State 2: Native/Invaded State to State 4: Invaded State generally occurs with long-term heavy grazing pressure or extended periods of non-use. 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).

Restoration pathway R3A
State 3 to 2

This from State 3: Wooded State to State 2: Native/Invaded State can be accomplished with brush control. Initial use of herbicides and/or mechanical brush control to reduce the shrubs will permit adequate fine fuel loads to establish, permitting the application of prescribed fire to further control sprouting shrubs species. However, depending upon level of remnant native grasses and forbs, a range planting may also be necessary to complete the restoration. A combination of mechanical brush management, chemical treatment, and prescribed burning is necessary to remove the woody vegetation and, if necessary, to prepare the seedbed for a successful range planting. Once this is accomplished, 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. 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. After establishment of the native plant species, management objectives must include the maintenance of those species, the associated reference state functions, and continued treatment of exotic grasses. Due to the resprouting nature of woody species within MLRA 56 repeated treatments will be necessary for a transition from this state. Following the removal of woody species, other restoration practices such as range planting, prescribed burning, and prescribed grazing may be necessary to complete the restoration. The prescribed grazing should include adequate recovery periods following each grazing event and stocking levels which match the available resources. If properly implemented, this will help suppress any exotic cool-season grasses on the site.

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 ; (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 woody and 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. Some evidence suggests the addition of exotic legumes to the seeding mixture may favor exotic cool-season grass expansion/invasion.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

Transition T3A
State 3 to 4

This is the transition from State 3: Wooded State to State 4: Invaded State resulting from brush control (e.g. mechanical and/or chemical) and prescribed burning.

Constraints to recovery. Labor and financial cost of removal/control of woody species either through repeated prescribed burns, mechanical and/or chemical treatment.

Context dependence. Societal norms have accepted woody invasion as positive for wildlife habitat, carbon sequestration, aesthetics, etc. Livestock managers may not understand the loss of production due to woody invasion and loss of native grass species. Wildlife managers may need to manage woody habitat for exotic wildlife species such as ring-necked pheasants instead of sharp-tailed grouse or other grassland nesting birds intolerant to woody species invasion.

Restoration pathway R4A
State 4 to 2

This Restoration Pathway from State 4: Invaded State to State 2: Native/Invaded State may be accomplished with the implementation of long-term prescribed grazing and prescribed burning, 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 4.1. 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. The prescribed grazing should include adequate recovery periods following each grazing event and stocking levels which match the available resources. If properly implemented, this will shift the competitive advantage from the exotic cool-season grasses to the native cool-season grasses.

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). 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.

Conservation practices

Prescribed Burning

Prescribed Grazing

Transition T4A
State 4 to 3

This Transition from State 4: Invaded State to State 3: Wooded State occurs during periods of no use and no fire. It frequently occurs when the site is in close proximity to wooded areas where the woodland vegetation may encroach vegetatively upon the site and/or serve as a seed source for these species to colonize the site. It has also become more frequent following European settlement when the historic fire regime was markedly reduced.

Restoration pathway R5A
State 5 to 2

This Restoration from State 5: Go-Back State to State 2: Native/Invaded State can be accomplished with a successful range planting. Following seeding, 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, and management objectives must include the maintenance of those species, the associated reference state functions, and continued treatment of exotic grasses.

Restoration pathway R5B
State 5 to 4

A failed range planting and/or secondary succession will lead to State 4: Invaded State.

Restoration pathway T6A
State 6 to 5

This transition from any plant community to State 5: 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 a tillage induce compacted layer, erosion, fertility, herbicide/pesticide carryover). Thus, soil conditions should be assessed when considering restoration techniques.

Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall Warm-Season Grasses**			840–1470	
	Indiangrass	SONU2	*Sorghastrum nutans*	840–1260	–
	big bluestem	ANGE	*Andropogon gerardii*	630–1050	–
	switchgrass	PAVI2	*Panicum virgatum*	420–840	–
	prairie cordgrass	SPPE	*Spartina pectinata*	0–210	–
2	**Mid Warm-Season Grasses**			210–1050	
	little bluestem	SCSC	*Schizachyrium scoparium*	630–1050	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	210–420	–
	prairie dropseed	SPHE	*Sporobolus heterolepis*	42–210	–
3	**Cool-Season Grasses**			210–630	

	porcupinegrass	HESP11	*Hesperostipa spartea*	210–420	–
	green needlegrass	NAVI4	*Nassella viridula*	0–210	–
	Canada wildrye	ELCA4	*Elymus canadensis*	42–210	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	42–210	–
	northern reedgrass	CASTI3	*Calamagrostis stricta ssp. inexpansa*	42–126	–
	western wheatgrass	PASM	*Pascopyrum smithii*	42–126	–
4	**Other Native Grasses**			42–210	
	Grass, perennial	2GP	*Grass, perennial*	42–420	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–168	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	42–126	–
	mat muhly	MURI	*Muhlenbergia richardsonis*	42–84	–
	prairie wedgescale	SPOB	*Sphenopholis obtusata*	42–84	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–42	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–42	–
	scratchgrass	MUAS	*Muhlenbergia asperifolia*	0–42	–
5	**Grass-likes**			42–210	
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–210	–
	sedge	CAREX	*Carex*	42–126	–
	spikerush	ELEOC	*Eleocharis*	42–84	–
Forb					
6	**Forbs**			210–420	
	Forb, native	2FN	*Forb, native*	42–210	–
	Indianhemp	APCA	*Apocynum cannabinum*	42–126	–
	Norwegian cinquefoil	PONO3	*Potentilla norvegica*	42–126	–
	pussytoes	ANTEN	*Antennaria*	42–84	–
	purple prairie clover	DAPU5	*Dalea purpurea*	42–84	–
	smooth horsetail	EQLA	*Equisetum laevigatum*	42–84	–
	downy gentian	GEPU5	*Gentiana puberulenta*	42–84	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	42–84	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	42–84	–
	Lewis flax	LILE3	*Linum lewisii*	42–84	–
	palespike lobelia	LOSP	*Lobelia spicata*	42–84	–
	soft-hair marbleseed	ONBEB	*Onosmodium bejariense var. bejariense*	42–84	–
	prairie groundsel	PAPL12	*Packera plattensis*	42–84	–
	blackeyed Susan	RUHI2	*Rudbeckia hirta*	42–84	–
	Canada goldenrod	SOCA6	*Solidago canadensis*	42–84	–
	prairie violet	VIPE2	*Viola pedatifida*	42–84	–
	meadow zizia	ZIAP	*Zizia aptera*	42–84	–
	white sagebrush	ARLUA	*Artemisia ludoviciana ssp. albula*	0–84	–
	rough bugleweed	LYAS	*Lycopus asper*	0–84	–
	common yarrow	ACMI2	*Achillea millefolium*	0–42	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–42	–
	Canadian anemone	ANCA8	*Anemone canadensis*	0–42	

	Canadian anemone	ANCA8	*Anemone canadensis*	0–42	–
	whorled milkweed	ASVE	*Asclepias verticillata*	0–42	–
	bluebell bellflower	CARO2	*Campanula rotundifolia*	0–42	–
	flat-top goldentop	EUGR5	*Euthamia graminifolia*	0–42	–
	Virginia strawberry	FRVI	*Fragaria virginiana*	0–42	–
	closed bottle gentian	GEAN	*Gentiana andrewsii*	0–42	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–42	–
	common goldstar	HYHI2	*Hypoxis hirsuta*	0–42	–
	tall blazing star	LIAS	*Liatris aspera*	0–42	–
	stiff goldenrod	OLRI	*Oligoneuron rigidum*	0–42	–
	cinquefoil	POTEN	*Potentilla*	0–42	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–42	–
	blue-eyed grass	SISYR	*Sisyrinchium*	0–42	–
	white prairie aster	SYFA	*Symphyotrichum falcatum*	0–42	–
	New England aster	SYNO2	*Symphyotrichum novae-angliae*	0–42	–
	mountain deathcamas	ZIEL2	*Zigadenus elegans*	0–42	–
Shrub/Vine					
7	**Shrubs**			42–210	
	leadplant	AMCA6	*Amorpha canescens*	42–126	–
	prairie rose	ROAR3	*Rosa arkansana*	42–126	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–126	–
	willow	SALIX	*Salix*	0–42	–

Table 8. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall Warm-Season Grasses**			840–1470	
	Indiangrass	SONU2	*Sorghastrum nutans*	840–1260	–
	big bluestem	ANGE	*Andropogon gerardii*	630–1050	–
	switchgrass	PAVI2	*Panicum virgatum*	420–840	–
	prairie cordgrass	SPPE	*Spartina pectinata*	0–210	–
2	**Mid Warm-Season Grasses**			210–1050	
	little bluestem	SCSC	*Schizachyrium scoparium*	630–1050	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	210–420	–
	prairie dropseed	SPHE	*Sporobolus heterolepis*	42–210	–
3	**Cool-Season Grasses**			210–630	
	porcupinegrass	HESP11	*Hesperostipa spartea*	210–420	–
	green needlegrass	NAVI4	*Nassella viridula*	0–210	–
	Canada wildrye	ELCA4	*Elymus canadensis*	42–210	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	42–210	–
	northern reedgrass	CASTI3	*Calamagrostis stricta ssp. inexpansa*	42–126	–
	western wheatgrass	PASM	*Pascopyrum smithii*	42–126	–
4	**Other Native Grasses**			42–210	

	blue grama	BOGR2	*Bouteloua gracilis*	0–168	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	42–126	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–126	–
	mat muhly	MURI	*Muhlenbergia richardsonis*	42–84	–
	prairie wedgescale	SPOB	*Sphenopholis obtusata*	42–84	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–42	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–42	–
	scratchgrass	MUAS	*Muhlenbergia asperifolia*	0–42	–
5	**Grass-likes**			42–210	
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–210	–
	sedge	CAREX	*Carex*	42–126	–
	spikerush	ELEOC	*Eleocharis*	42–84	–
6	**Exotic Cool-Season Grasses**			42–210	
	Kentucky bluegrass	POPR	*Poa pratensis*	0–210	–
	redtop	AGGI2	*Agrostis gigantea*	0–210	–
Forb					
7	**Forbs**			210–420	
	Forb, native	2FN	*Forb, native*	42–210	–
	Indianhemp	APCA	*Apocynum cannabinum*	42–126	–
	Norwegian cinquefoil	PONO3	*Potentilla norvegica*	42–126	–
	pussytoes	ANTEN	*Antennaria*	42–84	–
	purple prairie clover	DAPU5	*Dalea purpurea*	42–84	–
	smooth horsetail	EQLA	*Equisetum laevigatum*	42–84	–
	downy gentian	GEPU5	*Gentiana puberulenta*	42–84	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	42–84	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	42–84	–
	Lewis flax	LILE3	*Linum lewisii*	42–84	–
	palespike lobelia	LOSP	*Lobelia spicata*	42–84	–
	soft-hair marbleseed	ONBEB	*Onosmodium bejariense var. bejariense*	42–84	–
	prairie groundsel	PAPL12	*Packera plattensis*	42–84	–
	blackeyed Susan	RUHI2	*Rudbeckia hirta*	42–84	–
	Canada goldenrod	SOCA6	*Solidago canadensis*	42–84	–
	prairie violet	VIPE2	*Viola pedatifida*	42–84	–
	meadow zizia	ZIAP	*Zizia aptera*	42–84	–
	white sagebrush	ARLUA	*Artemisia ludoviciana ssp. albula*	0–84	–
	rough bugleweed	LYAS	*Lycopus asper*	0–84	–
	common yarrow	ACMI2	*Achillea millefolium*	0–42	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–42	–
	Canadian anemone	ANCA8	*Anemone canadensis*	0–42	–
	whorled milkweed	ASVE	*Asclepias verticillata*	0–42	–
	bluebell bellflower	CARO2	*Campanula rotundifolia*	0–42	–
	flat-top goldentop	EUGR5	*Euthamia graminifolia*	0–42	–

	Virginia strawberry	FRVI	*Fragaria virginiana*	0–42	–
	closed bottle gentian	GEAN	*Gentiana andrewsii*	0–42	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–42	–
	common goldstar	HYHI2	*Hypoxis hirsuta*	0–42	–
	tall blazing star	LIAS	*Liatris aspera*	0–42	–
	stiff goldenrod	OLRI	*Oligoneuron rigidum*	0–42	–
	cinquefoil	POTEN	*Potentilla*	0–42	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–42	–
	blue-eyed grass	SISYR	*Sisyrinchium*	0–42	–
	white prairie aster	SYFA	*Symphyotrichum falcatum*	0–42	–
	New England aster	SYNO2	*Symphyotrichum novae-angliae*	0–42	–
	mountain deathcamas	ZIEL2	*Zigadenus elegans*	0–42	–
8	**Exotic Forbs**			42–210	
	Canada thistle	CIAR4	*Cirsium arvense*	0–210	–
	leafy spurge	EUESE	*Euphorbia esula var. esula*	0–210	–
Shrub/Vine					
9	**Shrubs**			42–210	
	leadplant	AMCA6	*Amorpha canescens*	42–126	–
	prairie rose	ROAR3	*Rosa arkansana*	42–126	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–126	–
	willow	SALIX	*Salix*	0–42	–

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.

Other references

Bluemle. J.P. 2016. North Dakota’s Geologic Legacy. North Dakota State University Press. 382 pages.

Briske, D.D. (editor). 2017. Rangeland Systems – Processes, Management, and Challenges. Springer Series on Environmental Management. 661 pages.

DeKeyser, E.S., G. Clambey, K. Krabbenhoft, and J. Ostendorf. 2009. Are changes in species composition on central North Dakota rangelands due to non-use management? Rangelands 31:16-19

Dix, R.L. and F.E. Smeins. 1967. The prairie, meadow, and marsh vegetation of Nelson County, North Dakota. Canadian Journal of Botany 45:21-57.

Dornbusch, M.J., R.F. Limb, and C.K. Gasch. 2018. Facilitation of an exotic grass through nitrogen enrichment by an exotic legume. Rangeland Ecology & Management 71:691-694.

Dyke, S.R., S.K. Johnson, and P.T. Isakson. 2015. North Dakota State Wildlife Action Plan. North Dakota Game and Fish Department, Bismarck, ND. 468 pages.

Ereth, C., J. Hendrickson, D. Kirby, E. DeKeyser, K. Sedevic, and M. West. 2017. Controlling Kentucky bluegrass with herbicide and burning is influenced by invasion level. Invasive Plant Science and Management 10: 80-89.

Hendrickson, J.R., S.L. Kronberg, and E.J. Scholljegerdes. 2020. Can targeted grazing reduce abundance of invasive perennial grass (Kentucky Bluegrass) on native mixed-grass prairie? Rangeland Ecology and Management, 73:547-551.

Higgins, K.F. 1984. Lightning fires in grasslands in North Dakota and in pine-savanna lands in nearby South Dakota and Montana. J. Range Manage. 37:100-103.

Higgins, K.F. 1986. Interpretation and compendium of historical fire accounts in the northern great plains. United States Department of Interior, Fish and Wildlife Service. Resource Publication 161. 39 pages.

High Plains Regional Climate Center, University of Nebraska, 830728 Chase Hall, Lincoln, NE 68583-0728. (http://hprcc.unl.edu)
Johnson, Sandra. 2015. Reptiles and Amphibians of North Dakota. North Dakota Game and Fish Department. 64 pages.

Jordan, N. R., D.L. Larson, and S.C. Huerd. 2008. Soil modification by invasive plants: effects on native and invasive species of mixed-grass prairies. Biological Invasions 10:177-190.

Minnesota Department of Natural Resources. 2005. Field guide to the native plant communities of Minnesota. Minnesota DNR.

North Dakota Division of Tourism, Accessed on February 25, 2019. Available at https://www.ndtourism.com/sports-recreation

North Dakota Parks and Recreation Department, Accessed on February 25, 2019. Available at https://www.parkrec.nd.gov/

Reeves, J.L., J.D. Derner, M.A. Sanderson, J.R. Hendrickson, S.L. Kronberg, M.K. Petersen, and L.T. Vermeire. 2014. Seasonal weather influences on yearling beef steer production in C3-dominated Northern Great Plains rangeland. Agriculture, Ecosystems and Environment 183:110-117.

Royer, R. A., 2003. Butterflies of North Dakota: An Atlas and Guide. Minot State University, Minot, ND.

Seabloom, R. 2011. Mammals of North Dakota. North Dakota Institute for Regional Studies, Fargo, ND. 461 pages.

Severson, K. E. and C. Hull Sieg. 2006. The Nature of Eastern North Dakota: Pre-1880 Historical Ecology. North Dakota Institute for Regional Studies.

Spaeth, K.E., Hayek, M.A., Toledo, D., and Hendrickson, J. 2019. Cool Season Grass Impacts on Native Mixedgrass Prairie Species in the Norther Great Plains. America’s Grassland Conference: Working Across Boundaries. The Fifth Biennial Conference on the Conservation of America’s Grasslands. Bismarck, ND. 20-22 August.

USDA, NRCS. National Range and Pasture Handbook, September 1997

USDA, NRCS. National Soil Information System, Information Technology Center, 2150 Centre Avenue, Building A, Fort Collins, CO 80526. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/tools/?cid=nrcs142p2_053552

USDA, NRCS. National Water and Climate Center, 101 SW Main, Suite 1600, Portland, OR 97204-3224. https://www.nrcs.usda.gov/wps/portal/wcc/home/

USDA, NRCS. 2001. The PLANTS Database, Version 3.1 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

USDA, NRCS, Various Published Soil Surveys.

Vinton, M.A. and E.M. Goergen. 2006. Plant-soil feedbacks contribute to the persistence of Bromus intermis in tallgrass prairie. Ecosystems 9: 967-976.

Contributors

Mark Hayek
Chuck Lura
Jeff Printz
Alan Gulsvig
Steve Sieler
David Dewald
Ezra Hoffman, Ecological Site Specialist, NRCS

Approval

Suzanne Mayne-Kinney, 9/04/2024

Acknowledgments

Non-discrimination Statement: In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident. Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English. To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:(1) mail: U.S. Department of Agriculture Office of the Assistant Secretary for Civil Rights 1400 Independence Avenue, SW Washington, D.C. 20250-9410;(2) fax: (202) 690-7442; or(3) email: program.intake@usda.gov USDA is an equal opportunity provider, employer, and lender.

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:**

---

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:**
