USDA Natural Resources Conservation Service

Ecological site R058CY095ND
Limy Sands

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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.

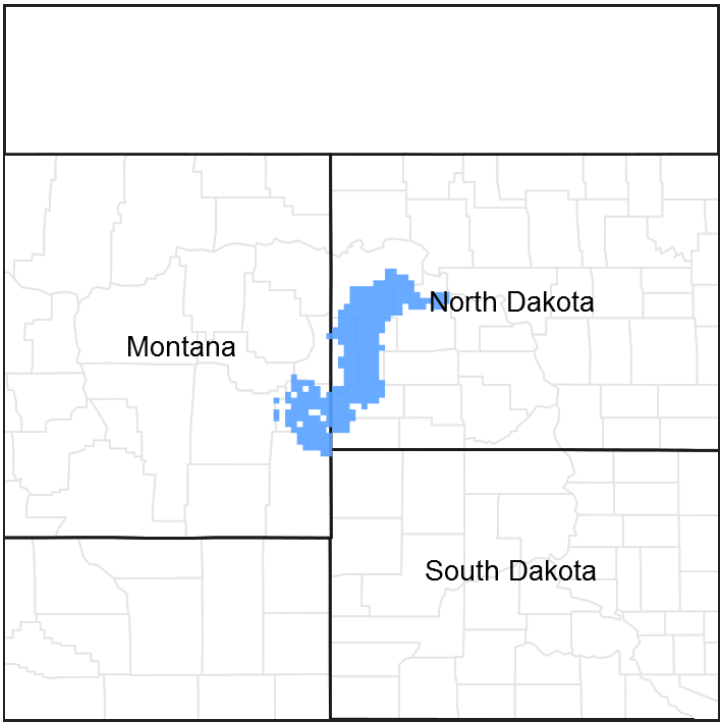

Figure 1. Mapped extent

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

MLRA notes

Major Land Resource Area (MLRA): 058C–Northern Rolling High Plains, Northeastern Part

MLRA 58C covers 2,320 square miles and encompasses approximately 1.8 million acres.

MLRA 58C spans two states, with 96 percent located in North Dakota and the remaining 4 percent is in Montana. The MLRA 58C landscape is characterized by steeply sloping dissected badlands along the Little Missouri River and its tributaries. Primary land uses are of rangeland for grazing and wildlife habitat. Microclimates inherent in badlands landscapes influence both variety and abundance of vegetation in MLRA 58C. South- and west- facing exposures are dry, hot, and sparsely vegetated. More humid and cooler north- and east-facing exposures are favorable for abundant forage and woody vegetation.

MLRA 58C is known as the Little Missouri Badlands, which formed when the Little Missouri River was diverted along a shorter, steeper course by Pleistocene glaciers. Due to the resulting increased gradient after its eastward diversion by the glaciers, the Little Missouri River began rapidly downcutting into the soft, calcareous sedimentary shale, siltstone, and sandstone of the Fort Union and Hell Creek geological formations. This rapid downcutting eroded and carved the badlands of the MLRA. This cycle of erosion and deposition continues today.

Most of the soils in MLRA 58C developed from residuum weathered in place. As a result of constant erosion and deposition, the majority of soils in MLRA 58C are Entisols and Inceptisols. Mollisols formed on the high, stable drainageway divides and plateaus above the steeper, dissected hillslopes and fans that define the Little Missouri Badlands. Elevation ranges from 1,835 feet (560 meters) to 3,400 feet (1,036 meters). The Little Missouri River flows through the entire length of MLRA 58C and empties into Lake Sakakawea that was formed by the Garrison Dam on the Missouri River.

Classification relationships

Level IV Ecoregions of Conterminous United States: 43b-Little Missouri Badlands.

Ecological site concept

The Limy Sands ecological site is formed in sandy materials weathered from calcareous soft sandstone. These sites are located on sedimentary uplands. Slopes range from 3 to 40 percent. The Limy Sands site has a soil surface layer that ranges from 2 to 12 inches thick. This site has a loamy fine sand soil texture above the weathered sandstone. Depth to calcium carbonates is 0 to 12 inches. Depth to sandstone (affects root growth), is 20 to 40 inches. On the landscape, the Shallow Sandy ecological site is higher; the Sands, Sandy, and Steep-Sided Wooded Draw sites are lower. The Choppy Sands site is on nearby dune areas.

To see a full copy of the ecological site description with all tables and the full version 5 rangeland health worksheet, please use the following hyperlink: https://efotg.sc.egov.usda.gov/references/public/ND/58C_Limy_Sands_Narrative_FINAL_Ref_FSG.pdf

Associated sites

R058CY077ND	**Sandy** These are coarse loamy, somewhat excessively to well drained soils down-slope from Limy Sands sites. The Sandy ecological sites have less sand and carbonates occur lower in the soil profile than the Limy Sands site. The soils will form a weak ribbon less than 1 inch long. The Sandy site has more production than the Limy Sands ecological site.
R058CY082ND	**Choppy Sands** This ecological site occurs on dunes associated with hillslopes and may have blown-out areas associated with this site. The soils typically have a thin surface layer (<5 inches thick) and carbonates may be present lower in the soil profile (>36 inches). The soils on this site are excessively drained. The soil will not form a ribbon, but it may form a ball when squeezed.
R058CY088ND	**Shallow Sandy** This ecological site is on hillslopes; it is up-slope from the Limy Sands ecological site. The soils have coarse or moderately coarse or coarse textures 10 to 20 inches thick over soft sandstone (affects root growth). They are somewhat excessively drained. If the soil forms a ribbon, it is less than 1 inch long. The Shallow Sandy ecological site has less production than the Limy Sands ecological site.
R058CY101ND	**Steep-Sided Wooded Draw** This site occurs on sideslopes of ridges; it is lower on the landscape than the Limy Sands site. The aspect is typically north or east. The woodland canopy has influenced the understory plant community.
R058CY076ND	**Sands** This ecological site is on backslopes and footslopes lower on the landscape than the Limy Sands site. The soils are >40 inches to sandstone. If carbonates are present in the soil profile, effervescence is very slight or slight to a depth greater than 12 inches. The soil will not form a ribbon, but it may form a ball when squeezed. The Sands site has more production than the Limy Sands ecological site.

Similar sites

R058CY076ND	**Sands** The Sands ecological site is on backslopes and footslopes lower on the landscape. The soils are >40 inches to sandstone. If carbonates are present in the soil profile, effervescence is very slight or slight to a depth greater than 12 inches. The soil will not form a ribbon, but it may form a ball when squeezed. The Sands site has more production than the Limy Sands ecological site.

R058CY088ND	**Shallow Sandy** The Shallow Sandy ecological site is on hillslopes; it is up-slope from the Limy Sands ecological site. The soils have coarse or moderately coarse or coarse textures 10 to 20 inches thick over soft sandstone (affects root growth). They are somewhat excessively drained. If the soil forms a ribbon, it is less than 1 inch long. The Shallow Sandy ecological site has less production than the Limy Sands ecological site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Physiographic features

The Limy Sands sites are located on gently sloping to very steep sedimentary uplands. Slope ranges from 3 to 40 percent.

Table 2. Representative physiographic features

Landforms	(1) Hillslope
Runoff class	Very low to medium
Flooding frequency	None
Ponding frequency	None
Elevation	1,835–3,400 ft
Slope	3–40%
Ponding depth	0 in
Water table depth	80 in
Aspect	Aspect is not a significant factor

Climatic features

MLRA 58C is considered to have a continental climate with cold winters and hot summers, low humidity, light rainfall, and much sunshine. Extremes in temperature are common and characteristic of the MLRA. The continental climate is the result of the location of this MLRA in the geographic center of North America. There are few natural barriers on the northern Great Plains, so air masses move unobstructed across the plains and account for rapid changes in temperature.

Annual precipitation ranges from 14 to 17 inches per year. The normal average annual temperature is about 41° F. January is the coldest month with an average temperature of

about 17° F. July is the warmest month with an average temperature of about 70° F. The range of normal average monthly temperatures between the coldest and warmest months is 53° F. This large temperature range attests to the continental nature of the MLRA 58C climate. Wind speeds average about 11 miles per hour, ranging from about 13 miles per hour during the spring to about 10 miles per hour during the summer. Daytime wind speeds are generally stronger than nighttime wind speeds, and occasional strong storms may bring brief periods of high winds with gusts to more than 50 miles per hour.

Growth of native cool-season plants begins in late March and continues to early to mid-July. Native warm- season plants begin growth in mid-May and continue to the end of August. Greening up of cool-season plants can occur in September and October when adequate soil moisture is present.

Table 3. Representative climatic features

Frost-free period (characteristic range)	91-100 days
Freeze-free period (characteristic range)	119-123 days
Precipitation total (characteristic range)	15-16 in
Frost-free period (actual range)	84-102 days
Freeze-free period (actual range)	116-123 days
Precipitation total (actual range)	14-16 in
Frost-free period (average)	95 days
Freeze-free period (average)	121 days
Precipitation total (average)	15 in

Climate stations used

- (1) TROTTERS 3 SSE [USC00328812], Beach, ND
- (2) WATFORD CITY 14S [USC00329246], Grassy Butte, ND
- (3) MEDORA 7 E [USW00094080], Fairfield, ND
- (4) AMIDON [USC00320209], Amidon, ND
- (5) CARLYLE 13 NW [USC00241518], Wibaux, MT

Influencing water features

No significant water features influence this site. It is on a runoff landscape position. A seasonal water table is deeper than 6 feet throughout the growing season. Surface infiltration is moderately rapid to rapid. Permeability above the sandstone is rapid. Water loss is through evapotranspiration and percolation below the root zone.

Soil features

Soils associated with Limy Sands ES are in the Entisol order; they are classified further as Aridic Ustipsamments. These soils were developed under prairie vegetation. They formed in sandy residuum weathered from the calcareous sandstone. Depth to soft, sedimentary sandstone is 20 to 40 inches; the sandstone affects root growth. The soils are somewhat excessively drained. Slope ranges from 3 to 40 percent. Soil texture throughout the profile is loamy fine sand. Typically, the surface layer is less than 3 inches thick, but ranges to 12 inches thick. Calcium carbonates are within a depth of 12 inches.

Soil reaction typically is neutral to moderately alkaline (pH 6.6 to 8.4) in the surface layer; however, in some soils it is slightly acid (pH 6.1 to 6.5). The substratum is slightly alkaline to moderately alkaline (pH 7.4 to 8.4). Calcium carbonate content, typically, is low (<5%) in surface layer; but increases to 5 to 15 percent immediately below the surface layer. Soil salinity is none or very low (<2 dS/m).

The soils have a rapid infiltration rate. The soil surface is potentially unstable therefore slumping, erosion, and deposition can occur on this site. Cryptobiotic crusts are present. These soils are susceptible to wind and water erosion. The hazard of water erosion increases on slopes greater than about 6 percent. Loss of the soil surface layer can result in a shift in species composition and/or production.

The major soil series which characterizes the Limy Sands ecological site is Tusler.

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) Residuum–calcareous sandstone
Surface texture	(1) Loamy fine sand (2) Fine sand (3) Loamy sand
Family particle size	(1) Sandy
Drainage class	Somewhat excessively drained
Permeability class	Rapid
Depth to restrictive layer	20–40 in
Surface fragment cover <=3"	0–8%
Surface fragment cover >3"	0–1%
Available water capacity (0-40in)	1–3 in
Calcium carbonate equivalent (0-40in)	1–15%

Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0–5
Soil reaction (1:1 water) (0-40in)	6.1–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–9%
Subsurface fragment volume >3" (Depth not specified)	0–2%

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, combined with weather variables, impact the ecological processes which influence the competitive interactions, thereby maintaining or altering plant community structure.

Prior to European influence, the historical disturbance regime for MLRA 58C 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, pronghorn, mule deer, 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.

A Note on Prairie Dogs: Prairie dogs prefer habitats composed predominantly of shortgrasses and avoid those dominated by tallgrasses. Historically prairie dogs likely occupied a wide range of soils (at least occasionally) due to variations in environmental factors such as drought severity and length, grazing, etc. Presently, the known occupation of this ecological site in this MLRA by prairie dogs is uncommon to rare. As a result, the

presence of prairie dog towns for this ecological site in this MLRA is not included in this ecological description. However, prairie dog towns may be encountered on the site. If encountered, impact would include increased bare ground and decreased production and plant vigor.

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.

Five vegetative states have been identified for the site (Reference, Native/Invaded, Invaded, Go-Back, and Conifer Invaded). 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; they have been determined by study of historical documents, relict areas, scientific studies, and ecological aspects of plant species and plant communities. Transitional pathways and thresholds have been determined through similar methods.

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

Currently, the primary disturbances include 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, 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; it often resulted from colonization by exotic cool-season grasses (such as Kentucky bluegrass, smooth brome, Canada bluegrass, crested wheatgrass, and/or annual bromes) which have been particularly and consistently invasive under extended periods of no use and no fire. Other exotics, such as Canada thistle and leafy spurge, are also known to invade the site.

Three community phases have been identified for this state and are similar to the 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 combined 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 techniques (e.g., prescribed grazing, prescribed burning) be carefully constructed, monitored, and evaluated with respect to that objective. If management does not include measures to control or reduce these exotic plants, the transition to State 3: Invaded State should be expected (T2A). This state may also transition to State 5: Invaded Conifer State during extended periods of no fire (T2B). Managers need to understand when the plant community is at or near these parameters; all data available needs to be evaluated to determine needed management actions.

State 3: Invaded State. The threshold for this state is reached when both the exotic cool-season grasses (e.g., Kentucky bluegrass, smooth brome, Canada bluegrass, crested wheatgrass, annual bromes) exceed 30% of the plant community and native grasses represent less than 40% of the community. Managers need to understand when the plant community is at or near these parameters; all data available needs to be evaluated to determine needed management actions. 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 which alters 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 (R3A). This state may also transition to State 5: Invaded Conifer State during extended periods of no fire (T3A).

State 4: Go-Back State. This 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, crested wheatgrass, Canada bluegrass, and/or annual bromes) will likely predominate.

Initially, due to extensive bare ground and a preponderance of shallow-rooted annual plants, the potential for soil erosion is high. Plant species richness may be high, but overall diversity (i.e., equitability) is typically low, with the site dominated by a relatively small assemblage of species. Due to the lack of native perennials and other factors, restoring the site with the associated ecological processes is difficult. However, a successful range planting may result in something approaching State 2: Native/Invaded State (R4A). Following 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 (R4B).

State 5: Invaded Conifer State. This state historically existed as small patches of fire-tolerant trees and shrubs when precipitation, fire frequency, and other factors enabled woody species to colonize or encroach on the site. This often resulted in a mosaic of small, scattered patches of woody vegetation interspersed within the grass dominated vegetation.

A marked decrease in fire frequency and increased fire suppression since European influence has enabled this state to expand and become more widespread. This is particularly important to the fire-intolerant juniper species' ability to expand and exploit and dominate grasslands. Where a conifer seed source is available, woody encroachment processes begin to dominate as fire intervals increase or fire is eliminated from the site. As depicted in the following diagram, conifer seeds disperse into an intact grassland State 1.0 or 2.0, beginning the process of woody encroachment. Extended fire intervals allow conifer to establish allowing for a transition to a Invaded Conifer State.

This conifer invaded community phase often results from extended periods of no fire (T2B, T3A). Brush control (e.g., prescribed burning, and/or chemical/mechanical brush management) may lead to State 2: Native/Invaded State (R5A) or perhaps State 3: Invaded State (R5B).

The following state and transition model diagram illustrates the common states, community phases, community pathways, and 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 and 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

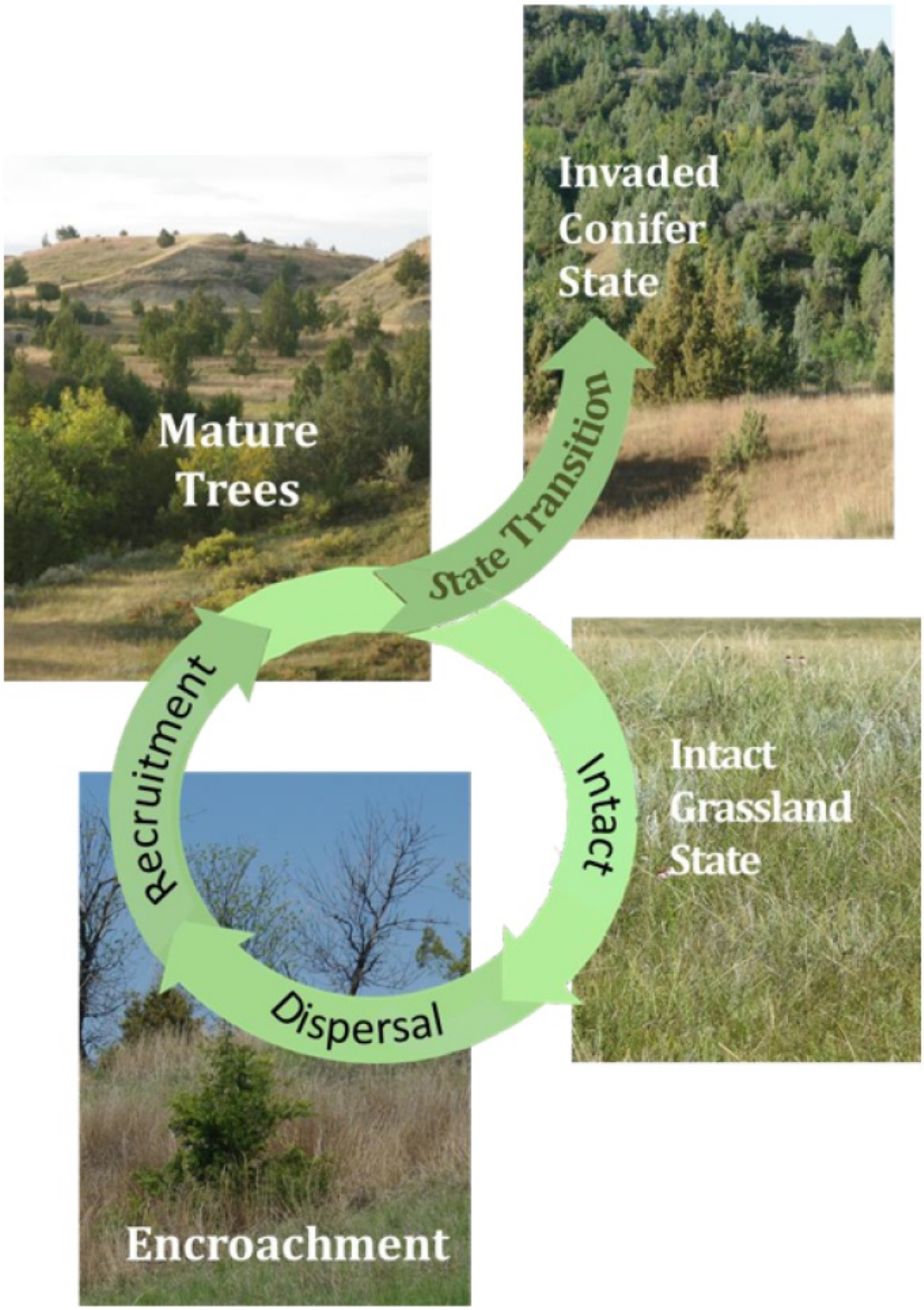

Figure 8. Stages of Woody Encroachment - Adapted from: Reducing Woody Encroachment in Grasslands – A Guide for Understanding Risk and Vulnerability; Oklahoma Cooperative Extension Service

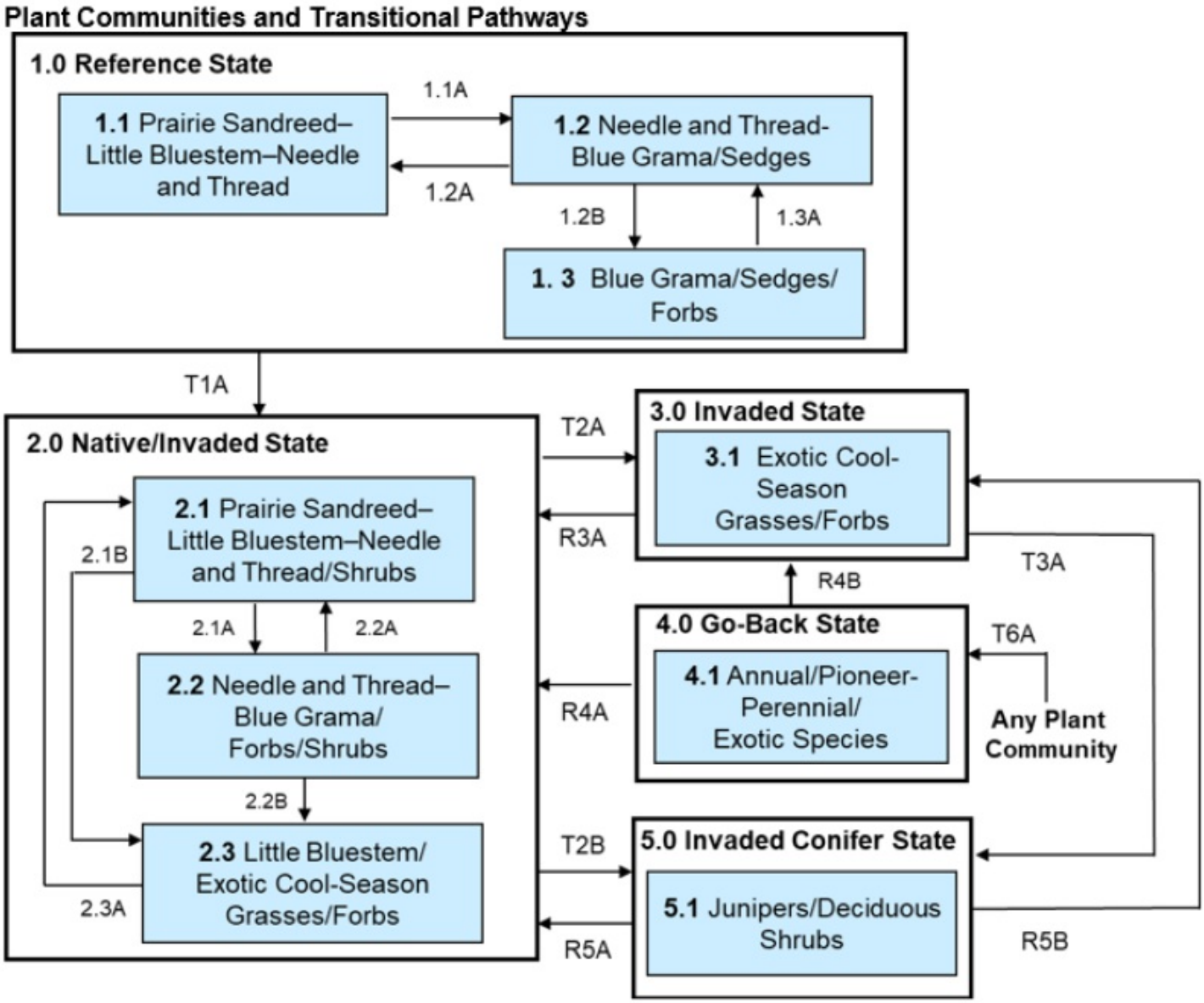

Figure 9. Limy Sands State and Transition Model

Diagram Legend - MLRA 58C Limy Sands	
T1A	Introduction of exotic cool-season grasses
T2A	Extended periods of non-use or very light grazing, no fire
T2B	Extended periods of no fire
T3A	Extended periods of no fire
T6A	Cessation of annual cropping
R3A	Prescribed burning coupled with prescribed grazing
R4A	Successful range planting with prescribed grazing and prescribed burning
R4B	Failed range planting and/or secondary succession
R5A	Prescribed burning and/or chemical/mechanical brush management
R5B	Prescribed burning and/or chemical/mechanical brush management
CP 1.1 - 1.2 (1.1A)	Long-term drought with/without heavy, long-term grazing
CP 1.2 - 1.1 (1.2A)	Return to average growing conditions and reduced grazing
CP 1.2 - 1.3 (1.2B)	Long term heavy continuous grazing, with drought
CP 1.3 - 1.2 (1.3A)	Return to average growing conditions and reduced grazing
CP 2.1 - 2.2 (2.1A)	Heavy season-long grazing with or without drought
CP 2.1 - 2.3 (2.1B)	Extended periods of non-use or very light grazing, no fire
CP 2.2 - 2.1 (2.2A)	Prescribed grazing and prescribed burning, return to average precipitation
CP 2.2 - 2.3 (2.2B)	Extended periods of non-use or very light grazing, no fire
CP 2.3 - 2.1 (2.3A)	Prescribed grazing and prescribed burning, return to average precipitation

Figure 10. State and Transition Model Legend

State 1
Reference State

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, combined with weather events, dictated the dynamics that occurred within the natural range of variability. These factors likely caused the community to shift both spatially and temporally between three community phases.

Characteristics and indicators. 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. 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 condition is contingent upon a monitoring protocol to guide management.

Community 1.1
Prairie Sandreed-Little Bluestem-Needle and Thread (Calamovilfa longifolia-Schizachyrium scoparium-Hesperostipa comata)

Figure 11. Community Phase 1.1: Prairie Sandreed-Little Bluestem-Needle and Thread. Note sand bluestem in foreground.

Figure 12. Community Phase 1.1: Prairie Sandreed-Little Bluestem-Needle and Thread, with cryptobiotic crust in plant interspaces.

This community phase was historically the most dominant both temporally and spatially. Warm-season grasses dominated this plant community with cool-season grasses and sedges being subdominant. The major grasses and sedges included big bluestem, little bluestem, prairie sandreed, and sideoats grama with associates of needle and thread, porcupinegrass, prairie Junegrass, and upland sedges. Common forbs and shrubs included tarragon, blacksamson echinacea, blazing star, purple locoweed, scurfpea, prairie sagewort, skunkbush sumac, silver sagebrush, and shrubby cinquefoil. Annual production likely varied from about 1100-2500 pounds per acre with grasses and grass-likes, forbs, and shrubs contributing about 85%, 10% and 5%, respectively. Both warm-season grasses and cool-season grasses are well represented in the community; as a result, production is 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 (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	980	1602	2220
Forb	85	135	185
Shrub/Vine	35	63	95
Total	**1100**	**1800**	**2500**

Community 1.2
Needle and Thread-Blue Grama/ Sedges (Hesperostipa comata-Bouteloua gracilis/ Carex spp.)

Community Phase 1.2 occurred during periods of long-term drought with/without heavy, long-term grazing. Compared to Community Phase 1.1, this community would have resulted in increasse in the more drought and grazing tolerant graminoids, such as blue grama and upland sedges (e.g., threadleaf sedge, sun sedge), with corresponding decreases in the less drought and grazing tolerant grasses (such as prairie sandreed, little bluestem, and porcupinegrass). Forbs and shrubs (such as white heath aster, silverleaf Indian breadroot, prairie sagewort, silver sagebrush, and pricklypear) would have increased. Annual production would have declined compared to that of Community Phase 1.1.

Community 1.3
Blue Grama/ Sedges/ Forbs (Bouteloua gracilis/ Carex spp./ Forbs)

Community Phase 1.3 occurred during periods of long-term heavy continuous grazing with drought. It would have been similar to Community Phase 1.2 with further increases in the more drought and grazing tolerant graminoids, such as blue grama and upland sedges. Forbs and shrubs (such as tarragon, prairie sagewort, white heath aster, and scarlet globemallow) would have been conspicuously abundant.

Pathway 1.1A
Community 1.1 to 1.2

Community Phase Pathway 1.1 to 1.2 occurred during periods of long-term drought with/without heavy, long- term grazing. This resulted in a marked increase of the drought and grazing tolerant graminoids (e.g., blue grama, upland sedges) with a corresponding decrease of the less drought and grazing tolerant graminoids (e.g., prairie sandreed, little bluestem).

Pathway 1.2A
Community 1.2 to 1.1

Community Phase Pathway 1.2 to 1.1 would have occurred with return to average growing conditions and reduced grazing. This would have resulted in increases in prairie sandreed and little bluestem with corresponding decreases in blue grama and sedges.

Pathway 1.2B
Community 1.2 to 1.3

Community Phase Pathway 1.2 to 1.3 occurred during periods of long-term heavy continuous grazing with drought. This would have resulted in further increases in blue grama, upland sedges, and forbs with corresponding decreases in the more drought and grazing intolerant grasses (e.g., prairie sandreed, porcupinegrass).

Pathway 1.3A
Community 1.3 to 1.2

Community Phase Pathway 1.3 to 1.2 occurred with the return to average growing conditions and reduced grazing, leading to an increase in the less drought and grazing intolerant grasses (e.g., prairie sandreed, porcupinegrass), with a corresponding decrease in blue grama, upland sedges, and forbs.

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, crested wheatgrass, Canada bluegrass, and/or annual bromes) 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 techniques (e.g., prescribed grazing, prescribed burning) be carefully constructed, monitored, and evaluated with respect to that objective. If management does not include measures to control or reduce these exotic cool-season grasses, the transition to State 3: Invaded State should be expected. Annual production of this state can be quite variable, in large part due to the amount of exotic cool-season grasses.

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 techniques (e.g., prescribed grazing, prescribed burning) be carefully constructed, monitored, 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 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.

Community 2.1
Prairie Sandreed-Little Bluestem-Needle and Thread/ Shrubs (Calamovilfa longifolia-Schizachyrium scoparium-Hesperostipa comata/ Shrubs)

This Community Phase is similar to Community Phase 1.1 but has been colonized by exotic cool-season grasses (often Kentucky bluegrass, smooth brome, crested wheatgrass, Canada bluegrass, and/or annual bromes). However, these exotics are present in smaller amounts with the community still dominated by native grasses. Common shrubs often include leadplant, silver buffaloberry, silver sagebrush, and rose. Annual production may be comparable to that of Community Phase 1.1 (1100-2500 pounds per acre). However, as the exotic cool-season grasses increase, peak production will shift to earlier in the growing season.

Community 2.2
Needle and Thread-Blue Grama/ Forbs/ Shrubs (Hesperostipa comata-Bouteloua gracilis/ Forbs/ Shrubs)

Figure 14. Community Phase 2.2: Needle and Thread-Blue Grama/Sedges/Forbs/Shrubs. Note the scattered silver sagebrush.

This Community Phase occurs with heavy continuous grazing with or without drought. It is similar to Community Phase 1.2 but has now been colonized by exotic cool-season grasses (often Kentucky bluegrass, smooth brome, crested wheatgrass, Canada bluegrass, and/or annual bromes). These exotics, however, are present in smaller amounts with the community still dominated by native grasses. Goldenrod, white heath aster, and scurfpea are often among the more common forbs. Prairie sagewort, skunkbush sumac, silver sagebrush, and shrubby cinquefoil are among the more common shrubs. This community phase is often dispersed throughout a pasture in an overgrazed/undergrazed pattern, typically referred to as patch grazing. Some overgrazed areas will exhibit the impacts of heavy use, while the ungrazed areas will have a build-up of litter and increased plant decadence. This is a typical pattern found in properly stocked pastures grazed season-long. As a result, Kentucky bluegrass tends to increase more in the undergrazed areas while the more grazing tolerant, short statured species (such as blue grama and sedges) increase in the heavily grazed areas. If present, Kentucky bluegrass may increase under heavy grazing.

Community 2.3
Little Bluestem/ Exotic Cool-Season Grasses/ Forbs (Schizachyrium scoparium/ Exotic Cool-Season Grasses/ Forbs)

Increasing amounts of exotic cool-season grasses, particularly Kentucky bluegrass, can make this an “at risk” community, even though its presence may not be obvious. If management does not include measures to control or reduce Kentucky bluegrass, the transition to State 3: Invaded State should be expected.

Pathway 2.1A
Community 2.1 to 2.2

Community Phase Pathway 2.1 to 2.2 occurs with heavy continuous grazing with or without drought. This results in marked increases of the drought and grazing tolerant graminoids (e.g., blue grama, upland sedges) with corresponding decreases of the less drought and grazing tolerant graminoids (e.g., prairie sandreed, little bluestem).

Pathway 2.1B
Community 2.1 to 2.3

Community Phase Pathway 2.1 to 2.3 occurs with extended periods of non-use or very light grazing, and no fire, which results in a marked increase in exotic cool-season grasses and corresponding decreases in prairie sandreed and needle and thread.

Pathway 2.2A
Community 2.2 to 2.1

Community Phase Pathway 2.2 to 2.1 occurs with the implementation of prescribed grazing, prescribed burning, and return to average precipitation. This results in increases in the more grazing intolerant grasses, such as prairie sandreed and little bluestem, with corresponding decreases in blue grama and sedges.

Pathway 2.2B
Community 2.2 to 2.3

Community Phase Pathway 2.2 to 2.3 occurs with extended periods of no use or very light grazing, and no fire, which results in increases in little bluestem, exotic cool-season grasses, and forbs.

Pathway 2.3A
Community 2.3 to 2.1

Community Phase Pathway 2.3 to 2.1 occurs with the implementation of prescribed grazing and prescribed burning and return to average precipitation. This results in a decrease in the exotic cool-season grasses and increases in the native grasses, including prairie sandreed and needle and thread.

State 3
Invaded State

This state is the result of invasion and dominance by the exotic cool-season grasses (commonly Kentucky bluegrass, smooth brome, crested wheatgrass, Canada bluegrass, and/or annual bromes). Exotic forbs (e.g., 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 show marked increases. Once the state is well established, prescribed burning and grazing techniques have been largely ineffective in suppressing or eliminating these 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.

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.

Community 3.1
Exotic Cool-Season Grasses/Forbs

This community phase is dominated by exotic cool-season grasses (such as Kentucky bluegrass, smooth brome, crested wheatgrass, Canada bluegrass, and/or annual bromes), often with a conspicuous forb component. Excessive accumulation of mulch may also be present, particularly when dominated by Kentucky bluegrass. Common forbs often include silverleaf Indian breadroot, white heath aster, hairy false goldenaster, and goldenrod. The exotic forb leafy spurge may also invade the site. Annual production of this state can be quite variable, in part due to the amount of exotic cool-season grasses. The longer this community phase exists, the more resilient it becomes. Natural or management disturbances that reduce the cover of Kentucky bluegrass or smooth brome are typically short-lived.

State 4
Go-Back State

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

Characteristics and indicators. Tillage has destroyed the native plant community, altered soil structure and biology, reduced soil organic matter, and resulted in the formation of a tillage induced compacted layer which is restrictive to root growth. Removal of perennial grasses and forbs results in decreased infiltration and increased runoff.

Resilience management. Continued tillage will maintain the state. Control of noxious weeds will be required.

Community 4.1
Annual/Pioneer Perennial/Exotic Species

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

State 5
Invaded Conifer State

This state historically existed as small patches of fire-tolerant trees and shrubs when precipitation, fire frequency, and other factors enabled woody species to colonize or encroach on the site. It often resulted in a mosaic of small, scattered patches of woody vegetation interspersed within the grass dominated vegetation. A marked decrease in fire frequency and increased fire suppression since European influence has enabled this state to expand and become more widespread. This is particularly important to the fire-intolerant juniper species' ability to expand and exploit and dominate grasslands. Where a conifer seed source is in close proximity, encroachment processes begin to dominate as fire intervals increase or fire is eliminated from the site. One community phase has been identified and often results from extended periods of no fire (T2B, T3A). Brush control (e.g., prescribed burning, and/or chemical/mechanical brush management) may lead to State 2: Native/Invaded State (R5A) or perhaps State 3: Invaded State (R5B).

Characteristics and indicators. The dominance of woody species (by cover and production) distinguishes this state from other herbaceously dominated states.

Resilience management. This state is resistant to change in the long-term absence of fire. Restoration efforts would require the use of prescribed fire, mechanical treatment, and prescribed grazing. Considerable time and effort will be required to restore to other States.

Community 5.1
Junipers-Deciduous Shrubs (Juniperus spp.-Deciduous Shrubs)

This community phase results from extended periods of no fire and typically consists of stands of juniper (e.g., common juniper, Rocky Mountain juniper, and creeping juniper) with associates deciduous shrubs. A variety of shrubs may be present including silver buffaloberry, silver sagebrush, and skunkbush sumac. Associated grasses can be quite variable depending on variations in shading and other factors, but often includes exotic cool-season grasses (e.g., crested wheatgrass, Kentucky bluegrass, Canada bluegrass, and/or annual bromes) and few forbs.

State 6
Any Plant Community

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 (such as Kentucky bluegrass, smooth brome, crested wheatgrass, Canada bluegrass, and/or annual bromes). This transition was probably inevitable and corresponded to a decline in native warm-season and cool-season grasses; it 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 brome, crested wheatgrass, Canada bluegrass, annual bromes, or other exotic cool-season grasses became established on the site.

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

Transition T2A
State 2 to 3

This transition from the State 2: Native/Invaded State to State 3: Invaded State generally occurs during extended periods of no use or very light grazing, and no fire. Exotic cool-season grasses (such as Kentucky bluegrass, smooth brome, crested wheatgrass, Canada bluegrass, and/or annual bromes) became the dominant graminoids. Studies indicate that a threshold may exist in this transition when both 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. This transition may occur under a wide range of managerial conditions ranging from non-use and no fire to heavy season-long grazing (primarily Kentucky bluegrass).

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

Transition T2B
State 2 to 5

This transition from State 2: Native/Invaded State to State 5: Invaded Conifer State occurs over extended periods with no fire. A marked decrease in fire frequency and increased fire suppression since European influence has been particularly important to the fire-intolerant juniper species ability to expand and exploit and dominate grasslands.

Constraints to recovery. The extended fire interval may make recovery doubtful due to the abundance of exotic cool-season grasses and lack of native grasses. Fire intensity along with consumption of available fuels may cause incomplete or patchy burns. Ladder fuel and/or fuel loading are required for successfully controlling ponderosa pine (crown vs. ground fire). Continued recruitment of seeds (juniper and pine) from adjacent sites will hamper site restoration. Constraints to recovery include reticence to undertake tree removal and the perception that trees may be a desirable vegetation component for wildlife habitat, carbon sequestration, aesthetics, etc. Management of the site for mule deer, big horn sheep, livestock, or grassland nesting birds will need to consider the intensive management required to restore and maintain the site in State 2. The disturbance regime necessary to restore this site to State 2: Native/Invaded State is very labor intensive and costly; therefore, addressing woody removal earlier in the encroachment phase is the most cost-effective treatment for woody control.

Restoration pathway R3A
State 3 to 2

This restoration pathway from State 3: 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 3.1. That remnant population, however, may not be readily apparent without close inspection. The application of several prescribed burns may be needed at relatively short intervals in the early phases of this restoration process, in part because many of the shrubs (e.g., western snowberry) sprout profusely following one burn. Early season prescribed burns have been successful; however, fall burning may also be an effective technique. 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).

Transition T3A
State 3 to 5

This transition from State 3: Invaded State to State 5: Invaded Conifer State occurs over extended periods with no fire. A marked decrease in fire frequency and increased fire suppression since European influence has been particularly important to the fire-intolerant juniper species’ ability to expand and exploit and dominate grasslands.

Constraints to recovery. The extended fire interval may make recovery doubtful due to the abundance of exotic cool-season grasses and lack of native grasses. Fire intensity along with consumption of available fuels may cause incomplete or patchy burns. Ladder fuel and/or fuel loading are required for successfully controlling ponderosa pine (crown vs. ground fire). Continued recruitment of seeds (juniper and pine) from adjacent sites will hamper site restoration. Constraints to recovery include reticence to undertake tree removal and the perception that trees may be a desirable vegetation component for wildlife habitat, carbon sequestration, aesthetics, etc. Management of the site for mule deer, big horn sheep, livestock, or grassland nesting birds will need to consider the intensive management required to restore and maintain the site in State 2. The disturbance regime necessary to restore this site to State 2: Native/Invaded State is very labor intensive and costly; therefore, addressing woody removal earlier in the encroachment phase is the most cost-effective treatment for woody control.

Restoration pathway R4A
State 4 to 2

This Restoration Pathway from State 4: 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. A successful range planting will include proper seedbed preparation, weed control (both prior to and after the planting), selection of adapted native species representing functional/structural groups inherent to the State 1, and proper seeding technique. Management (e.g., prescribed grazing, prescribed burning) during and after establishment must be applied in a manner that maintains the competitive advantage for the seeded native species. Adding non-native species can impact the above and below ground biota. Elevated soil nitrogen levels have been shown to benefit smooth brome and Kentucky bluegrass more than some native grasses. As a result, fertilization, exotic legumes in the seeding mix, and other techniques that increase soil nitrogen may promote smooth brome and Kentucky bluegrass invasion. The method or methods of herbaceous weed treatment will be site specific to each situation; but generally, the goal would be to apply the pesticide, mechanical control, or biological control (either singularly or in combination) in a manner that shifts the competitive advantage from the targeted species to the native grasses and forbs. The control method(s) should be as specific to the targeted species as possible to minimize impacts to non-target species.

Restoration pathway R4B
State 4 to 3

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

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

Restoration pathway R5A
State 5 to 2

This from State 5: Invaded Conifer State to State 2: Native/Invaded State can be accomplished with prescribed burning and/or chemical/mechanical brush management. Following the removal of woody species, other restoration practices such as 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. This restoration is similar to that of R5B but differs in the resulting abundance of exotic cool-season species.

Context dependence. Fire intensity along with consumption of available fuels may cause incomplete or patchy burns. Ladder fuel and/or fuel loading are required for successfully controlling ponderosa pine (crown vs. ground fire). Continued recruitment of seeds (juniper and pine) from adjacent sites will hamper site restoration. Intensive management is required to restore and maintain the site in State 2.

Restoration pathway R5B
State 5 to 3

This restoration pathway from State 5: Invaded Conifer State to State 3: Invaded State can be accomplished with prescribed burning and/or chemical/mechanical brush management. Following the removal of woody species, other restoration practices, such as 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. This restoration is similar to that of R5A but differs in the resulting abundance of exotic cool-season species.

Context dependence. Fire intensity along with consumption of available fuels may cause incomplete or patchy burns. Ladder fuel and/or fuel loading are required for successfully controlling ponderosa pine (crown vs. ground fire). Continued recruitment of seeds (juniper and pine) from adjacent sites will hamper site restoration. Intensive management is required to restore and maintain the site in State 3.

Restoration pathway T6A
State 6 to 4

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

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					

Grass/Grasslike					
1	**Bluestem**			180–270	
	sand bluestem	ANHA	*Andropogon hallii*	180–270	–
	big bluestem	ANGE	*Andropogon gerardii*	0–18	–
2	**Sandreed and Bluestem**			270–450	
	prairie sandreed	CALO	*Calamovilfa longifolia*	90–360	–
	little bluestem	SCSC	*Schizachyrium scoparium*	90–360	–
3	**Needlegrass**			90–180	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	72–144	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	36–144	–
4	**Grama**			90–270	
	sideoats grama	BOCU	*Bouteloua curtipendula*	90–180	–
	blue grama	BOGR2	*Bouteloua gracilis*	90–144	–
5	**Other native grasses**			54–126	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–54	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	18–36	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	18–36	–
	plains muhly	MUCU3	*Muhlenbergia cuspidata*	18–36	–
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	18–36	–
	Grass, perennial	2GP	*Grass, perennial*	18–36	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	18–36	–
6	**Grass-likes**			126–216	
	threadleaf sedge	CAFI	*Carex filifolia*	108–180	–
	sun sedge	CAINH2	*Carex inops ssp. heliophila*	36–54	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–18	–
Forb					
7	**Forbs**			90–180	
	tarragon	ARDR4	*Artemisia dracunculus*	18–36	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	18–36	–
	hairy false goldenaster	HEVIV	*Heterotheca villosa var. villosa*	18–36	–

	blazing star	LIATR	*Liatris*	18–36	–
	purple locoweed	OXLA3	*Oxytropis lambertii*	18–36	–
	beardtongue	PENST	*Penstemon*	18–36	–
	scurfpea	PSORA2	*Psoralidium*	18–36	–
	eastern pasqueflower	PUPA5	*Pulsatilla patens*	18–36	–
	goldenrod	SOLID	*Solidago*	18–36	–
	white heath aster	SYER	*Symphyotrichum ericoides*	18–36	–
	silky prairie clover	DAVI	*Dalea villosa*	0–36	–
	rush skeletonplant	LYJU	*Lygodesmia juncea*	0–18	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–18	–
	longbract spiderwort	TRBR	*Tradescantia bracteata*	0–18	–
	pussytoes	ANTEN	*Antennaria*	0–18	–
	plains milkvetch	ASGI5	*Astragalus gilviflorus*	0–18	–
	wavyleaf thistle	CIUN	*Cirsium undulatum*	0–18	–
	sanddune wallflower	ERCAC	*Erysimum capitatum var. capitatum*	0–18	–
	buckwheat	ERIOG	*Eriogonum*	0–18	–
	old man's whiskers	GETR	*Geum triflorum*	0–18	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–18	–
	lacy tansyaster	MAPI	*Machaeranthera pinnatifida*	0–18	–
	large Indian breadroot	PEES	*Pediomelum esculentum*	0–18	–
	spiny phlox	PHHO	*Phlox hoodii*	0–18	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–18	–
	Forb, perennial	2FP	*Forb, perennial*	0–18	–
Shrub/Vine					
8	**Shrubs**			36–90	
	prairie sagewort	ARFR4	*Artemisia frigida*	18–36	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	0–36	–
	rose	ROSA5	*Rosa*	0–18	–
	leadplant	AMCA6	*Amorpha canescens*	0–18	–

	silver sagebrush	ARCA13	*Artemisia cana*	0–18	–
	shrubby cinquefoil	DAFRF	*Dasiphora fruticosa ssp. floribunda*	0–18	–
	creeping juniper	JUHO2	*Juniperus horizontalis*	0–18	–
	pricklypear	OPUNT	*Opuntia*	0–18	–
	western sandcherry	PRPUB	*Prunus pumila var. besseyi*	0–18	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–18	–
	soapweed yucca	YUGL	*Yucca glauca*	0–18	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–18	–

Animal community

Wildlife Interpretations

Landscape:

The MLRA 58C landscape is characterized by moderately dissected rolling plains with areas of local Badlands, buttes, and isolated hills. MLRA 58C is considered to have a continental climate with cold winters and hot summers, low humidity, light rainfall, and much sunshine. Extremes in temperature are common and characteristic of the MLRA. This area supports natural mixed-grass prairie vegetation with prairie rose, leadplant, and patches of western snowberry interspersed throughout the area. Green ash, chokecherry, and buffaloberry occur in draws and narrow valleys, creating woody riparian corridors. Complex/intermingled ecological sites create diverse grass- and shrubland habitats interspersed with varying densities linear, slope, depressional, and in-stream wetlands associated with headwater streams and tributaries to the Missouri River. These habitats provide critical life-cycle components for many wildlife species.

Historic Communities/Conditions within MLRA 58C:

The northern mixed-grass prairie was a disturbance-driven ecosystem with fire, herbivory, and climate functioning as the primary ecological drivers (either singly or often in combination). Many species of grassland birds, small mammals, insects, reptiles, amphibians, and large herds of Audubon bighorn sheep, roaming bison, elk, and pronghorn were historically among the inhabitants adapted to this semi-arid region. Bighorn sheep have been re-introduced. Roaming herbivores, as well as several small mammal and insect species, were the primary consumers linking the grassland resources to large predators (such as the wolf, mountain lion, and grizzly bear) and smaller carnivores (such as the coyote, bobcat, red fox, and raptors). The black-tailed prairie dog was once abundant and provided ecological services by manipulating the plant and soil community providing habitat for the black-footed ferret, burrowing owl, ferruginous hawk, mountain plover, swift fox, small mammals, and amphibians and reptiles. Extirpated

species include free-ranging American bison, Canada lynx, common raven, grizzly bear, gray wolf, black-footed ferret, mountain plover, and peregrine falcon (breeding). Extinct from the region is the Rocky Mountain locust.

Present Communities/Conditions within MLRA 58C:

Following European influence, domestic livestock grazing, elimination of fire, energy development, and other anthropogenic factors influenced plant community composition and abundance. Transportation corridors, energy development, and Rocky Mountain juniper and ponderosa pine encroachment are the main factors contributing to habitat fragmentation, reducing habitat quality for area-sensitive species. These influences fragmented the landscape, reduced or eliminated ecological drivers (fire), and introduced exotic plant species including smooth brome, crested wheatgrass, Kentucky bluegrass, and leafy spurge further impacting plant and animal communities. The loss of the bison, reduction of black-tailed prairie dogs, and fire, as primary ecological drivers, greatly influenced the character of the remaining native plant communities and the associated wildlife moving towards a less diverse and more homogeneous landscape, lacking diverse species composition and stature.

Extensive fragmentation by annual cropping has not occurred within the MLRA. Limited fragmentation from annual cropping or tame hay production has occurred within the Little Missouri River flood plain and the higher, flat plateaus. Fragmentation east and west of MLRA 58C has funneled many species into this area in search of expansive grasslands.

Some wildlife species in this area are: mule deer, white-tailed deer, elk, bighorn sheep, pronghorn, mountain lion, coyote, red fox, bobcat, prairie rattlesnake, American badger, raccoon, North American porcupine, beaver, striped skunk, American mink, white-tailed jackrabbit, black-tailed prairie dog, Eastern and Merriam’s wild turkey, golden eagle, ferruginous hawks, sharp-tailed grouse, greater sage-grouse, black-billed magpie, and numerous species of grassland-nesting birds and pollinating insects. The highest diversity of bats in North Dakota also occurs in this MLRA, where eleven species have been documented.

Presence of wildlife species is often determined by ecological site characteristics including grass and forb species, hydrology, aspect, and other associated ecological sites. Home ranges for most species are larger than one ecological site or are dependent on more than one ecological site for annual life requisites. Ecological sites offer different habitat elements as the annual life requisites change. Habitat improvement and creation must be conducted within the mobility limits of a known population for the species.

Insects play an important role providing ecological services for plant community development. Insects that are scavengers or aid in decomposition provide the food chain baseline sustaining the carnivorous insects feeding upon them. Many insects provide the ecological services necessary for pollination, keeping plant communities healthy and productive. Insects provide a protein food source for numerous species including

grassland nesting birds and their young.

Species unique to the MLRA:

Mountain Lions: Mountain lions were relatively common in the Badlands but disappeared from the state by the early 20th Century. Sightings resumed in the 1950's and have subsequently increased since that time. The species has recently taken up permanent residency within the region. Mountain lions occur in of the Little Missouri Badlands and woody habitat in MLRA 58C. Rugged terrain and forest provide excellent stalking cover to hunt large mammals and other prey. Mountain lions make use of caves for escape and loafing cover.

Bighorn sheep: Bighorn sheep make use of the rugged terrain, rocky outcrops, and high plateaus of MLRA 58C along the Little Missouri River. North Dakota bighorn sheep populations are almost exclusively within MLRA 58C. Bighorn sheep were once extirpated from North Dakota but were successfully reintroduced in the mid-twentieth century. They now occur in several distinct populations within MLRA 58C. Rocky Mountain juniper encroachment degrades the limited habitat for bighorn sheep. Managers should consider bighorn sheep association with domestic sheep, since transfer of pneumonia and other diseases is known to occur.

Golden eagle: The badlands within MLRA 58C are key areas for Golden eagle nesting. Adjacent grasslands, shrublands, and black-tailed prairie dog towns are used for hunting.

Bats: MLRA 58C provides life requisites for several bat species, in part due to presence of riparian forest, wooded draws, caves, and rocky outcrops. Hibernacula of six bat species have been found in MRLA 58C; however, additional work is needed to further understand utilization of hibernacula by bats during the winter months in North Dakota.

Short-horned lizard and sagebrush lizard: This MLRA provides preferred habitat for these two species. The short-horned lizard prefers semi-arid, shortgrass prairie in rough terrain, and is uncommon to locally abundant in MLRA 58C. The rare sagebrush lizard prefers sagebrush and rocky areas provided by this MLRA and adjacent MLRA 58D.

Greater sage-grouse and Brewer's sparrow: The extreme southwest extension of MLRA 58C have ecological sites capable of producing sufficient big sage canopy cover to provide greater sage-grouse life requisites. MLRA 58C and 58D are the only MLRAs in North Dakota that support Wyoming big sage brush (big sage) production. Research data indicates greater sage-grouse prefer big sagebrush canopy cover for nesting at ≥8% with an average height of around 16 inches. The species prefers winter cover canopy that averages 15% with an average height of around 8 inches. Soil site potential, management, climate, and other factors all play a role in the amount, if any, of big sagebrush on an ecological site. Changes in big sage canopy cover occur slowly (30-50 years) unless the site is impacted by fire or cultivation. Big sage recovery after a burn can take 30 to 100 years. Greater sage- grouse and Brewer's sparrow habitat and populations are reduced or

eliminated when big sagebrush canopy is reduced to less than 8% for greater sage-grouse and 10% cover for Brewer's sparrow. As conifer encroachment increases, greater sage-grouse lekking activity decreases. Once conifer encroachment exceeds 4% canopy cover, no leks remain.

Species of Concern within the MLRA:

Following is a list of species considered "species of conservation priority" in the North Dakota State Wildlife Action Plan (2015); "species of greatest conservation need" in the Montana State Wildlife Action Plan (2015); and species listed as "threatened, endangered, or petitioned" under the Endangered Species Act within MLRA 58C at the time this section was developed:

Invertebrates: Dakota skipper, monarch butterfly, regal fritillary, yellow-banded bumble bee, and western bumble bee.

Birds: American kestrel, Baird's sparrow, bald eagle, black-billed cuckoo, bobolink, Brewer's sparrow, burrowing owl, chestnut-collared longspur, common poorwill, eastern screech-owl ferruginous hawk, golden eagle, grasshopper sparrow, greater sage-grouse, lark bunting, loggerhead shrike, long-billed curlew, marbled godwit, McCown's longspur, mountain plover, northern harrier, northern pintail, peregrine falcon (migration), prairie falcon, red knot (migration), red-headed woodpecker, sharp-tailed grouse, short-eared owl, Sprague's pipit, Swainson's hawk, upland sandpiper, western meadowlark, Wilson's phalarope, whooping crane (migration), and willet.

Mammals: Big brown bat, black-footed ferret, black-tailed prairie dog, dwarf shrew, gray wolf, hispid pocket mouse, little brown bat, long-eared bat, long-legged bat, meadow jumping mouse, Merriam's shrew, northern long-eared bat, porcupine, sagebrush vole, swift fox, Townsend's big- eared bat, and western small-footed bat.

Amphibians and Reptiles: Common snapping turtle, Great Plains toad, greater short-horned lizard, milk snake, northern leopard frog, plains hognose snake, plains spadefoot, sagebrush lizard, smooth softshell, smooth green snake, and spiny softshell.

Fish and Mussels: Blue sucker, burbot, Flathead chub, northern redbelly dace, sickle-fin chub, pearl dace, shortnose gar, sturgeon chub, and sauger.

Grassland Management for Wildlife in the MLRA

Management activities within the community phase pathways impact wildlife. Community phase, transitional, and restoration pathways are keys to long-term management within each State and between States. Significant inputs must occur to cross the threshold between States (e.g., State 3.0 to 2.0) requiring substantial economic inputs and management (mechanical, reseeding, prescribed fire, woody vegetation removal, grazing intensity, etc.). Timing, intensity, and frequency of these inputs can have dramatic positive

or negative effects on local wildlife species. Ranchers and other land managers must always consider the long-term beneficial effects of management on the habitat in comparison to potential short-term negative effects to individuals.

Ecological sites occur as intermingled complexes on the landscape with gradual or sometimes abrupt transitions. Rarely do ecological sites exist in large enough acreage to manage independently. Ecological sites, supporting a dominance of herbaceous vegetation (Loamy/Limy Residual), can be located adjacent to ecological sites that support medium to tall shrubs (Loamy Overflow). Conversely, ecological sites that are dominated by short to mid statured grasses (Claypan) can be adjacent to sites with bare soil only supporting minor amounts of short grasses and forbs (Thin Claypan).

Management of these complex ecological sites can provide a heterogeneous or a homogenous landscape. Grassland bird use declines as the plant community transitions to a homogenous state. Managers need to recognize ecological sites and the complexes they occur in to properly manage the landscape. A management regime for one ecological site may negatively impact an adjacent site (e.g., alteration of a grazing regime within a Flat Bottom Wooded Draw ecological site to encourage understory growth may encourage exotic, cool-season grasses to increase or dominate an adjacent ecological site).

Life requisites and habitat deficiencies are determined for targeted species. Deficiencies need to be addressed along community phase, transitional, and restoration pathways as presented in specific state and transition models. Ecological sites should be managed and restored within the capabilities of the site to provide sustainable habitat. Managers also need to consider habitat provided by adjacent/intermingled ecological sites for species with home ranges or life requisites that cannot be provided by one ecological site.

With populations of many grassland-nesting birds in decline, it is important to maintain these ecological sites in a 1.0 Reference State or the 2.0 Native/Invaded. Plant communities, optimal for a guild of grassland species, serve as a population source where the birth rate exceeds mortality. Species may use marginal plant communities; however, these sites may function as a population sink where mortality exceeds the birth rate.

Understanding preferred vegetative stature and sensitivity to woody encroachment is necessary to manage for the specific grassland species. Various grass heights may be used for breeding, nesting, foraging, or winter habitat. While most species use varying heights, many have a preferred vegetative stature height. Please reference the provisional ESD on the North Dakota eFOTG (linked below) for a chart that provides preferred vegetative stature heights and sensitivity to woody vegetation encroachment. https://efotg.sc.egov.usda.gov/references/public/ND/58C_Limy_Sands_Narrative_FINAL_Ref_FSG.pdf

Limy Sands Wildlife Habitat Interpretation:

Limy Sands ecological sites are droughty sites identified by the presence of sandy

materials with calcium carbonates within 12 inches of the surface. Limy Sands sites support diverse stands of tall and short warm-season grasses, along with a diverse stand of cool-season grass and numerous forb species. Associated ecological sites include Sands, Sandy, Choppy Sands, Shallow Sandy, and Steep-Sided Wooded Draw. This complex of ecological sites provides habitat for many edge- sensitive grassland bird species.

Limy Sands habitat features and components commonly support grassland-nesting birds. Slope ranges may be too steep to support sharp-tailed grouse lekking sites, but should provide nesting and brood cover, dependent upon its state and plant community phase. Insects rely on associated forbs and grasses for survival and serve as food sources for birds and their young, and as forage for small and large herbivores. Ecological services, historically provided by bison, are mirrored by domestic livestock.

Limy Sands ecological sites may be found in five plant community states (1.0 Reference State, 2.0 Native/Invaded State, 3.0 Invaded State, 4.0 Go-Back State, and 5.0 Invaded Conifer State) within a local landscape. Multiple plant community phases exist within States 1.0 and 2.0. Today, these states occur primarily in response to grazing and drought. Secondary influences include anthropogenic disturbances and fire.

Because there is no known restoration pathway from State 2.0 to State 1.0, it is important to intensively manage using tools in State 1.0 and State 2.0 Community Phase Pathways to prevent further plant community degradation along the T1A transitional pathway to Native/Invaded State 2.0. Native wildlife generally benefits from a heterogeneous grassland found in States 1.0 and 2.0 that include diverse grass and forb species with varying stature and density. As plant communities degrade within State 2.0, short warm-season grasses increase while native forbs are reduced. This transition results in reduced stature and increased plant community homogeneity. When adjacent/intermingled ecological sites undergo the same transition, the result can be an expansive, homogenous landscape.

State 3.0 has a dramatic increase in exotic cool-season grasses with a further reduction in native forbs. Reduced forb diversity limits insect populations, negatively affecting foraging opportunities for grassland-nesting birds. Increased club moss can limit access to bare ground by nesting. A homogenous grassland landscape does not provide quality escape or winter cover. As a result, many species are not able to meet life requisites within the Limy Sands ecological site. Further degradation within State 3.0 occurs when cool-season exotic crested wheatgrass begins to dominate the site. Successful restoration along the R3A pathway may be accomplished with the implementation of prescribed grazing and prescribed burning.

Likewise, success along Restoration Pathway R4A from State 4.0 to State 2.0 is very difficult and is dependent upon presence of a remnant native grass population. This concept also applies to wildlife as the target species must either be present on adjacent State 1.0 or State 2.0 plant communities or ecological sites within the species' mobility

limits. Species with limited mobility, such as Dakota skippers, must exist near the plant community in order to utilize restored sites. Mobile species such as grassland-nesting birds can easily locate isolated, restored plant communities.

Management along community phase, transition, or restoration pathways should focus upon attainable changes. Short- and long-term monetary costs must be evaluated against short- and long- term ecological services in creating and maintaining habitat of sufficient quality to support a sustainable population density.

1.0 Reference State

Community Phase 1.1 Prairie Sandreed-Little Bluestem-Needle and Thread:
This plant community offers quality wildlife habitat; every effort should be made to maintain this ecological site within this community phase. This phase retains high functionality through continued maintenance, including prescribed grazing with adequate recovery period, as well as prescribed fire. Predominance of grass species in this community favors grazers and mixed-feeders (animals selecting grasses as well as forbs and shrubs). The structural diversity provides habitat for a wide array of migratory and resident birds.

Invertebrates: Insects play a role in maintaining the forb community and provide a forage base for grassland birds, reptiles, and rodents. These services include putting plant material and dung in contact with mineral soil to be used by low trophic level consumers (such as invertebrate shredders, predators, herbivores, dung beetles, and fungal-feeders).

Dakota skippers may use this site due to presence of host plants, such as little bluestem and prairie dropseed. Regal fritillary habitat is limited due to the rarity of Nuttall's violet and prairie violets. Monarch butterfly may use flowering forbs on this site; however, few milkweed species are found on this site to support breeding. Bumblebees and other native bees utilize forbs as a nectar source and bare ground for nesting sites in bunchgrasses. Prescribed grazing with adequate recovery periods, (as well as prescribed fire), to maintain the 1.1 phase, has little effect on nests of ground-dwelling insects.

Birds: This plant community provides quality nesting, foraging, and escape habitats favored by mid- to tallgrass-nesting birds. Several species of grassland birds that prefer mid- to tallgrass stature will use this site. In years with reduced precipitation or drought, nesting recruitment may be compromised. This plant community provides suitable areas for sharp-tailed grouse nesting and brood-rearing habitat. Diverse prey populations provide good hunting opportunities for grassland raptors.

Mammals: The diversity of grasses and forbs provide high nutrition levels for small and large herbivores including voles, mice, rodents, jackrabbits, pronghorn, and white-tailed and mule deer. Short to moderate stature provides suitable food, thermal, protective, and escape cover for small herbivores. The composition of mid- to tallgrasses may limit use by the hispid pocket mouse.

Amphibians/Reptiles: The Limy Sands ecological site and associated plant communities provide habitat for smooth green snakes. This ecological site can provide habitat for the plains hog-nosed snake and plains spadefoot. The plains spadefoot needs small ephemeral ponds for breeding and, if not available, they may not use this site. Northern leopard frog and Great Plains toad may be present if freshwater habitats (such as stock water ponds) are located in or adjacent to the site. Sandy soils provide burrowing sites for short-horned lizards; however, vegetation may be too dense. Even though silver sagebrush is common on this site, this site may not provide habitat for sagebrush lizards since they prefer rocky areas. This ecological site can provide habitat for the plains hog-nosed snake (prefer sandy soils) and plains spadefoot (prefer gravelly or sandy soils).

Fish and Mussels: This ecological site is not directly associated with streams, rivers, or water bodies. Permeability is rapid with limited runoff to associated ecological sites such as Sands, Sandy, or Choppy Sands. Management on these interconnected sites may have limited, secondary effects on aquatic species.

Community Phase 1.2 Needle and Thread–Blue Grama/Sedges:
Long-term drought, with or without heavy long-term grazing, increases the percentage of sedges in this plant community. The loss of tall warm- season grasses changes the stature of the plant community from mid- to tallgrass, to mid- to short-grass species.

Invertebrates: This phase provides similar life requisites as Community Phase 1.1. However, heavy, long- term-grazing may negatively impact ground-nesting sites for bumblebees, other native bees, and other ground-nesting insects due to reduction of forbs, timing of forb flowering, or increased soil compaction.

Birds: This plant community provides nesting, foraging, and escape habitats favored by short- to midgrass-nesting birds. A shift to a shorter herbaceous plant structure (along Community Phase Pathway 1.1A) begins to benefit McCown’s longspur, chestnut collared longspur, horned lark, and burrowing owl. Species that prefer a midgrass stature will be generally successful with normal to above-normal precipitation and a change in management along the 1.2A Community Phase Pathway. In years with reduced precipitation or heavy grazing, nesting recruitment may be compromised for midgrass-nesting species. This plant community provides areas suitable for sharp-tailed grouse leks. Limited cover and diverse prey populations provide good hunting opportunities for grassland raptors.

Mammals: Provides similar life requisites as Community Phase 1.1; however, the loss of the tall warm- season grass component my reduce thermal and escape covers.

Amphibians/Reptiles: Provides similar life requisites as Community Phase 1.1.

Fish and Mussels: Provides similar life requisites as Community Phase 1.1.

Community Phase 1.3 Blue Grama/Sedges/Forbs:
Short-statured grasses will dominate with continued long-term heavy continuous grazing and drought.

Invertebrates: Reduction in forbs (stature and abundance) may reduce nectar availability for foraging insect populations. Continued heavy grazing may negatively impact ground-nesting sites for bumblebees, other native bees, and other ground-nesting insects due to reduction of forbs, timing of forb flowering, or increased soil compaction.

Birds: This plant community provides quality nesting, foraging, and escape habitats favored by shortgrass- nesting birds. A shift to a shorter plant structure (along Community Phase Pathway 1.2B) benefits McCown's longspur, chestnut collared longspur, horned lark, and burrowing owl. Species that prefer a midgrass stature may be successful with normal to above-normal precipitation and a change in management along the 1.3A Community Phase Pathway. In years with reduced precipitation or heavy grazing, nesting recruitment may be compromised for midgrass-nesting species. Limited cover and diverse prey populations provide good hunting opportunities for grassland raptors.

Mammals: This short-statured plant community limits use by most mammals. Richardson's and thirteen- lined ground squirrels may increase.

Amphibians/Reptiles: Provides similar life requisites as Community Phase 1.1.

Fish and Mussels: Provides similar life requisites as Community Phase 1.1.

2.0 Native/Invaded State

Community Phase 2.1 Prairie Sandreed-Little Bluestem-Needle and Thread/Shrubs:
This plant community develops through Transition Pathway T1A, due to changes in management (chronic season-long or heavy late season grazing or complete rest) and the presence of exotic, cool-season grasses. The threshold between States 1.0 and 2.0 is crossed when Kentucky bluegrass, crested wheatgrass, smooth brome, or other exotic species become established. This plant community phase has a very similar appearance and function to the Reference State of Community 1.1, except that it has a minor amount of cool-season exotic grasses and forbs. This phase functions at a high level for native wildlife; therefore, managers should consider the 2.0 Community Phase Pathways to avoid transitioning to State 3.0.

Invertebrates: Provides similar life requisites as Community Phase 1.1.

Birds: Provides similar life requisites as Community Phase 1.1.

Mammals: Provides similar life requisites as Community Phase 1.1.

Amphibians/Reptiles: Provides similar life requisites as Community Phase 1.1.

Fish and Mussels: Provides similar life requisites as Community Phase 1.1.

Community Phase 2.2 Needle and Thread-Blue Grama/Forbs/Shrubs:
Heavy, continuous grazing along Community Phase Pathway 2.1A leads to shorter-statured plant species, such as blue grama and sedges. Dominated by shorter-statured grasses and a loss of nitrogen-fixing or leguminous native forbs, the diversity of this plant community is reduced. Both tap- and fibrous-rooted perennial forbs increase in this phase, but remain a minor component. Prescribed grazing with adequate recovery periods along Community Phase Pathway 2.2A is an efficient, effective method to regain the cool-season grass and forb diversity components in Community Phase 2.1.

Invertebrates: The loss of native forbs and increase in sod-forming grasses limit foraging and nesting sites for all pollinators. Continuous, heavy grazing may reduce ground-nesting site availability. Homogeneity of forb species may limit season-long nectar availability.

Birds: Heavy, continuous grazing will reduce nesting sites, forage (invertebrates), and cover. A reduced forb component may limit foraging opportunities. The stature is generally short, serving both mid- and shortgrass-nesting birds. Species that prefer a midgrass stature will be generally successful with normal to above-normal precipitation and a change in management along the 2.2A Community Phase Pathway. In years with reduced precipitation or heavy grazing during the nesting season, nesting recruitment may be compromised for midgrass-nesting species. This plant community provides areas suitable for sharp- tailed grouse lek site development. Limited stature and diverse prey populations provide good hunting opportunities for grassland raptors.

Mammals: Suitable food, thermal, protective, and escape cover for most mammals becomes limited. The loss of diversity of grasses and forbs reduces nutrition levels for small and large herbivores including voles, mice, rodents, jack rabbits, pronghorn, and deer.

Amphibians/Reptiles: Provides similar life requisites as Community Phase 1.1.

Fish and Mussels: Provides similar life requisites as Community Phase 1.1.

Community Phase 2.3 Little Bluestem/Exotic Cool-Season Grasses/Forbs:
Community Phase Pathway 2.2B is characterized by complete rest or light utilization (less than 20 percent) grazing and elimination of fire when exotic cool-season grasses are present as in Community Phase 2.2. Plant community diversity is reduced with a decline of deeper-rooted native species, replaced by shallow-rooted exotic cool-season grasses. This plant community is “at risk” of crossing the threshold to the 3.0 Invaded State. Prescribed grazing with adequate recovery periods between grazing may shift the competitive edge to native species along Community Phase Pathway 2.3A; this is the most effective method to regain diverse cool-season grass and forb components in Community Phase 2.1. Every effort should be used to manage within Community Phase

Pathway 2.3A to avoid crossing the threshold into State 3.0. Restoration Pathway R3A requires intensive management and economic inputs to successfully cross back to State 2.0.

Insects: Provides similar life requisites as Community Phase 2.2. However, the reduction of native forbs and increase in sod-forming grasses limit foraging and nesting sites for all pollinators. Homogeneity of forb species may limit season-long nectar availability. Litter build-up, resulting from complete rest or light utilization, may reduce ground-nesting site availability.

Birds: An increase in exotic cool-season grasses moves this plant community towards homogeneity. Native grasses are still present in the plant community; however, the increase in cool-season exotic grasses reduces plant structure. With reduced amounts of native grasses and forbs, reduced plant stature, and increased litter, bird species shift from mid- to short-grass species. Sharp-tailed grouse may still use this plant community for lek sites and brood-rearing; however, winter cover must be provided by adjacent ecological sites or plant communities. Management for bird species that prefer mid- to tall-statured grasses should follow Community Phase Pathway 2.3A.

Mammals: Provides similar life requisites as Community Phase 2.2.

Amphibians/Reptiles: Provides similar life requisites as Community Phase 1.1.

Fish and Mussels: Provides similar life requisites as Community Phase 1.1.

3.0 Invaded State

Community Phase 3.1 Exotic Cool-Season Grasses/Forbs:
Community Phase Pathway T2A is characterized by extend periods of no use or very light grazing and elimination of fire when exotic cool- season grasses are present as in Community Phase 2.0. This plant community phase is characterized by a dominance (more than 30 percent) to a complete dominance of exotic cool-season grasses (such as Kentucky bluegrass, crested wheatgrass, and smooth brome). Western snowberry becomes a dominant shrub and tends to increase in density and cover. Restoration Pathway R3A requires remnant amounts of native warm- and cool-season grasses and forbs. These remnant populations can only be expressed through frequent prescribed burns and high levels of prescribed grazing management targeting the exotic cool-season grasses. Intensified management along the R3A pathway will have significant short-term negative impacts on wildlife habitat; however, this is necessary to restore long-term native habitat functions.

Invertebrates: Lack of grazing leads to limited contact between plant material and mineral soil; this results in a cooler micro-climate, which is unfavorable to most insects. Lack of bare soil limits ground nesting sites for native bees and other ground-nesting insects. The lack of nectar-producing plants limits forage opportunities for bumblebees, regal fritillary,

monarch butterfly, and other pollinating species.

Birds: This homogeneous community phase, dominated by exotic plant species, provides limited habitat and life requisites for most obligate grassland-nesting birds. Lack of stature and plant diversity, along with increased litter and the tendency of Kentucky bluegrass and smooth brome to lay down, limits use by many grassland-nesting birds. Litter accumulations reduce use by chestnut-collared and McCown's longspurs. Western snowberry reduces use of this site by species that avoid areas with woody vegetation. Sharp-tailed grouse may use these sites for brood-rearing and lek sites; however, the reduction in forbs and exotic cool-season grasses may limit winter cover and foraging opportunities for chicks.

Mammals: This plant community phase provides limited foraging habitat for large ungulates and desired plant structure for Richardson's and thirteen lined ground squirrels. Litter accumulation favors thermal, protective, and escape cover for small rodents. Reduced availability of native grass seed may reduce food availability for species such as the hispid pocket mouse.

Amphibians/Reptiles: Provides similar life requisites as Community Phase 1.1. However, increased litter and cooler soil temperature may reduce use by sagebrush lizard, plains spadefoot, and short-horned lizard.

Fish and Mussels: Provides similar life requisites as Community Phase 1.1.

4.0 Go-Back State

Community Phase 4.1 Annual/Pioneer Perennial/Exotic Species: These plant communities are the result of severe soil disturbance (such as cropping, recreational activity, or concentrated livestock activity for a prolonged period). Following cessation of disturbances, the resulting plant community is dominated by early pioneer annual and perennial plant species. Plant species composition and production are highly variable. Weedy plants can provide pollinator habitat along with spring and summer cover for many mammals and birds, and their young. Dense weed cover can keep soils moist, increasing insect presence. Tall stature provided by some weeds such as marsh elder and ragweed offer thermal cover and seeds throughout winter.

Successful restoration of native species along Transition Pathway R4A results in a native grass and forb community in State 2.0. Failed restoration to native species through Restoration Pathway R4B results in Invaded State 3.0. Wildlife species response may be dependent upon plant community composition, vegetative structure, patch size, and management activities (such as prescribed grazing, burning, range planting, haying, or noxious weed control).

5.0 Invaded Conifer State

Community Phase 5.1 Juniper/Deciduous Shrubs: Resulting from Pathways T2B and T3A, elimination of fire is the major contributor to this community phase crossing the threshold from an herbaceous plant community to a community completely dominated by Rocky Mountain juniper and/or deciduous shrubs. Limy Sands sites did not historically support a Rocky Mountain juniper plant community. This phase is dependent upon seed dispersal by birds and mammals from nearby sites. Dense conifers lead to changes in soil chemistry and a change in the associated herbaceous plan. A detritus layer of pine needles and juniper needles-leaves, shade, a shallow root system, and the interception of precipitation, along with a possible soil chemistry change (decrease in pH) reduces or eliminates an herbaceous or forb understory.

Invertebrates: Conifers are wind-pollinated and thus do not benefit pollinating insects. The loss of a forb component limits insect populations.

Birds: Juniper and pine occur along a continuum. Light infestation may continue to support some grassland and open-area species tolerant of woody invasion (e.g., lark sparrow, vesper sparrow). Bird species intolerant of woody vegetation are eliminated. Species associated with woodlands and woodland edges may increase. The presence of woody plant species may increase predation by mammals and avian predators and brood parasitism by brown-headed cowbirds. Nearly all grassland-nesting bird species are negatively affected by Community Phase 5.1.

Mammals: Bat species found in MLRA 58C use Community Phase 5.1 for roost sites if mature trees are available. Nearby community phases supporting insects provide foraging opportunities. This phase can provide significant thermal, escape, and loafing habitat for elk and deer. However, a high density of Rocky Mountain juniper can limit access and use by large ungulates.

Amphibians/Reptiles: Dense stands of juniper may reduce or eliminate life for amphibians and reptiles.

Fish and Mussels: Provides similar life requisites as Community Phase 1.1.

Grazing Interpretations

This site is well adapted to managed grazing by domestic livestock. The predominance of herbaceous plants across all plant community phases best lends these sites to grazing by cattle, but other domestic grazers with differing diet preferences may also be a consideration depending upon management objectives. Often, the current plant community does not match any particular plant community (as described in the ecological site description). Because of this, a resource inventory is necessary to document plant composition and production. Proper interpretation of this inventory data will permit the establishment of a safe, initial stocking rate for the type and class of animals and level of grazing management. More accurate stocking rate estimates should eventually be calculated using actual stocking rate information and monitoring data.

NRCS defines prescribed grazing as “managing the harvest of vegetation with grazing and/or browsing animals with the intent to achieve specific ecological, economic, and management objectives”. As used in this site description, the term ‘prescribed grazing’ is intended to include multiple grazing management systems (e.g., rotational grazing, twice-over grazing, conservation grazing, targeted grazing, etc.) provided that, whatever management system is implemented, it meets the intent of prescribed grazing definition.

The basic grazing prescription addresses balancing forage demand (quality and quantity) with available forage, varying grazing and deferment periods from year-to-year, matching recovery/deferment periods to growing conditions when pastures are grazed more than once in a growing season, implementation of a contingency (e.g., drought) plan, and a monitoring plan. When the management goal is to facilitate change from one plant community phase or state to another, then the prescription needs to be designed to shift the competitive advantage to favor the native grass and forb species.

Grazing levels are noted within the plant community narratives and pathways in reference to grazing management on adjacent sites. “Degree of utilization” is defined as the proportion of the current years forage production that is consumed and/or destroyed by grazing animals (may refer to a single plant species or a portion or all the vegetation). “Grazing utilization” is classified as slight, moderate, full, close, and severe (see the following table for description of each grazing use category). The following utilization levels are also described in the Ranchers Guide to Grassland Management IV. Utilization levels are determined by using the landscape appearance method as outlined in the Interagency Technical Reference “Utilization Studies and Residual Measurements” 1734-3.

Utilization Level:
Slight (Light) 0-20% Appears practically undisturbed when viewed obliquely. Only choice areas and forage utilized.

Moderate 20-40% Almost all of accessible range shows grazing. Little or no use of poor forage. Little evidence of trailing to grazing.

Full 40-60% All fully accessible areas are grazed. The major sites have key forage species properly utilized (about half taken, half left). Points of concentration with overuse limited to 5 to 10 percent of accessible area.

Close (Heavy) 60-80% All accessible range plainly shows use and major sections closely cropped. Livestock forced to use less desirable forage, considering seasonal preference.

Severe > 80% Key forage species completely used. Low-value forages are dominant.

Hydrological functions

Water is the principal factor limiting herbage production on this site. The site is dominated

by soils in hydrologic group A. Infiltration rate is rapid and runoff potential for this site varies from very low to medium depending upon slope and ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. An exception would be where short grasses form a dense sod and dominate the site. Areas where ground cover is less than 50% have the greatest potential to have reduced infiltration and higher runoff (refer to Section 4, NRCS National Engineering Handbook for runoff quantities and hydrologic curves).

Recreational uses

The largest acreage of public land available for recreation in the MLRA is owned and managed by the United States Forest Service (USFS) within the Little Missouri National Grasslands in North Dakota (525,211 acres). These areas are available for hunting, fishing, hiking, camping, horse and bike riding, nature viewing, etc. In addition, the Bureau of Land Management (BLM) manages 30,895 acres in North Dakota and Montana with the same recreational opportunities as the USFS lands. North Dakota and Montana Department of Trust Lands (80,220 acres) provide hunting, bird watching, hiking, and other outdoor recreation opportunities. North Dakota Wildlife Management Areas (3,447 acres) of land managed by the states for wildlife habitat in MLRA 58C.

MLRA 58C is home to the North and South Units of Theodore Roosevelt National Park. The Park encompasses approximately 70,000 acres and welcomes approximately 900,000 visitors annually. 29,920 acres of the park is designated Wilderness Area. The south unit of the park has a 48-mile scenic drive while the north unit has a 28-mile scenic drive. The Badland and associated ecological sites provide the main scenery attraction.

Bird watching: Public and private grasslands within MLRA 58C provide essential habitat for prairie-dependent bird species (such as Sprague's pipits, western meadowlark, and Baird's sparrow) along with some of the larger, showy members of the upland prairie including marbled godwits, upland sandpipers, and willets. The abundance of publicly owned lands (such as Theodore Roosevelt National Park, USFS, North Dakota Department of Trust Lands, BLM, etc.) provide excellent birding opportunities. MLRA 58C is in the Central Flyway.

Hunting/Fishing: MLRA 58C is a fall destination for upland game bird hunters, especially sharp-tailed grouse. This MLRA also provides excellent white-tailed deer, mule deer, pronghorn, elk, coyote, and mountain lion hunting opportunities along with the only bighorn sheep hunting units in the North Dakota. The North Dakota Game and Fish Department manages three man-made fishing lakes within the MLRA. Available species include rainbow and brown trout, bluegill, and largemouth and smallmouth bass.

Camping: Many camping opportunities exist in the MLRA. Modern and primitive camping is available at the Theodore Roosevelt National Park, Sully’s Creek State Park, Little Missouri State Park, Buffalo Gap Campground, BLM land, and the Dakota Prairie National Grasslands. The Sully’s Creek and Little Missouri State Parks are designated horse parks.

Hiking/Biking: Over 150 miles of the May-Daah-Hey Trail provide some of the best single-track trails in the world for biking, hiking, or horseback riding. The International Mountain Biking Association (IMBA) has designated the hiking, biking, and horseback riding trail as EPIC - meaning it's one of the top mountain biking trails in the United States. The trail has nine fenced campgrounds, each accessible by gravel surfaced roads; they include camping spurs, potable water, hitching rails, picnic tables, fire rings, and accessible toilets. They are spaced about every 20 miles along the trail. The North and South Units of the Theodore Roosevelt National Park provide 38.9 and 49.6 miles, respectively, of hiking trails for walkers, bikers, or horseback riders. The Little Missouri State Park has 45 miles of trails that run through the North Dakota Badlands.

Canoeing: Traversing 274 miles through MLRA 58C, the Little Missouri River provides early spring canoeing and kayaking. The Little Missouri River is the only designated State Scenic River in the MLRA. The river passes through Sully Creek State Park, the Little Missouri National Grassland, and Theodore Roosevelt National Park.

Wood products

No appreciable wood products are present on the site.

Other products

Seed harvest of native plant species can provide additional income on this site.

Other information

Site Development and Testing Plan.

NASIS revisions needed:
Tusler, severely eroded component has sandstone at 1 inch depth and is currently linked to Limy Sands. This should be relinked to Very Shallow or change the component name to Rock Outcrop and assign to Non-site.

This ESD is the best available knowledge. The site concept and species composition table have been used in the field and tested for more than five years. It is expected that as additional information becomes available revisions may be required.

Inventory data references

Information presented here has been derived from NRCS clipping and other inventory data. Also, field knowledge of range-trained personnel was used. All descriptions were peer reviewed and/or field tested by various private, state, and federal agency specialists.

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Approval

Suzanne Mayne-Kinney, 4/21/2025

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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)	USDA-NRCS North Dakota
Contact for lead author	NRCS North Dakota State Rangeland Management Specialist
Date	06/19/2025

Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are not expected on this site.

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2. **Presence of water flow patterns:** Water flow patterns would not be visible on this site when slopes are less than 15%. When slopes are greater than 15%, water flow patterns would be broken, irregular in appearance or discontinuous with numerous debris dams.

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3. **Number and height of erosional pedestals or terracettes:** Neither pedestals nor terracettes are expected when slopes are less than 15%. When slopes are greater than 15%, a few scattered pedestals may be observed.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground ranges from 20 to 25%. Bare ground patches should be scattered, unconnected, and less than 2 inches in diameter. Animal activity (burrows and ant mounds) may occasionally result in isolated bare patches of up to 24 inches in diameter.

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5. **Number of gullies and erosion associated with gullies:** Active gullies are not expected on this site. If present, gully channel(s) are fully vegetated with no active erosion visible.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** No wind-scoured or depositional areas expected on this site.

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7. **Amount of litter movement (describe size and distance expected to travel):** Plant litter movement not expected on this site when slopes are less than 15%. When slopes are greater than 15%, some movement of fine litter may be observable in association with water

flow patterns.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Stability class averages 4 to 6.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Primary surface structure is fine granular. A-horizon is 2 to 4 inches with very dark grayish brown (10YR 3/2 moist) or grayish brown (10 YR 5/2) colors.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Mid- and short-statured bunch grasses and Mid- and short-statured rhizomatous grasses are dominate and well distributed across the site. A diverse forb component and grass-likes are subdominant.

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** No compaction layers occur naturally on this site.

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

    Dominant: Phase 1.1
    Mid & short C4 bunch grasses (5); Tall C4 rhizomatous grasses (2)

    Sub-dominant: Phase 1.1
    Mid & short C3 bunch grasses (4); Grass-likes (2); Mid & short C4 rhizomatous grasses (1); Forbs (10)

    Other: Minor - Phase 1.1
    Shrub; Mid & short C3 rhizomatous grasses

    Additional: Due to differences in phenology, root morphology, soil biology relationships, and nutrient cycling Kentucky bluegrass, smooth brome, and crested wheatgrass are included in a new Functional/structural group, mid- and short-statured early cool-season grasses

(MSeC3), not expected for this site.

To see a full version 5 rangeland health worksheet with functional/structural group tables, please use the following hyperlink: https://efotg.sc.egov.usda.gov/references/public/ND/58C_Limy_Sands_Narrative_FINA

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Rare to not occurring on this site. Some dead centers on warm- season bunchgrasses and shrub branches may be visible following multi-year drought.

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14. **Average percent litter cover (%) and depth (in):** Plant litter cover is 15 to 35% with a depth of 0.25 to 0.5 inches. Litter cover is in contact with the soil surface.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Annual air-dry production is 1800 lbs./ac (reference value) with normal precipitation and temperatures. Low and high production years should yield 1100 lbs./ac to 2500 lbs./ac, respectively.

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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:** State and local noxious species, Kentucky bluegrass, smooth bromegrass, crested wheatgrass, and Rocky Mountain juniper.

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17. **Perennial plant reproductive capability:** Noninvasive species in all functional/structural groups are vigorous and capable of reproducing annually under normal weather conditions.
