USDA Natural Resources Conservation Service

Ecological site R056BY095MN
Subirrigated

Last updated: 9/04/2024
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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 Subirrigated ecological site is typically located on flats and sand sheets; The common features of soils in this site are a seasonal high-water table from 18 to 42 inches which contributes additional water for transpiration and surface and upper subsoil layers which are leached of calcium carbonates. Soils are somewhat poorly drained. Slopes typically range from 0 to 2 percent.

Associated sites

R056BY087MN	**Limy Subirrigated** This site occurs on similar landscape positions. It is highly calcareous within a depth of 16 inches. All textures are included in this site. It is non-saline to slightly saline (E.C. <8) in the surface and subsoil layers.
R056BY084MN	**Clayey** This site occurs higher on the landscape on lake plains. The soil forms a ribbon >2 inches long. It is deeper than 3 feet to redoximorphic features.
R056BY090MN	**Sands** This site occurs higher on the landscape on sand plains. It is sand or loamy sand (fine to coarse sands) within a depth of 10 inches without a significant amount of gravel; the soil does not form ribbon. It is deeper than 42 inches to redoximorphic features.
R056BY091MN	**Sandy** This site occurs higher on the landscape on lake plains and delta plains. It is fine sandy loam or sandy loam (forms a ribbon <1 inch long) to a depth >10 inches. It is deeper than 3 feet to redoximorphic features.

R056BY094MN	**Loamy** This site occurs higher on the landscape on lake plains. The soil is loam, clay loam, silt loam or silty clay loam (forms a ribbon 1 to 2 inches long) to a depth >20 inches. It is deeper than 3 feet to redoximorphic features.
R056BY096MN	**Subirrigated Sands** This site occurs slightly higher on the landscape on sand plains. It has redoximorphic features at a depth of 30 to 42 inches. The subsoil is fine sand or loamy fine sand (does not form a ribbon).
R056BY102MN	**Wet Meadow** This site occurs in depressions and slightly below 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.

Similar sites

R056BY096MN	**Subirrigated Sands** This site occurs slightly higher on the landscape on sand plains. It has redoximorphic features at a depth of 30 to 42 inches. The subsoil is fine sand or loamy fine sand (does not form a ribbon).
R056BY087MN	**Limy Subirrigated** This site occurs on similar landscape positions. It is highly calcareous within a depth of 16 inches. All textures are included in this site. It is non-saline to slightly saline (E.C. <8) in the surface and subsoil layers.
R056BY088MN	**Loamy Overflow** This site occurs in upland swales and on floodplains. The surface and subsoil layers form a ribbon 1 to 2 inches long. It is deeper than 30 inches to redoximorphic features.

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 sand sheets. Slopes typically are less than 2 percent.

Table 2. Representative physiographic features

Landforms	(1) Flat (2) Sand sheet
Runoff class	Negligible to low
Flooding duration	Brief (2 to 7 days)
Flooding frequency	None
Ponding duration	Brief (2 to 7 days)
Ponding frequency	None
Elevation	229–451 m
Slope	0–2%
Ponding depth	0 cm
Water table depth	46–107 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

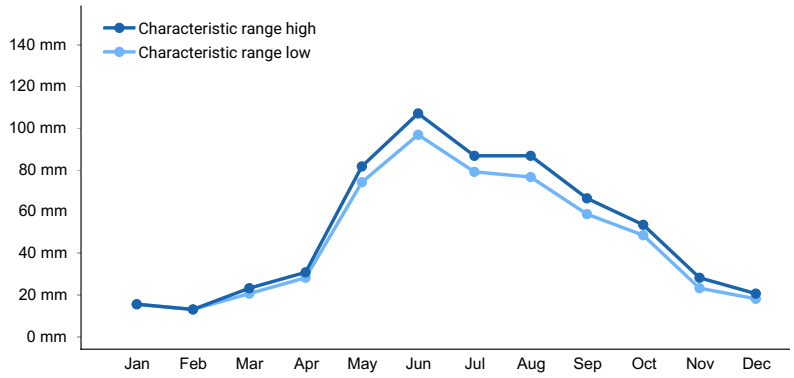


Figure 1. Monthly precipitation range

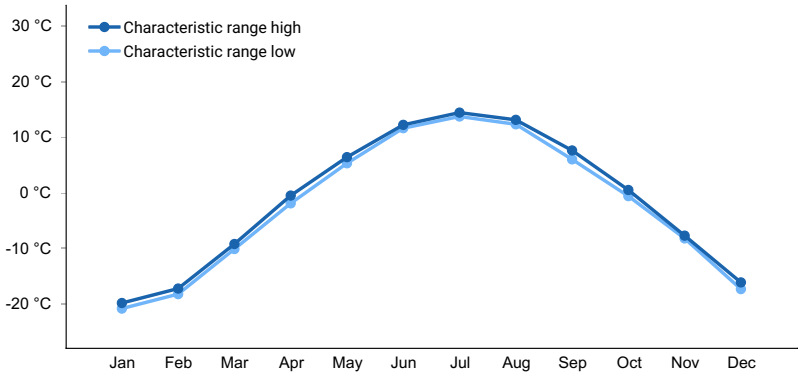


Figure 2. Monthly minimum temperature range

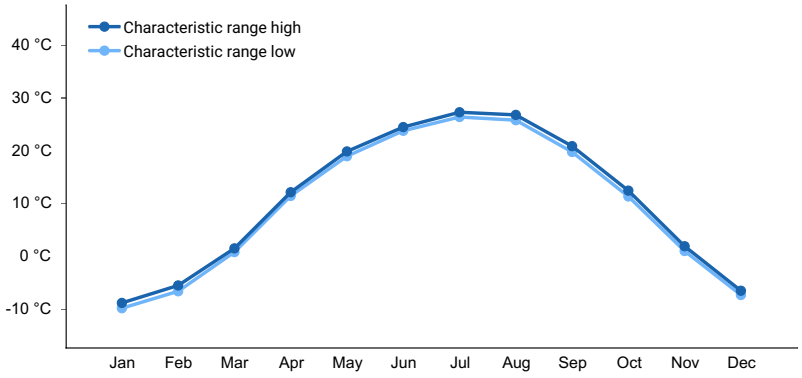


Figure 3. Monthly maximum temperature range

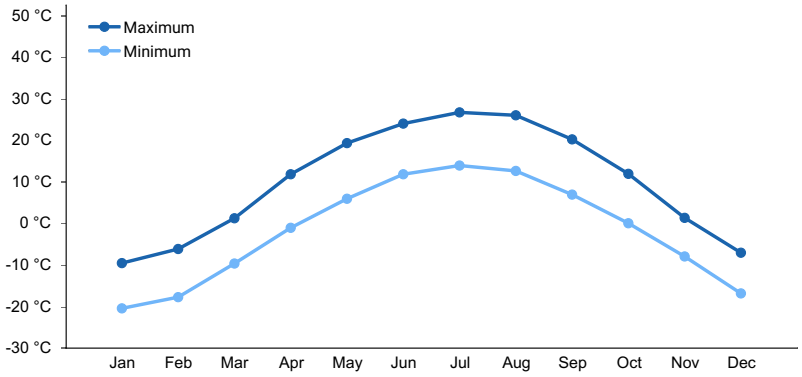


Figure 4. Monthly average minimum and maximum temperature

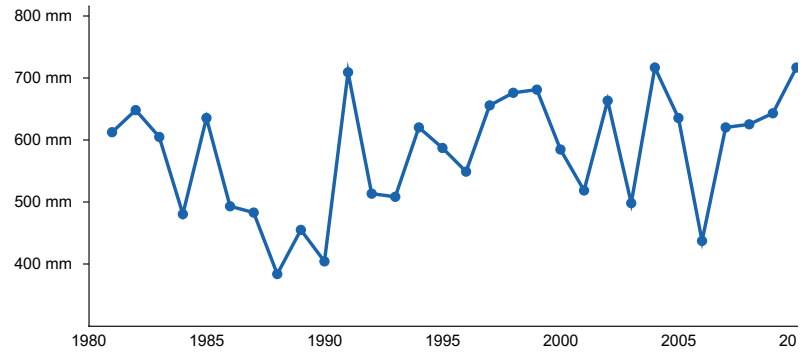


Figure 5. Annual precipitation pattern

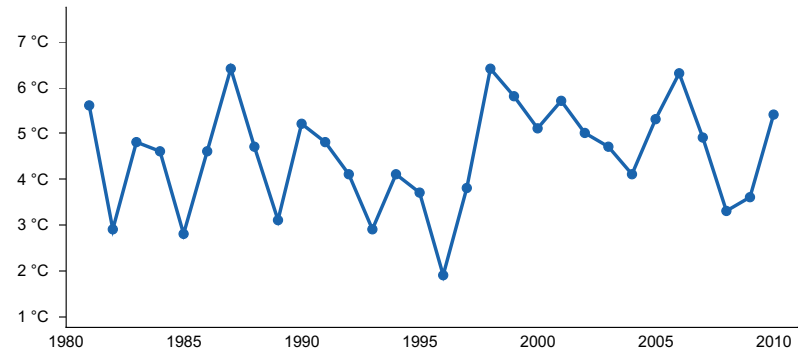


Figure 6. Annual average temperature pattern

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

Under normal climatic conditions, this site typically has no wetland functions; however, it can be closely associated with wetland sites, such as Wet Meadow. During prolonged wetter than normal periods, some wetland functions (a predominance of hydrophytic vegetation and ground water recharge) may be evident where this site occurs in shallow depressions.

The Subirrigated site does receive additional water from a seasonal high water table (endosaturation). During the growing season, water table depths typically are 1.5 to 3.5 feet during April through June. In mid-summer through autumn, the water table lowers a depth to 3 to 5 feet as a result of evapotranspiration and reduced precipitation. Surface infiltration ranges from slow to rapid. Saturated hydraulic conductivity through the profile typically ranges from moderately low to high. Water loss is primarily through evapotranspiration. During mid-summer, particularly during drier than normal cycles, percolation below the root zone may also occur.

Due to the low relief landscape that typically surrounds this site, additional water received as runoff from adjacent uplands is not a major factor in the soil/hydrology/plant relationship with the exception of the few areas where this site occurs as a minor component on flood plains. There, additional water may be received from stream overflow.

Soil features

Soils associated with Subirrigated ES are in the Mollisol and Entisol orders. These soils were developed under prairie vegetation.

The common features of soils in this site are a seasonal high water table which contributes additional water for transpiration and surface and upper subsoil layers which are leached of calcium carbonates. The soils are somewhat poorly drained - redoximorphic features typically occur at a depth between 18 and 80 inches. Therefore, soil physical properties associated with texture vary widely. Soil reaction is slightly acid to moderately alkaline (pH 6.1 to 8.4).

This site should show slight to no evidence of rills, wind-scoured areas, or pedestaled plants. No water flow paths are seen on this site. The soil surface is stable and intact. Sub-surface soil layers are non-restrictive to water movement and root penetration.

Major soil series correlated to the Subirrigated site are: Bantry and Garborg.

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) Eolian deposits
Surface texture	(1) Loamy fine sand
Drainage class	Somewhat poorly drained
Permeability class	Rapid
Depth to restrictive layer	203 cm
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	7.11–12.7 cm

Soil reaction (1:1 water) (0-25.4cm)	6.1–7.8
Subsurface fragment volume <=3" (0-152.4cm)	0%
Subsurface fragment volume >3" (0-152.4cm)	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 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 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, Invaded, Wooded, Go-Back, 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 two 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, redtop, 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, leafy spurge, and Russian olive are also known to invade the site.

Three community phases have been identified for this state and are similar to 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 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 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. This state may also transition to State 3: Wooded State during extended periods of no use and no fire (T2A).

State 3: Wooded State
This state historically existed as small patches of shrubs scattered across the site when precipitation, fire frequency, and other factors enabled shrubs to increase. This often resulted in a mosaic of patches of shrubs 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 and no fire (T2A, T4A).

Brush control (e.g. chemical, and/or mechanical treatment, prescribed burning) may lead to State 4: Invaded State (T3A). Brush control, perhaps followed by range planting, may also lead to State 2: Native/Invaded State (R3A).

State 4: Invaded State. The threshold for this state is reached when the exotic cool-season grasses, often Kentucky bluegrass, smooth brome, redtop, and/or quackgrass exceed 30% of the plant community and native grasses represent less than 40% of the community. One 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 can increase and become a physical barrier to plant growth and also alter 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 may be accomplished with the implementation of long-term prescribed grazing in conjunction with prescribed burning (R4A). This state may also transition to State 3: Wooded State during extended periods of no use and no fire (T4A).

State 5: Go-Back State often results following cropland abandonment and consists of only one community phase. This weedy assemblage may include noxious weeds that need control. Over time, the exotic cool-season grasses Kentucky bluegrass, smooth brome, redtop, 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 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..

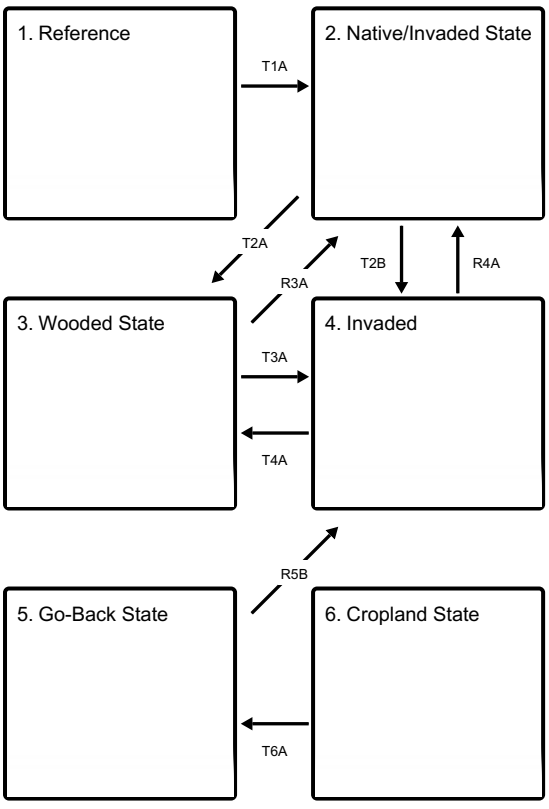
The following state and transition model diagram illustrates the common states, community phases, community pathways, transition and restoration pathways that can occur on the site. These are the most common plant community phases and states based on current knowledge and experience; changes may be made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

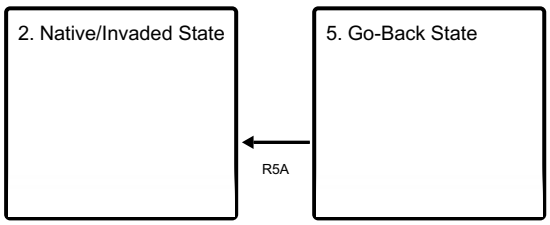
The plant community phase composition table(s) has been developed from the best available knowledge including research, historical records, clipping studies, and inventory records. As more data are collected, plant community species composition and production information may be revised.

State and transition model

Ecosystem states



States 2 and 5 (additional transitions)



T1A - Introduciton of exotic species

T2A - No use, no fire

T2B - Heavy season-long grazing

R3A - Brush control, perhaps with range planting

T3A - Brush control

R4A - Prescribed grazing and prescribed burning

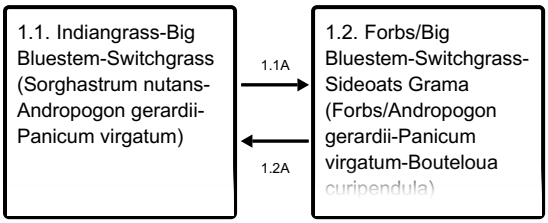
T4A - No use, no fire

R5A - Successful range planting

R5B - Failed range planting

T6A - Cessation of annual cropping

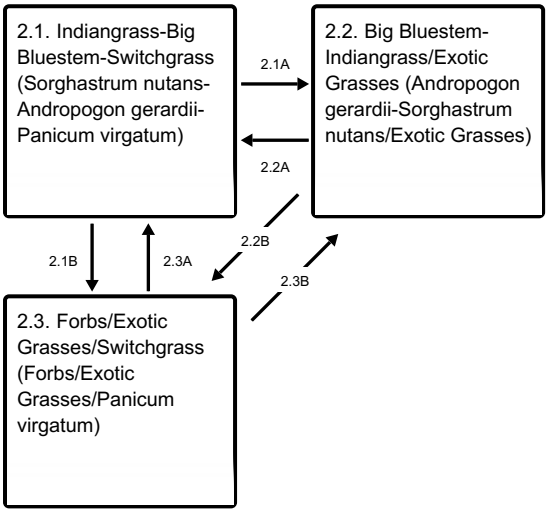
State 1 submodel, plant communities



1.1A - Periods of below average precipitation and increased disturbance

1.2A - Return to average precipitaiton and disturbance regime

State 2 submodel, plant communities



2.1A - No use and no fire

2.1B - Heavy season-long grazing without adequate recovery periods

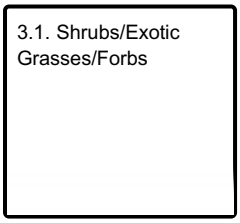
2.2A - Prescribed grazing and prescribed burning

2.2B - Heavy season-long grazing without adequate recovery periods

2.3A - Prescribed grazing, prescribed burning

2.3B - Prescribed grazing

State 3 submodel, plant communities



State 4 submodel, plant communities

4.1. Exotic Grasses/Exotic Forbs/Goldenrod

State 5 submodel, plant communities

5.1. Annual/Pioneer Perennial /Exotics

State 1
Reference

This state represented 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.

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 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

- leadplant (*Amorpha canescens*), shrub
- willow (*Salix*), shrub
- white meadowsweet (*Spiraea alba*), shrub
- western snowberry (*Symphoricarpos occidentalis*), shrub
- Indiangrass (*Sorghastrum nutans*), grass
- big bluestem (*Andropogon gerardii*), grass
- switchgrass (*Panicum virgatum*), grass
- porcupinegrass (*Hesperostipa spartea*), grass
- Indianhemp (*Apocynum cannabinum*), other herbaceous
- Norwegian cinquefoil (*Potentilla norvegica*), other herbaceous
- American licorice (*Glycyrrhiza lepidota*), other herbaceous
- upright prairie coneflower (*Ratibida columnifera*), other herbaceous

Community 1.1
Indiangrass-Big Bluestem-Switchgrass (Sorghastrum nutans-Andropogon gerardii-Panicum virgatum)

This community phase was historically the most dominant both temporally and spatially. It was dominated by tall and mid warm-season and mid cool-season grasses such as Indiangrass, big bluestem, switchgrass, porcupinegrass, and little bluestem. Other grass and grass-like species included prairie cordgrass, Canada wildrye, sideoats grama, slender wheatgrass, and sedges. A wide variety of native perennial forbs were present including Indianhemp, Norwegian cinquefoil, American licorice, Canada goldenrod, blackeyed Susan, and upright prairie

coneflower. Common shrubs included leadplant, willow, white meadowsweet, and western snowberry. Annual production would have varied from about 3500-6000 pounds per acre with graminoids, forbs, and shrubs contributing 85%, 10%, and 5% respectively. Both warm-season grasses and cool-season grasses were well represented in the community, and as a result production would have been distributed throughout the growing season. 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	3626	4715	5884
Forb	247	396	560
Shrub/Vine	50	158	280
Total	**3923**	**5269**	**6724**

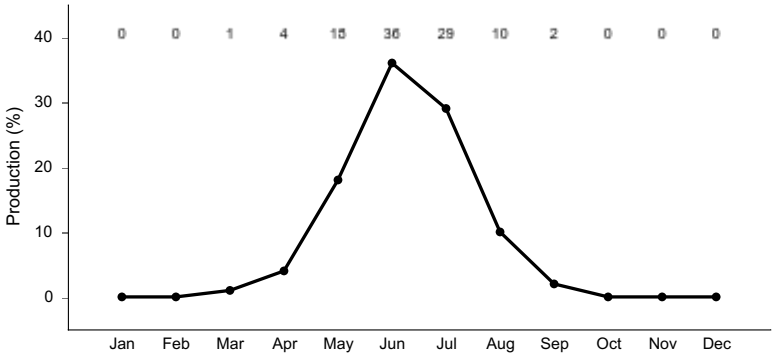


Figure 8. Plant community growth curve (percent production by month). ND5605, Red River Valley of the North, warm-season dominant.. Warm-season dominant..

Community 1.2
Forbs/Big Bluestem-Switchgrass-Sideoats Grama (Forbs/Andropogon gerardii-Panicum virgatum-Bouteloua curipendula)

Although still dominated by grasses this community phase would have been characterized by the conspicuous and diverse forb component. Showy forbs such as tall blazing star, sunflowers, mountain deathcamas, blackeyed Susan, goldenrods, and American licorice would have dominated the visual appearance of the site. Dominant grasses would have included switchgrass, prairie cordgrass, big bluestem, and sideoats grama. Annual production of graminoids would have been somewhat reduced and forb production increased in comparison to Community Phase 1.1.

Pathway 1.1A
Community 1.1 to 1.2

Community Pathway 1.1 to 1.2 occurred during periods of below average precipitation and increased disturbance. This resulted in a marked increase in forbs and a reduction in the more grazing sensitive species such as Indiangrass. Sideoats grama has also noticeably increased.

Pathway 1.2A
Community 1.2 to 1.1

Community Phase Pathway 1.2 to 1.1 occurred with the return to average precipitation and disturbance regime leading to a marked decrease in forbs and a corresponding increase in Indiangrass and other grazing sensitive plants.

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, redtop, 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 range from 3500-6000 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

- prairie rose (*Rosa arkansana*), shrub
- leadplant (*Amorpha canescens*), shrub
- western snowberry (*Symphoricarpos occidentalis*), shrub
- Indiangrass (*Sorghastrum nutans*), grass
- big bluestem (*Andropogon gerardii*), grass
- switchgrass (*Panicum virgatum*), grass
- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- Maximilian sunflower (*Helianthus maximiliani*), other herbaceous
- goldenrod (*Solidago*), other herbaceous
- Cuman ragweed (*Ambrosia psilostachya*), other herbaceous
- white heath aster (*Symphyotrichum ericoides*), other herbaceous
- sweetclover (*Melilotus officinalis*), other herbaceous

Community 2.1
Indiangrass-Big Bluestem-Switchgrass (Sorghastrum nutans-Andropogon gerardii-Panicum virgatum)

This Community Phase is similar to Community Phase 1.1 but has been colonized by exotic cool-season grasses,

often Kentucky bluegrass, smooth brome, redtop, and/or quackgrass. However, these exotics are present in smaller amounts with the community still dominated by native grasses. Annual production is similar to that of the reference plant community (3500-6000 pounds per acre).

Table 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	3626	4715	5884
Forb	247	396	560
Shrub/Vine	50	158	280
Total	**3923**	**5269**	**6724**

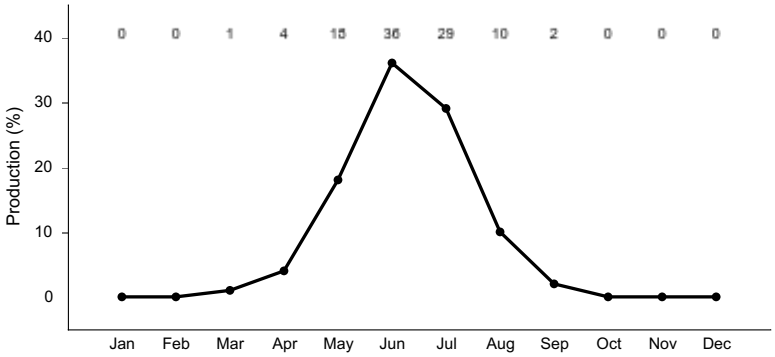


Figure 10. Plant community growth curve (percent production by month). ND5605, Red River Valley of the North, warm-season dominant.. Warm-season dominant..

Community 2.2
Big Bluestem-Indiangrass/Exotic Grasses (Andropogon gerardii-Sorghastrum nutans/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 or perhaps other exotic cool-season grasses 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 revert 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 State 1: Reference State. 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 that of the reference plant community (3500-6000 pounds per acre).

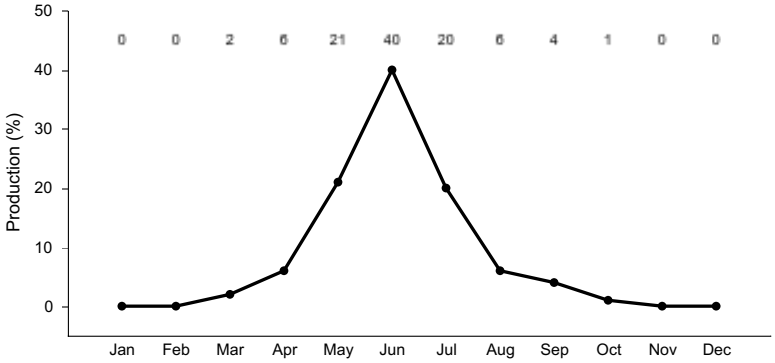


Figure 11. Plant community growth curve (percent production by month). ND5603, Red River Valley of the North, warm-season/cool-season co-

dominant.. Cool-season, warm-season co-dominant..

Community 2.3
Forbs/Exotic Grasses/Switchgrass (Forbs/Exotic Grasses/Panicum virgatum)

This community phase results from heavy season-long grazing of Community Phase 2.1 or 2.2. This results in a marked increase in forbs and exotic cool-season grasses with a corresponding decline in the tall warm-season grasses (i.e. Indiangrass, big bluestem). The more abundant forbs often include white sagebrush, white heath aster, Cuman ragweed, Canada goldenrod, and pussytoes. 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. 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.

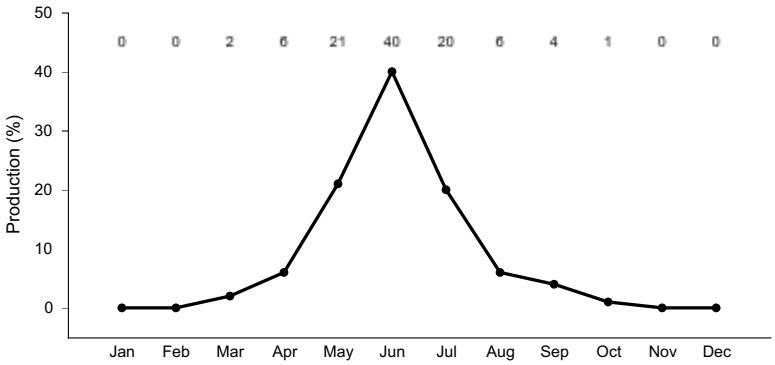


Figure 12. Plant community growth curve (percent production by month). ND5603, Red River Valley of the North, warm-season/cool-season co-dominant.. Cool-season, warm-season co-dominant..

Pathway 2.1A
Community 2.1 to 2.2

Community Phase Pathway 2.1 to 2.2 occurs during periods of no use and no fire which results in an increase in exotic cool-season grasses and corresponding decline in Indiangrass and other warm-season grasses.

Pathway 2.1B
Community 2.1 to 2.3

Community Phase Pathway 2.1 to 2.3 results from heavy season-long grazing without adequate recovery periods which results in a marked increase in forbs and exotic cool-season grass with a corresponding decrease in the less grazing tolerant grasses (i.e. Indiangrass and big bluestem).

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 Indiangrass and other warm-season grasses along with a corresponding decrease in the exotic cool-season grasses.

Conservation practices

Prescribed Grazing

Pathway 2.2B

Community 2.2 to 2.3

Community Phase Pathway 2.2 to 2.3 results from heavy season-long grazing without adequate recovery periods which results in a marked increase in forbs and exotic cool-season grass with a corresponding decrease in the less grazing tolerant grasses (i.e. Indiangrass and big bluestem).

Pathway 2.3A
Community 2.3 to 2.1

Community Phase Pathway 2.3 to 2.1 can occur with the implementation of prescribed grazing and prescribed burning resulting in a marked increase in Indiangrass, big bluestem, and switchgrass with a corresponding decrease in exotic cool-season grasses and forbs. The prescribed burning is particularly important in restoring the production and vigor of Indiangrass.

Conservation practices

Prescribed Burning
Prescribed Grazing

Pathway 2.3B
Community 2.3 to 2.2

Community Phase Pathway 2.3 to 2.2 can occur with the implementation of prescribed grazing. This results in an increase in big bluestem and Indiangrass and a corresponding decrease in the exotic cool-season grasses. 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 scattered across the site, particularly during high precipitation periods. A marked increase in non-use management and active fire suppression since European influence has also been a factor enabling this state to expand and become more widespread. Common shrubs often include willows, white meadowsweet, and western snowberry. Russian olive can also increase under this scenario.

Dominant plant species

- willow (*Salix*), shrub
- white meadowsweet (*Spiraea alba*), 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
Shrubs/Exotic Grasses/Forbs

Visually, this community phase is characterized by a dominance of shrubs such as willow, white meadowsweet, western snowberry, and an understory of exotic cool-season sod forming grass, commonly Kentucky bluegrass. Common associated forbs include Cuman ragweed, goldenrods, and white sagebrush. Native grasses may be still present but below that which would allow for recovery. Annual production is comparatively low due to the lack of tall and mid statured warm-season grasses; peak production has shifted to spring and early summer. Use by domestic livestock is greatly reduced due to the increase in shrubs.

State 4
Invaded

This state is the result of invasion and dominance by introduced species. This state is characterized by the dominance of primarily Kentucky bluegrass but may also include quackgrass, redtop, and other non-native forbs such as leafy spurge and Canada thistle. Other forbs present are western ragweed and goldenrods. Once this state is well established, even drastic events such as high intensity fires driven by high fuel loads of litter and thatch will not result in more than a very short term reduction of Kentucky bluegrass.

Dominant plant species

- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- quackgrass (*Elymus repens*), grass
- redtop (*Agrostis gigantea*), grass
- sweetclover (*Melilotus officinalis*), other herbaceous
- Cuman ragweed (*Ambrosia psilostachya*), other herbaceous
- black medick (*Medicago lupulina*), other herbaceous
- common yarrow (*Achillea millefolium*), other herbaceous
- goldenrod (*Solidago*), other herbaceous
- Canada thistle (*Cirsium arvense*), other herbaceous
- leafy spurge (*Euphorbia esula*), other herbaceous

Community 4.1
Exotic Grasses/Exotic Forbs/Goldenrod

This community phase is typically dominated by exotic grasses, commonly Kentucky bluegrass, smooth brome, quackgrass, and/or redtop with lesser amounts of sedges. Some native and exotic forbs can increase in production and cover as well. The dominant grass is typically Kentucky bluegrass along with common forbs including white sagebrush, goldenrod, aster, Cuman ragweed, common 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 or the other exotic cool-season grasses are very short-lived. Due to the preponderance of Kentucky bluegrass or other exotic cool-season grasses, production is largely limited to the early growing season.

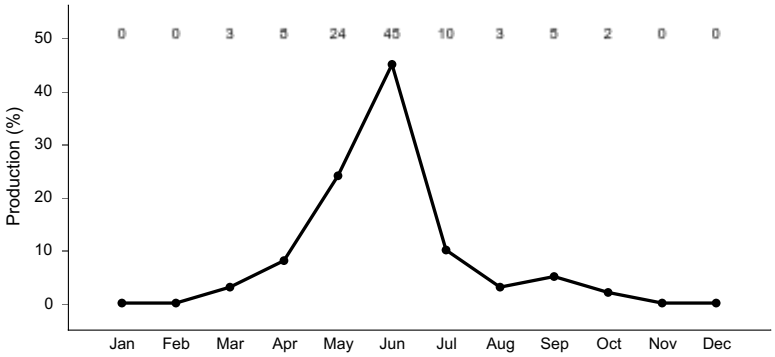


Figure 13. Plant community growth curve (percent production by month). ND5601, Red River Valley of the North, cool-season dominant.. Cool-season dominant..

State 5
Go-Back State

This state is highly variable depending on the level and duration of disturbance. 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, redtop, and/or quackgrass will likely predominate.

Dominant plant species

- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- redtop (*Agrostis gigantea*), grass
- quackgrass (*Elymus repens*), grass
- sweetclover (*Melilotus officinalis*), other herbaceous
- black medick (*Medicago lupulina*), other herbaceous
- leafy spurge (*Euphorbia esula*), other herbaceous
- Canada thistle (*Cirsium arvense*), 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, redtop, and/or quackgrass will likely predominate.

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, redtop, 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, redtop, 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 no use or very light grazing and no fire which results in a marked increase in shrubs such as willows, western snowberry, and white meadowsweet. It has become more frequent following European settlement when the historic fire regime was markedly reduced.

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 4

This transition from the State 2: Native/Invaded State to State 4: Invaded State generally occurs with heavy season-long grazing but may also occur under other management. Exotic cool-season grasses such as quackgrass, Kentucky bluegrass, redtop, 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. Once the threshold is crossed, a change in grazing management alone cannot cause a reduction in the exotic cool-season grasses.

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.

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, perhaps followed by a range planting. Initial use of herbicides and/or mechanical brush control to reduce the shrubs will permit adequate fine fuel loads to enable the application of prescribed burning 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 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
Herbaceous Weed Control

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, repeated prescribed burns).

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 which are 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.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing
Herbaceous Weed Control

Transition T4A
State 4 to 3

This is the transition from State 4: Invaded State to State 3: Wooded State during periods of no use and no fire which results in a marked increase in shrubs such as willow, western snowberry, and white meadowsweet.

Restoration pathway R5A
State 5 to 2

This Restoration Pathway from State 5: Go-Back State to the 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; management objectives must include the maintenance of those species, the associated reference state functions, and continued treatment of exotic 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).

Restoration pathway R5B
State 5 to 4

A failed range planting and/or secondary succession will lead to State 4: 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 T6A
State 6 to 5

TheT6A transitional pathway, in this MLRA, is most probable secondary succession following cropland abandonment.

Additional community tables

Table 7. 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**			1317–2371	
	big bluestem	ANGE	*Andropogon gerardii*	1054–2107	–
	Indiangrass	SONU2	*Sorghastrum nutans*	1054–2107	–
	switchgrass	PAVI2	*Panicum virgatum*	527–1054	–
	prairie cordgrass	SPPE	*Spartina pectinata*	53–263	–
2	**Mid Warm-Season Grasses**			263–790	
	little bluestem	SCSC	*Schizachyrium scoparium*	263–527	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	53–263	–
3	**Mid Cool-Season Grasses**			263–790	
	Canada wildrye	ELCA4	*Elymus canadensis*	158–421	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	158–421	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	53–263	–

	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–53	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–53	–
4	**Other Native Grasses**			53–263	
	Grass, perennial	2GP	*Grass, perennial*	53–263	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	53–105	–
	scratchgrass	MUAS	*Muhlenbergia asperifolia*	0–53	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	0–53	–
	prairie wedgescale	SPOB	*Sphenopholis obtusata*	0–53	–
	northern reedgrass	CASTI3	*Calamagrostis stricta ssp. inexpansa*	0–53	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–53	–
5	**Grass-likes**			53–263	
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–263	–
	sedge	CAREX	*Carex*	53–158	–
	spikerush	ELEOC	*Eleocharis*	53–105	–
	mountain rush	JUARL	*Juncus arcticus ssp. littoralis*	53–105	–
Forb					
6	**Forbs**			263–527	
	Forb, native	2FN	*Forb, native*	53–263	–
	Indianhemp	APCA	*Apocynum cannabinum*	53–158	–
	Norwegian cinquefoil	PONO3	*Potentilla norvegica*	53–158	–
	candle anemone	ANCY	*Anemone cylindrica*	53–105	–
	pussytoes	ANTEN	*Antennaria*	53–105	–
	purple prairie clover	DAPU5	*Dalea purpurea*	53–105	–
	downy gentian	GEPU5	*Gentiana puberulenta*	53–105	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	53–105	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	53–105	–
	Lewis flax	LILE3	*Linum lewisii*	53–105	–
	palespike lobelia	LOSP	*Lobelia spicata*	53–105	–
	soft-hair marbleseed	ONBEB	*Onosmodium bejariense var. bejariense*	53–105	–
	blackeyed Susan	RUHI2	*Rudbeckia hirta*	53–105	–
	Canada goldenrod	SOCA6	*Solidago canadensis*	53–105	–
	prairie violet	VIPE2	*Viola pedatifida*	53–105	–
	meadow zizia	ZIAP	*Zizia aptera*	53–105	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–105	–
	rough bugleweed	LYAS	*Lycopus asper*	0–105	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–53	–
	whorled milkweed	ASVE	*Asclepias verticillata*	0–53	–
	bluebell bellflower	CARO2	*Campanula rotundifolia*	0–53	–
	smooth horsetail	EQLA	*Equisetum laevigatum*	0–53	–
	flat-top goldentop	EUGR5	*Euthamia graminifolia*	0–53	–
	Virginia strawberry	FRVI	*Fragaria virginiana*	0–53	–
	closed bottle gentian	GEAN	*Gentiana andrewsii*	0–53	–

	closed bottle gentian	GLAN	*Gentiana andrewsii*	0–53	
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–53	–
	common goldstar	HYHI2	*Hypoxis hirsuta*	0–53	–
	tall blazing star	LIAS	*Liatris aspera*	0–53	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–53	–
	blue-eyed grass	SISYR	*Sisyrinchium*	0–53	–
	white prairie aster	SYFA	*Symphyotrichum falcatum*	0–53	–
	New England aster	SYNO2	*Symphyotrichum novae-angliae*	0–53	–
	mountain deathcamas	ZIEL2	*Zigadenus elegans*	0–53	–
Shrub/Vine					
7	**Shrubs**			53–263	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	53–158	–
	leadplant	AMCA6	*Amorpha canescens*	53–158	–
	willow	SALIX	*Salix*	53–105	–
	white meadowsweet	SPAL2	*Spiraea alba*	53–105	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	53–105	–
	rose	ROSA5	*Rosa*	0–53	–

Table 8. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall Warm-Season Grasses**			1317–2897	
	big bluestem	ANGE	*Andropogon gerardii*	1054–2107	–
	Indiangrass	SONU2	*Sorghastrum nutans*	1054–2107	–
	switchgrass	PAVI2	*Panicum virgatum*	527–1054	–
	prairie cordgrass	SPPE	*Spartina pectinata*	53–263	–
2	**Mid Warm-Season Grasses**			263–790	
	little bluestem	SCSC	*Schizachyrium scoparium*	263–527	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	53–263	–
3	**Mid Cool-Season Grasses**			263–790	
	Canada wildrye	ELCA4	*Elymus canadensis*	158–421	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	158–421	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	53–263	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–53	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–53	–
4	**Other Native Grasses**			53–158	
	Grass, perennial	2GP	*Grass, perennial*	53–263	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	53–105	–
	scratchgrass	MUAS	*Muhlenbergia asperifolia*	0–53	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	0–53	–
	prairie wedgescale	SPOB	*Sphenopholis obtusata*	0–53	–
	northern reedgrass	CASTI3	*Calamagrostis stricta ssp. inexpansa*	0–53	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–53	–

			schizandrum		
5	**Grass-likes**			53–263	
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–263	–
	sedge	CAREX	*Carex*	53–158	–
	spikerush	ELEOC	*Eleocharis*	53–105	–
	mountain rush	JUARL	*Juncus arcticus ssp. littoralis*	53–105	–
6	**Exotic Cool-Season Grasses**			53–263	
	Kentucky bluegrass	POPR	*Poa pratensis*	0–263	–
	creeping bentgrass	AGST2	*Agrostis stolonifera*	0–39	–
Forb					
7	**Forbs**			263–527	
	Forb, native	2FN	*Forb, native*	53–263	–
	Indianhemp	APCA	*Apocynum cannabinum*	53–158	–
	Norwegian cinquefoil	PONO3	*Potentilla norvegica*	53–158	–
	candle anemone	ANCY	*Anemone cylindrica*	53–105	–
	pussytoes	ANTEN	*Antennaria*	53–105	–
	purple prairie clover	DAPU5	*Dalea purpurea*	53–105	–
	downy gentian	GEPU5	*Gentiana puberulenta*	53–105	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	53–105	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	53–105	–
	Lewis flax	LILE3	*Linum lewisii*	53–105	–
	palespike lobelia	LOSP	*Lobelia spicata*	53–105	–
	soft-hair marbleseed	ONBEB	*Onosmodium bejariense var. bejariense*	53–105	–
	blackeyed Susan	RUHI2	*Rudbeckia hirta*	53–105	–
	Canada goldenrod	SOCA6	*Solidago canadensis*	53–105	–
	prairie violet	VIPE2	*Viola pedatifida*	53–105	–
	meadow zizia	ZIAP	*Zizia aptera*	53–105	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–105	–
	rough bugleweed	LYAS	*Lycopus asper*	0–105	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–53	–
	whorled milkweed	ASVE	*Asclepias verticillata*	0–53	–
	bluebell bellflower	CARO2	*Campanula rotundifolia*	0–53	–
	smooth horsetail	EQLA	*Equisetum laevigatum*	0–53	–
	flat-top goldentop	EUGR5	*Euthamia graminifolia*	0–53	–
	Virginia strawberry	FRVI	*Fragaria virginiana*	0–53	–
	closed bottle gentian	GEAN	*Gentiana andrewsii*	0–53	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–53	–
	common goldstar	HYHI2	*Hypoxis hirsuta*	0–53	–
	tall blazing star	LIAS	*Liatris aspera*	0–53	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–53	–
	blue-eyed grass	SISYR	*Sisyrinchium*	0–53	–
	white prairie aster	SYFA	*Symphyotrichum falcatum*	0–53	–

	New England aster	SYNO2	*Symphyotrichum novae-angliae*	0–53	–
	mountain deathcamas	ZIEL2	*Zigadenus elegans*	0–53	–
8	**Exotic Forbs**			53–263	
	leafy spurge	EUES	*Euphorbia esula*	53–263	–
Shrub/Vine					
9	**Shrubs**			53–263	
	leadplant	AMCA6	*Amorpha canescens*	53–158	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	53–158	–
	willow	SALIX	*Salix*	53–105	–
	white meadowsweet	SPAL2	*Spiraea alba*	53–105	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	53–105	–
	rose	ROSA5	*Rosa*	0–53	–

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. Controlling Kentucky bluegrass with herbicide and burning is influenced by invasion level. Invasive Plant Science and Management 10: 80-89.

Ewing, J. 1924. Plant Succession on the Brush Prairie in Northwestern Minnesota. Journal of Ecology 12:228-266.

Grant, T.A. and R.K. Murphy. 2005. Changes on woodland cover on prairie refuges in North Dakota, USA. Natural Areas Journal 25:359-368.

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 – the prairie parkland and tallgrass aspen parklands provinces. 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.

Shunk, R.A. 1917. Plant associations of Shenkford and Owego Townships, Ransom County, North Dakota. M.S. thesis. University of North Dakota.

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.

Swingen, M., R, M. Walker, R. Baker, G. Nordquist, T. Catton, K. Kirschbaum, B. Dirks, and N. Dietz. 2018. Northern Long-eared Bat Roost Tree Characteristics 2015-2017. Natural Research Institute, University of Minnesota Duluth, Technical Report NRRI/TR-2018/41, 88p.

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.

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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	11/21/2024

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:

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

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

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

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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:**
