USDA Natural Resources Conservation Service

# Ecological site R054XY035ND
# Very Shallow

Last updated: 3/31/2025
Accessed: 04/19/2025

## General information

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

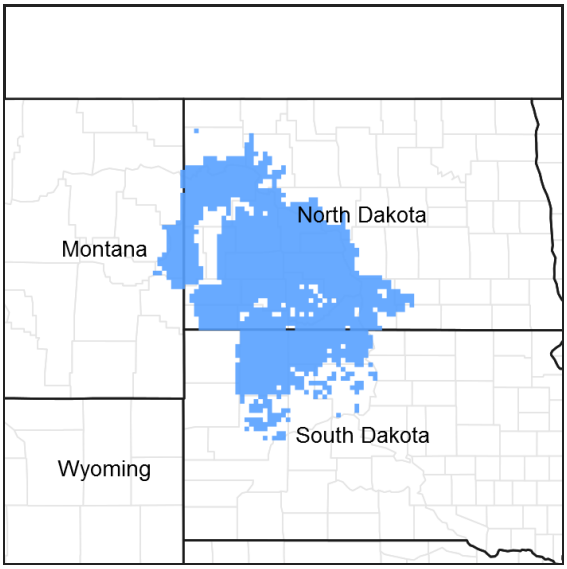



**Figure 1. Mapped extent**

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

## MLRA notes

Major Land Resource Area (MLRA): 054X–Rolling Soft Shale Plain

MLRA 54 covers 29,280 square miles and encompasses approximately 18.7 million acres. MLRA 54 spans three states with 64 percent of it in North Dakota, 33 percent in South Dakota, and 3 percent in Montana. Most of MLRA 54 is underlain by soft, calcareous shale, siltstone, and sandstone of the Tertiary Fort Union Group and the Cretaceous Fox Hills and Hell Creek Formations. Most of the soils in MLRA 54 developed from residuum weathered in place including colluvial and alluvial deposits from residuum. Along the eastern and northern edges of the MLRA where MLRA 54 transitions into the glaciated Missouri plateau, remnants of glacial till parent materials remain on the high areas of the landscape. The MLRA 54 landscape is characterized by moderately dissected rolling plains with areas of local badlands, hills, and isolated buttes. Elevation is 1,650 feet (505 meters) on the eastern side of the MLRA with a gradual rise to 3,600 feet (1,100 meters) on the western side. The Missouri River runs along the north and east side of MLRA 54. Most of the Standing Rock Indian Reservation, the northwest third of the Cheyenne River Indian Reservation, and the Grand River National Grasslands are in the southern part of the MLRA.

## Classification relationships

Level IV Ecoregions of the Conterminous United States: 43a – Missouri Plateau; 43c – River Breaks; 43j – Moreau Prairie.

## Ecological site concept

The Very Shallow ecological site is located on ridges, knobs, escarpments, and summits on sedimentary plains, glaciofluvial deposits, and outwash terraces. The depth to layers which affect or restrict root growth is the key to identifying this site. Soils with porcelanite (scoria) within a depth of 20 inches; gravelly sand (>15% gravel) within a depth of 14 inches; or very cobbly limestone within a depth of 10 inches are included in this site. Also included are soils with soft, sedimentary bedrock within a depth of 10 inches. The texture of the soil above these layers is variable (commonly loam, fine sandy loam, or sandy loam) and not used for site identification. The surface layer is less than 7 inches thick. Available water capacity in theses soils is low. Slopes range from 2 to 70 percent. On the landscape, Badlands Fan, Loamy, Limy Residual, Sandy, Shallow Gravel, Claypan, and Thin Claypan ecological sites occur lower than Very Shallow sites. Shallow Loamy sites occur on similar landscape positions as Very Shallow on sedimentary uplands; Shallow Loamy sites are 10 to 20 inches deep to soft, weathered bedrock. Also, in the Killdeer Mountains, the Upland Hardwood Forest ecological site is associated with the Very Shallow site.

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/54_Very_Shallow_Narrative_FINAL_Ref_FSG.pdf

## Associated sites

| | |
|---|---|
| R054XY021ND | **Claypan**<br>This site occurs lower on the landscape, particularly in association with porcelanite (Brandenburg and Ringling soils). It is 6 to 20 inches deep to a dense, sodic, root-restrictive subsoil; accumulated salts, where present, are deeper than 16 inches. |
| R054XY047ND | **Badland Fan**<br>This site is below badland escarpments on alluvial fans. These are medium-textured, well drained soils that developed in stratified layers of slope alluvium. |
| R053BY010ND | **Shallow Gravel**<br>This site occurs somewhat lower on the landscape. It is 14 to 20 inches deep to gravel. |
| R054XY026ND | **Sandy**<br>This site typically occurs somewhat lower on the landscape. It is deeper than 20 inches to a layer affects or restricts root growth. The surface and subsoil layers form a ribbon <1 inch long. |
| R054XY031ND | **Loamy**<br>This site typically occurs on sideslopes lower the landscape. It is deeper than 20 inches to a layer affects or restricts root growth. The surface and subsoil layers form a ribbon 1 to 2 inches long. |
| R054XY030ND | **Shallow Loamy**<br>This site occurs on similar landscape positions as Very Shallow ecological sites on sedimentary uplands; the soil does not have layers with high amounts of gravel, scoria, or limestone. Depth to soft, sedimentary bedrock (mudstone or siltstone) is 10 to 20 inches. |
| R054XY033ND | **Thin Claypan**<br>This site occurs lower on the landscape, particularly in association with poreclanite (Brandenburg and Ringling soils). It has a dense, sodic, root-restrictive subsoil within a depth of 6 inches and accumulated salts within a depth of 16 inches (usually near the surface). |
| R054XY046ND | **Limy Residual**<br>This site occurs lower on the landscape. The soils are deeper than 20 inches to weathered bedrock. They are calcareous within a depth of 8 inches these soils and form a ribbon 1 to 2 inches long. |
| F054XY046ND | **Upland Hardwood Forest**<br>This site is lower on the landscape than the Very Shallow ecological site on limestone capped buttes (Killdeer Mountains). The soil is >20 inches to a restrictive layer and has forest vegetation. |

## Similar sites

| | |
|---|---|
| R054XY030ND | **Shallow Loamy**<br>This site occurs on similar landscape positions as Very Shallow ecological sites on sedimentary uplands; the soil does not have layers with high amounts of gravel, scoria, or limestone. Depth to soft, sedimentary bedrock (mudstone or siltstone) is 10 to 20 inches. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | Not specified |
| Shrub | Not specified |
| Herbaceous | (1) *Schizachyrium scoparium var. scoparium*<br>(2) *Hesperostipa comata ssp. comata* |

## Physiographic features

This site typically occurs on ridges, knobs, summits, escarpments, on sedimentary plains and outwash terraces. Typical parent materials are channery residuum weathered from porcelanite, loamy alluvium over limestone gravelly alluvium, gravelly alluvium (outwash) or soft, weathered sedimentary bedrock. Slopes range from 2 to 70 percent.

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Ridge<br>(2) Knob<br>(3) Escarpment |
| Runoff class | Low to high |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 503–1,097 m |
| Slope | 2–70% |
| Water table depth | 203 cm |
| Aspect | Aspect is not a significant factor |

## Climatic features

MLRA 54 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 MLRA 54. The continental climate is the result of this MLRA's location 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 18 inches per year. The normal average annual temperature is about 42° F. January is the coldest month with average temperatures ranging from about 13° F (Beach, ND) to about 16° F (Bison, SD). July is the warmest month with temperatures averaging from about 69° F (Beach, ND) to about 72° F (Timber Lake, SD). The range of normal average monthly temperatures between the coldest and warmest months is about 57° F. This large temperature range attests to the continental nature of MLRA 54's 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 through 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 again in September and October when adequate soil moisture is present.

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (characteristic range) | 95-111 days |
| Freeze-free period (characteristic range) | 118-127 days |
| Precipitation total (characteristic range) | 381-457 mm |
| Frost-free period (actual range) | 91-114 days |
| Freeze-free period (actual range) | 116-129 days |
| Precipitation total (actual range) | 381-457 mm |
| Frost-free period (average) | 101 days |
| Freeze-free period (average) | 123 days |
| Precipitation total (average) | 406 mm |

### Climate stations used

- (1) FT YATES 4 SW [USC00323207], Fort Yates, ND
- (2) HETTINGER [USC00324178], Hettinger, ND
- (3) DUPREE [USC00392429], Dupree, SD
- (4) WATFORD CITY [USC00329233], Watford City, ND
- (5) MANDAN EXP STN [USC00325479], Mandan, ND
- (6) LUDLOW 3 SSE [USC00395048], Ludlow, SD
- (7) HEBRON [USC00324102], Hebron, ND

### Influencing water features

This site does not receive additional water as runoff from adjacent slopes; it is on a run-off landscape position. Neither does it receive additional water from a seasonal high-water table. Depth to the water table is deeper than 6 feet throughout the growing season. Infiltration is medium to very rapid. Permeability below the surface layer is rapid or very rapid. Water loss is through percolation below the root zone and evapotranspiration.

### Soil features

Soils associated with Very Shallow ES are in the Entisol and Mollisol orders. The Entisols are classified further as Typic Ustorthents. The Mollisols are classified further as Entic Haplustolls and Typic Haplustolls. These soils were developed under prairie vegetation. Typically, they formed in residuum from porcelanite (scoria), sandy and gravelly alluvium, or loamy alluvium over gravelly limestone alluvium. Some areas of weathered soft, sedimentary bedrock (mudstone, siltstone, sandstone, or shale) may also occur.

The common feature of soils in this site is the very shallow depth to layers which restrict or affect root growth: porcelanite within a depth of 20 inches; layers high in coarse sand and gravel (15 to >60 percent gravel) within a depth of 14 inches; very gravelly loam or very cobbly loam (limestone fragments) within a depth of 10 inches; or weathered, soft, sedimentary bedrock within a depth of 10 inches. These layers also impact the available water capacity, making the soils very droughty and limiting plant production. The soils are excessively drained to well drained. The surface layer is typically loam, silt loam, fine sandy loam, channery loam, gravelly loam, or gravelly sandy loam; however coarser textures are allowed. Thickness of the surface layer is 7 inches or less. Soils formed in weathered soft residuum are less than 10 inches to root-restrictive sedimentary bedrock; surface texture on these soils ranges from fine sandy loam to clay.

Salinity is typically none or very slight (E.C. <4 dS/m); sodicity is typically none or low (SAR <5). However, where weathered shale occurs, salinity may be none to slight (E.C. <8 ds/m) and SAR values may be as high as 10. Soil reaction is typically neutral to alkaline (pH 6.6 to 8.4). Calcium carbonate content ranges from 0 to 20 percent.

The soil surface on sandy and gravelly soils may be unstable but is usually intact. Sub-surface soil layers affect or restrict root penetration. These soils are mainly susceptible to water erosion. The hazard of water erosion increases on slopes greater than about 15 percent. Very low available water capacity caused by the shallow rooting depth strongly influences the soil/water/pant relationship. Loss of the soil surface layer can result in a shift in species composition and/or production.

Major soil series correlated to the Very Shallow site are Baahish, Brandenburg, Ringling, and Wabek.

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

Surface Texture Modifier: gravelly, very gravelly, channery, very channery, very stony

*The Subsurface Fragments <3” (% Volume) range shown is for soils formed in gravelly deposits; where the soils formed in soft, sedimentary bedrock, coarse fragments may not be present.

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Residuum<br>(2) Outwash<br>(3) Glaciofluvial deposits<br>(4) Porcellanite<br>(5) Shale<br>(6) Till |
| Surface texture | (1) Loam<br>(2) Sandy loam<br>(3) Silt loam<br>(4) Fine sandy loam |
| Family particle size | (1) Loamy<br>(2) Sandy |
| Drainage class | Well drained to excessively drained |
| Permeability class | Moderately slow to very rapid |
| Depth to restrictive layer | 10–51 cm |
| Surface fragment cover <=3" | 3–15% |
| Surface fragment cover >3" | 0–5% |
| Available water capacity (0-50.8cm) | 2.54–6.35 cm |
| Calcium carbonate equivalent (0-50.8cm) | 0–20% |
| Electrical conductivity (0-50.8cm) | 0–8 mmhos/cm |
| Sodium adsorption ratio (0-50.8cm) | 0–10 |
| Soil reaction (1:1 water) (0-50.8cm) | 6.6–8.4 |
| Subsurface fragment volume <=3" (Depth not specified) | 15–85% |
| Subsurface fragment volume >3" (Depth not specified) | 0–25% |

## 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 54 included frequent fires, both anthropogenic and natural in origin. Most fires, however, were anthropogenic fires set by Native Americans. Native Americans set fires in all months except perhaps January. These fires occurred in two peak periods, one from March-May with the peak in April and another from July-November with the peak occurring in October. Most of these fires were scattered and of small extent and duration.

The grazing history would have involved grazing and browsing by large herbivores (such as American bison, elk, and whitetail deer). Herbivory by small mammals, insects, nematodes, and other invertebrates are also important factors influencing the production and composition of the communities. Grazing and fire interaction, particularly when coupled with drought events, influenced the dynamics discussed and displayed in the following state and transition diagram and descriptions.

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

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

Four vegetative states have been identified for the site (Reference, Native/Invaded, Invaded, and Go- Back). 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 four 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 (e.g., Kentucky bluegrass, smooth brome, crested wheatgrass) which have been particularly and consistently invasive under extended periods of no use and no fire. Other exotic plants, such as leafy spurge, are also known to invade the site.

Four community phases have been identified for this state; they 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. This also changes the micro-climate near the soil surface and may alter infiltration, nutrient cycling, and biological activity near the soil surface. As a result, these factors coupled with shading cause desirable native plants to have increasing difficulty remaining viable and recruitment declines.

To slow or limit the invasion of these exotic grasses or other exotic plants, it is imperative that managerial 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).

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

The exotic cool-season grasses can be quite invasive and often form monotypic stands. As they increase, both forage quantity and quality of the annual production becomes increasingly restricted to late spring and early summer, even though annual production may increase. Forb diversity often declines. Under non-use or minimal use management, mulch can increase and become a physical barrier to plant growth 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).

State 4: Go-Back State often results following cropland abandonment and consists of only one plant community phase. This weedy assemblage may include noxious weeds that need control. Over time, the exotic cool-season grasses (Kentucky bluegrass, smooth brome, and/or crested wheatgrass) 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, long-term prescribed grazing and 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).

Juniper Invasion - Juniper species may have been present as scattered trees or shrubs prior to European influence. Since that time, decreased fire frequency, increased fire suppression, and dispersal from shelterbelts have been particularly important in enabling junipers to increase and potentially dominate a wide range of rangeland and forest land ecological sites in MLRA 54. Extended periods of non-use or very light grazing may also be factors.

Where a conifer seed source is available, woody encroachment begins to expand, exploit, and eventually dominate the sites, threatening the ecological integrity of the sites. Without managerial intervention these sites may transition to a Conifer Invaded State. As depicted in the following diagram, confer seeds disperse into an intact grassland beginning the process of woody encroachment.

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

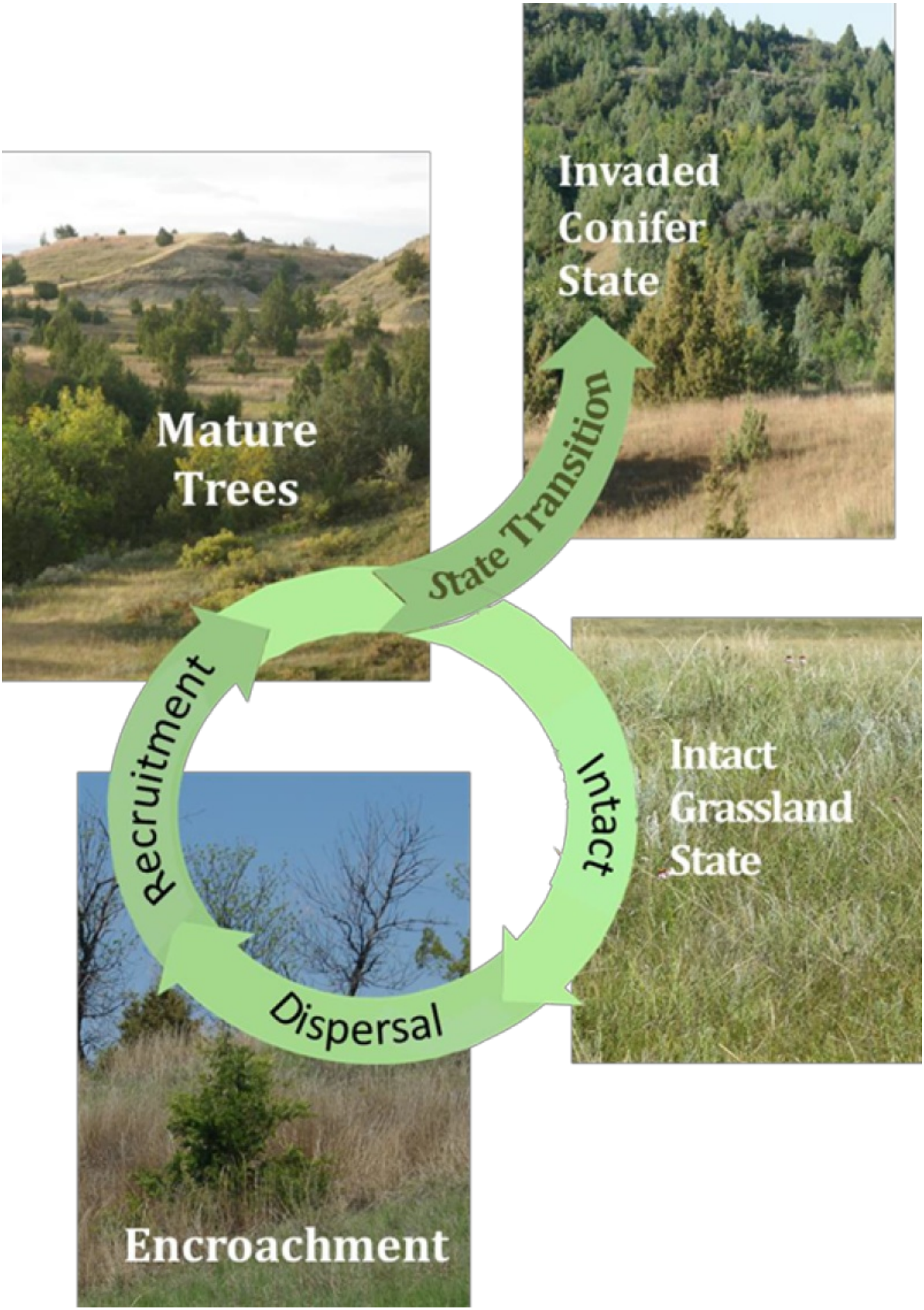
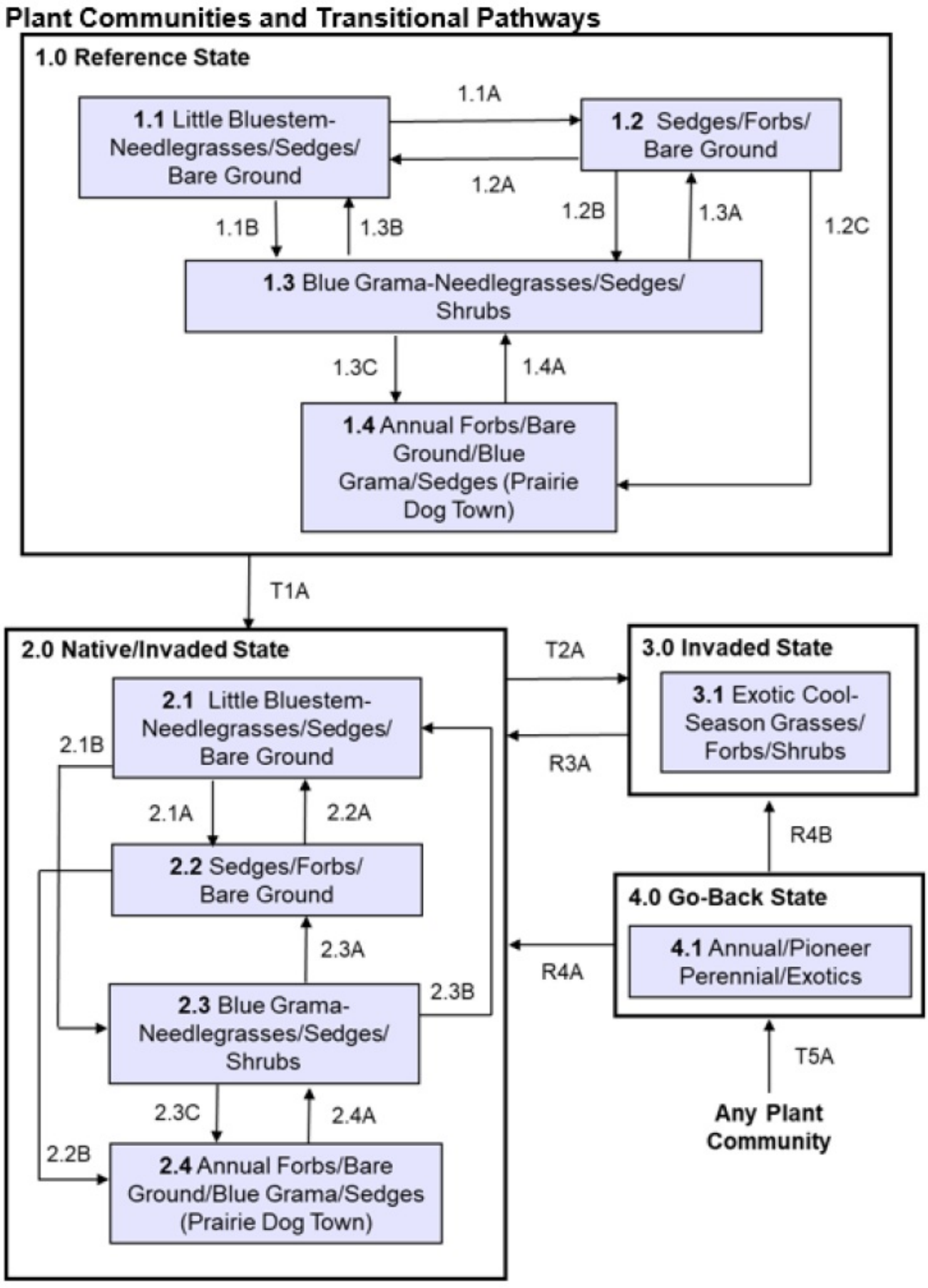

Invaded
Conifer
State
Mature
Trees
State Transition
Recruitment
Intact
Intact
Grassland
State
Dispersal
Encroachment

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



| Diagram Legend - MLRA 54 Very Shallow | |
|---|---|
| T1A | Introduction of exotic cool-season grasses |
| T2A | Extended periods of non-use or very light grazing, no fire |
| T5A | Cessation of annual cropping |
| R3A | Long-term prescribed grazing and prescribed burning |
| R4A | Successful range planting |
| R4B | Failed range planting and/or secondary succession |
| CP 1.1 - 1.2 (1.1A) | Multiyear drought with/without heavy, long-term grazing |
| CP 1.1 - 1.3 (1.1B) | Long-term absence of fire |
| CP 1.2 - 1.1 (1.2A) | Return to average precipitation and reduced grazing |
| CP 1.2 - 1.3 (1.2B) | Return to average precipitation and long-term absence of fire |
| CP 1.2 - 1.4 (1.2C) | Long-term occupation by prairie dogs |
| CP 1.3 - 1.2 (1.3A) | Multiyear drought and return to average fire intervals |
| CP 1.3 - 1.1 (1.3B) | Return to average precipitation and fire intervals |
| CP 1.3 - 1.4 (1.3C) | Long-term occupation by prairie dogs |
| CP 1.4 - 1.3 (1.4A) | Abandonment of prairie dogs |
| CP 2.1 - 2.2 (2.1A) | Multiyear drought with/without heavy, long-term grazing |
| CP 2.1 - 2.3 (2.1B) | Long-term absence of fire |
| CP 2.2 - 2.1 (2.2A) | Long-term prescribed grazing and prescribed burning, and return to average precipitation |
| CP 2.2 - 2.4 (2.2B) | Long-term occupation by prairie dogs |
| CP 2.3 - 2.2 (2.3A) | Long-term drought with fire |
| CP 2.3 - 2.1 (2.3B) | Return to average precipitation and fire intervals |
| CP 2.3 - 2.4 (2.3C) | Long-term occupation by prairie dogs |
| Cp 2.4 - 2.3 (2.4A) | Removal/abandonment of prairie dogs |

## 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, coupled with weather events, dictated the dynamics that occurred within the natural range of variability. These factors likely caused the community to shift both spatially and temporally between four 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
### Little Bluestem-Needlegrasses/Sedges/Bare Ground: (Schachyrium scoparium-Nassella viridula, Hesperostipa spp./Carex spp./Bare Ground)

This community phase was historically the most dominant both temporally and spatially and was composed of a near equal mixture of warm-season grasses and cool-season grasses. The major cool-season grasses included needle and thread, western wheatgrass, and slender wheatgrass. Major warm-season grasses were little bluestem, sideoats grama, and blue grama. Other grasses included Fendler threeawn, prairie Junegrass, Sandberg bluegrass, and plains muhly. Blazing star, blacksamson echinacea, prairie clover, and cutleaf ironplant were among the more common forbs. Common shrubs included prairie sagewort, rose, broom snakeweed, and creeping juniper. Annual production likely varied from about 400-1200 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 were well represented in the community; as a result, production was distributed throughout the growing season. This community represents the plant community phase upon which interpretations are primarily based and is described

in the “Plant Community Composition and Group Annual Production” portion of this ecological site description.

**Table 5. Annual production by plant type**

| Plant Type | Low (Kg/Hectare) | Representative Value (Kg/Hectare) | High (Kg/Hectare) |
|---|---|---|---|
| Grass/Grasslike | 404 | 798 | 1188 |
| Forb | 39 | 67 | 95 |
| Shrub/Vine | 6 | 27 | 50 |
| Moss | – | 4 | 11 |
| **Total** | **449** | **896** | **1344** |

**Figure 10. Plant community growth curve (percent production by month). ND5402, Missouri Slope, Native Grasslands, Cool/Warm-season Mix. Cool-season/warm-season dominant.**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 2 | 6 | 21 | 40 | 20 | 6 | 4 | 1 | 0 | 0 |

## Community 1.2
## Sedges/Forbs/Bare Ground (Carex spp./Forbs/Bare Ground)

This plant community resulted from multiyear drought, with or without heavy long-term grazing, leading to a decrease in mid-statured grasses and an increase in bare ground. It may be characterized by the abundance of sedges, forbs, and bare ground. If present, lesser spikemoss would have increased to become a minor component of the plant community. Evidence from the years 1932-1941 indicates multiyear drought results in major shifts in species composition. Blue grama, needle and thread, western wheatgrass, prairie Junegrass, and needleleaf sedge are reduced in density and abundance during one or two seasons of severe drought. Of the major species, only threadleaf sedge maintained approximately the same area. Blue grama and western wheatgrass were the most severely affected and required three to four years to fully recover. Little bluestem, prairie sandreed, and plains muhly were seriously reduced during the two drought years and did not fully recover from the drought effects. Sandberg’s bluegrass increased remarkably during the drought years, but it decreased during post-drought years due to competition from threadleaf sedge, needle and thread, prairie Junegrass, and needleleaf sedge which recovered to pre-drought levels. The height of all species was reduced (Whitman et.al. 1943).

## Community 1.3
## Blue Grama-Needlegrasses/Sedges/Shrubs: (Bouteloua gracilis-Nassella viridula, Hesperostipa spp./Carex spp./Shrubs)

This plant community phase can be characterized by an increase in both spouting and non-sprouting shrubs resulting from a decrease in fire frequency. Major graminoids included blue grama, needle and thread, and upland sedges. Increased shrubs would have included creeping juniper, skunkbush sumac, and buffaloberry.

## Community 1.4
## Annual Forbs/Bare Ground/Blue Grama/Sedges: (Annual Forbs/Bare Ground/Bouteloua gracilis/Carex spp.) (Prairie Dog Town)

This plant community phase formed during periods of long-term occupation by prairie dogs. It was characterized by the abundance of annual forbs (e.g., fetid marigold, woolly plantain), bare ground, blue grama, and sedges. Some perennial native species remained but were greatly reduced in vigor and may not have been readily visible.

## Pathway 1.1A
## Community 1.1 to 1.2

Community Phase Pathway 1.1 to 1.2 occurred with multiyear drought with or without heavy long- term grazing. This led to marked decreases in species such as needle and thread, little bluestem, and sideoats grama with corresponding increases in disturbance-tolerant species (such as Fendler threeawn, sand dropseed, sedges, and

forbs).

### Pathway 1.1B
### Community 1.1 to 1.3

Community Phase Pathway 1.1 to 1.3 occurred with long-term absence of fire leading to marked increases in shrubs (such as creeping juniper, skunkbush sumac, and buffaloberry).

### Pathway 1.2A
### Community 1.2 to 1.1

Community Phase Pathway 1.2 to 1.1 occurred with the return to average precipitation and reduced grazing. This led to marked increases in species such as needle and thread, little bluestem, and sideoats grama with corresponding decreases in disturbance-tolerant species (such as Fendler threeawn, sand dropseed, sedges and forbs).

### Pathway 1.2B
### Community 1.2 to 1.3

Community Phase Pathway 1.2 to 1.3 occurred the return to average precipitation and long-term absence of fire, leading to a marked increase in shrubs (such as creeping juniper, skunkbush sumac, and buffaloberry).

### Pathway 1.2C
### Community 1.2 to 1.4

Community Phase Pathway 1.2 to 1.4 occurred with long-term occupation by prairie dogs resulting the site becoming characterized by annual forbs, bare ground, blue grama, and sedges.

### Pathway 1.3B
### Community 1.3 to 1.1

Community Phase Pathway 1.3 to 1.1 with the return to average precipitation and fire intervals which lead to a marked decrease in shrubs and the site becoming characterized by little bluestem, needlegrasses, sedges, and bare ground.

### Pathway 1.3A
### Community 1.3 to 1.2

Community Phase Pathway 1.3 to 1.2 occurred with multiyear drought and return to average fire frequency. This led to a marked decrease in shrubs and needlegrasses with corresponding increases in sedges, forbs, and bare ground.

### Pathway 1.3C
### Community 1.3 to 1.4

Community Phase Pathway 1.3 to 1.4 occurred with long-term occupation by prairie dogs, resulting in the site becoming characterized by annual forbs, bare ground, blue grama, and sedges.

### Pathway 1.4A
### Community 1.4 to 1.3

Community Phase Pathway 1.4 to 1.3 formed due to prairie dog abandonment leading to a community phase characterized by blue grama, needlegrasses, sedges, and shrubs.

## State 2
## Native/Invaded State

This state is similar to State 1: Reference State but has now been colonized by the exotic cool-season grasses (commonly Kentucky bluegrass, smooth brome, and/or crested wheatgrass) 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 non-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. However, as the exotic cool-season grasses increase, peak production will shift to earlier in the growing season.

**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) early spring 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
### Little Bluestem-Needlegrasses/Sedges/Bare Ground: (Schachyrium scoparium-Nassella viridula, Hesperostipa spp./Carex spp./Bare Ground)

This Community Phase is similar to Community Phase 1.1 but has been colonized by exotic cool- season grasses (often Kentucky bluegrass, smooth brome, and/or crested wheatgrass). However, these exotics are present in smaller amounts with the community still dominated by native grasses. Annual production may be comparable to that of Community Phase 1.1 (400-1200 pounds per acre). However, as the exotic cool-season grasses increase, peak production will shift to earlier in the growing season. This Phase may become an at-risk community if exotic cool-season grasses are on the increase with current management.

### Community 2.2
### Sedges/Forbs/Bare Ground (Carex spp./Forbs/Bare Ground)

This Community Phase results from multiyear drought with or without heavy long-term grazing. It is similar to Community Phase 1.2 but has now been colonized by exotic cool-season grasses (often Kentucky bluegrass, smooth brome, and/or crested wheatgrass). These exotics, however, are present in smaller amounts with the community still dominated by native grasses. Evidence from the years 1932-1941 indicates multiyear drought results in major shifts in species composition. Blue grama, needle and thread, western wheatgrass, prairie Junegrass, and needleleaf sedge are reduced in density and abundance during one or two seasons of severe drought. Of the major species, only threadleaf sedge maintained approximately the same area. Blue grama and western wheatgrass were the most severely affected and required three to four years to fully recover. Little

bluestem, prairie sandreed, and plains muhly were seriously reduced during the two drought years and did not fully recover from the drought effects. Sandberg's bluegrass increased remarkably during the drought years, but it decreased during post-drought years due to competition from threadleaf sedge, needle and thread, prairie Junegrass, and needleleaf sedge which recovered to pre-drought levels. The height of all species was reduced (Whitman et.al. 1943).

### Community 2.3
### Blue Grama-Needlegrasses/Sedges/Shrubs: (Bouteloua gracilis-Nassella viridula, Hesperostipa spp./Carex spp./Shrubs)

This plant community phase can be characterized by an increase in both spouting and non-sprouting shrubs resulting from a decrease in fire frequency. Native grasses and forbs still dominate the herbaceous portion of the vegetation with some increase in exotic grasses and forbs. Major graminoids included blue grama, needle and thread, and upland sedges. Increased shrubs often include creeping juniper, skunkbush sumac, and buffaloberry.

### Community 2.4
### Annual Forbs/Bare Ground/Blue Grama/Sedges: (Annual Forbs/Bare Ground/Bouteloua gracilis/Carex spp.) (Prairie Dog Town)

This plant community phase forms during periods of long-term occupation by prairie dogs. It is characterized by the abundance of annual forbs (e.g., fetid marigold, woolly plantain), bare ground, blue grama, and sedges. Some perennial native species remain but are greatly reduced in vigor and may not be readily visible.

### Pathway 2.1A
### Community 2.1 to 2.2

Community Phase Pathway 2.1 to 2.2 occurs with multiyear drought with or without heavy long-term grazing which leads to marked decreases in species (such as needle and thread, little bluestem, and sideoats grama) with corresponding increases in disturbance-tolerant species (such as Fendler threeawn, sand dropseed, sedges and forbs).

### Pathway 2.1B
### Community 2.1 to 2.3

Community Phase Pathway 2.1 to 2.3 with the long-term absence of fire. This leads to a marked increase in shrubs (such as creeping juniper, skunkbush sumac, and buffaloberry).

### Pathway 2.2A
### Community 2.2 to 2.1

Community Phase Pathway 2.2 to 2.1 occurs with the initiation of long-term prescribed grazing and prescribed burning and return to average precipitation. This leads to marked increases in species such as needle and thread, little bluestem, and sideoats grama with corresponding decreases in disturbance-tolerant species (such as Fendler threeawn, sand dropseed, sedges, and forbs).

### Pathway 2.2B
### Community 2.2 to 2.4

Community Phase Pathway 2.2 to 2.4 occurs with long-term occupation by prairie dogs resulting the site becoming characterized by annual forbs, bare ground, blue grama, and sedges.

### Pathway 2.3B
### Community 2.3 to 2.1

Community Phase Pathway 2.3 to 2.1 occurs with the return to average precipitation and fire intervals which leads to a marked decrease in shrubs and the site becoming characterized by little bluestem, needlegrasses, sedges, and bare ground.

### Pathway 2.3A
### Community 2.3 to 2.2

Community Phase Pathway 2.3 to 2.2 occurs with multiyear drought and fire. This leads to marked decreases in shrubs and needlegrasses with corresponding increases in sedges, forbs, and bare ground.

### Pathway 2.3C
### Community 2.3 to 2.4

Community Phase Pathway 2.3 to 2.4 occurs with long-term occupation by prairie dogs resulting the site becoming characterized by annual forbs, bare ground, blue grama, and sedges.

### Pathway 2.4A
### Community 2.4 to 2.3

Community Phase Pathway 2.4 to 2.3 results from prairie dog removal or abandonment. This results in increases in needlegrasses and shrubs with corresponding decreases in annual forbs and bare ground.

## State 3
## Invaded State

This state is the result of invasion and dominance by the exotic cool-season grasses (commonly Kentucky bluegrass, smooth brome, and/or crested wheatgrass). The exotic 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. 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. However, as the exotic cool-season grasses increase, peak production will shift to earlier in the growing season.

**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 long-term prescribed grazing 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/Shrubs

This community phase is characterized by dominance of exotic cool-season grasses (e.g., Kentucky bluegrass, smooth brome, and/or crested wheatgrass) with remnant amounts (<5%) of native warm-season grasses (e.g., blue grama, Fendler threeawn, plains muhly), cool-season grasses (e.g., needlegrasses, western wheatgrass, prairie Junegrass), and forbs (e.g., white sagebrush, silverleaf Indian breadroot, blacksamson echinacea). Shrubs such as buffaloberry, creeping juniper, and rose may increase. Production is largely limited to the exotic cool-season grasses.

## State 4
## Go-Back State

This state is highly variable depending on the level and duration of disturbance related to the T5A 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, and/or crested wheatgrass) 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/Exotics

This community phase is highly variable depending on the level and duration of disturbance related to the T5A 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., leafy spurge) which may need control. Over time, the exotic cool-season grasses (Kentucky bluegrass, smooth brome, and/or quackgrass crested wheatgrass) will likely predominate.

## State 5
## Any Plant Community

Usually associated with annual or perennial crops.

### Transition T1A
### State 1 to 2

This is the transition from the State 1: Reference State to the State 2: Native/Invaded State due to the introduction and establishment of exotic cool-season grasses (typically Kentucky bluegrass, smooth brome, and/or crested wheatgrass). 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, or other exotic species 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 with extended periods of non-use or very light grazing, and no fire. Exotic cool-season grasses (such as Kentucky bluegrass, smooth brome, and/or crested wheatgrass) become 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 other exotic cool-season grasses. This transition may occur under other managerial conditions such as 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.

### 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 some shrubs sprout 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).

### 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, long-term prescribed grazing and 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.

### Transition T5A
### State 5 to 4

This transition from any plant community to State 4: Go-Back State. It is 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, herbicide/pesticide carryover). Thus, soil conditions should be assessed when considering restoration techniques.

## Additional community tables

**Table 6. Community 1.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Kg/Hectare) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |
| 1 | **Needlegrasses** | | | 90–179 | |
| | needle and thread | HECOC8 | *Hesperostipa comata ssp. comata* | 90–179 | – |
| 2 | **Mid Warm-Seasons** | | | 90–179 | |
| | little bluestem | SCSC | *Schizachyrium scoparium* | 90–135 | – |
| | plains muhly | MUCU3 | *Muhlenbergia cuspidata* | 18–45 | – |
| 3 | **Grama** | | | 90–179 | |
| | blue grama | BOGR2 | *Bouteloua gracilis* | 45–135 | – |
| | sideoats grama | BOCU | *Bouteloua curtipendula* | 45–90 | – |
| 4 | **Wheatgrass** | | | 45–90 | |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 45–90 | – |
| | slender wheatgrass | ELTRT | *Elymus trachycaulus ssp. trachycaulus* | 0–18 | – |
| 5 | **Other Native Grasses** | | | 45–90 | |
| | Fendler threeawn | ARPUL | *Aristida purpurea var. longiseta* | 9–27 | – |
| | sand dropseed | SPCR | *Sporobolus cryptandrus* | 9–18 | – |
| | prairie Junegrass | KOMA | *Koeleria macrantha* | 9–18 | – |
| | Sandberg bluegrass | POSE | *Poa secunda* | 9–18 | – |
| | plains reedgrass | CAMO | *Calamagrostis montanensis* | 0–9 | – |
| | Grass, perennial | 2GP | *Grass, perennial* | 0–9 | – |
| 6 | **Grass-Likes** | | | 18–45 | |
| | threadleaf sedge | CAFI | *Carex filifolia* | 18–45 | – |
| | Grass-like (not a true grass) | 2GL | *Grass-like (not a true grass)* | 0–9 | – |
| **Forb** | | | | | |
| 7 | **Forbs** | | | 45–72 | |
| | blazing star | LIATR | *Liatris* | 18–27 | – |
| | blacksamson echinacea | ECAN2 | *Echinacea angustifolia* | 18–27 | – |
| | prairie clover | DALEA | *Dalea* | 18–27 | – |
| | upright prairie coneflower | RACO3 | *Ratibida columnifera* | 9–18 | |

| | | | | | |
|---|---|---|---|---|---|
| | upright prairie coneflower | RACO3 | *Ratibida columnifera* | 9–18 | – |
| | lacy tansyaster | MAPI | *Machaeranthera pinnatifida* | 9–18 | – |
| | Forb, perennial | 2FP | *Forb, perennial* | 9–18 | – |
| | Forb, annual | 2FA | *Forb, annual* | 0–9 | – |
| | pussytoes | ANTEN | *Antennaria* | 0–9 | – |
| | rush skeletonplant | LYJU | *Lygodesmia juncea* | 0–9 | – |
| | onion | ALLIU | *Allium* | 0–9 | – |
| | alpine golden buckwheat | ERFLF | *Eriogonum flavum var. flavum* | 0–9 | – |
| | tarragon | ARDR4 | *Artemisia dracunculus* | 0–9 | – |
| | white heath aster | SYER | *Symphyotrichum ericoides* | 0–9 | – |
| | spiny phlox | PHHO | *Phlox hoodii* | 0–9 | – |
| | plains milkvetch | ASGI5 | *Astragalus gilviflorus* | 0–9 | – |
| | eastern pasqueflower | PUPA5 | *Pulsatilla patens* | 0–9 | – |
| | blanketflower | GAAR | *Gaillardia aristata* | 0–9 | – |
| | scarlet globemallow | SPCO | *Sphaeralcea coccinea* | 0–9 | – |
| | scarlet beeblossom | OESU3 | *Oenothera suffrutescens* | 0–9 | – |
| **Shrub/Vine** | | | | | |
| 8 | **Shrubs** | | | 45–54 | |
| | broom snakeweed | GUSA2 | *Gutierrezia sarothrae* | 9–18 | – |
| | buffaloberry | SHEPH | *Shepherdia* | 0–18 | – |
| | creeping juniper | JUHO2 | *Juniperus horizontalis* | 9–18 | – |
| | prairie sagewort | ARFR4 | *Artemisia frigida* | 9–18 | – |
| | rose | ROSA5 | *Rosa* | 9–18 | – |
| | skunkbush sumac | RHTR | *Rhus trilobata* | 0–9 | – |
| | Shrub (>.5m) | 2SHRUB | *Shrub (>.5m)* | 0–9 | – |
| | kinnikinnick | ARUV | *Arctostaphylos uva-ursi* | 0–9 | – |
| | rubber rabbitbrush | ERNA10 | *Ericameria nauseosa* | 0–9 | – |
| | pricklypear | OPUNT | *Opuntia* | 0–9 | – |
| **Moss** | | | | | |
| 9 | **Cryptogams** | | | 0–9 | |
| | lesser spikemoss | SEDE2 | *Selaginella densa* | 0–9 | – |

**Table 7. Community 3.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Kg/Hectare) | Foliar Cover (%) |
|---|---|---|---|---|---|

## Animal community

Animal Community – Wildlife Interpretations

Landscape

The MLRA 54 landscape is characterized by moderately dissected rolling plains with areas of local badlands, buttes, and isolated hills. MLRA 54 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/shrub

land 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:

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 roaming American bison, elk, and pronghorn were historically among the inhabitants adapted to this semi-arid region. 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, thus 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, 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:

Following European influence, domestic livestock grazing, elimination of fire, energy development, and other anthropogenic factors influenced plant community composition and abundance. Agriculture, transportation corridors, and energy development 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 species including smooth brome, crested wheatgrass, Kentucky bluegrass, and leafy spurge. This further impacted plant and animal communities. The loss of the bison, 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.

Included in this MLRA are the isolated Killdeer Mountains (limestone capped residual butte) containing bur oak, quaking aspen, green ash, paper birch, and American elm. Except for floodplain forests within the MLRA, the Killdeer Mountains contain the largest deciduous forest in southwestern North Dakota.

Some wildlife species in this area are deer (white-tailed and mule), elk, pronghorn, moose, 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 turkey, golden eagle, ferruginous hawks, sharp-tailed grouse, black-billed magpie, and numerous species of grassland-nesting birds and pollinating insects.

Presence of wildlife species is often determined by ecological site characteristics including grass and forb species, hydrology, aspect, and other associated ecological sites. The home ranges of a majority 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 MLRA:

Bald eagle: Bald Eagles prefer large rivers, lakes, reservoirs, or wetlands that are bordered by mature stands of trees or a single large tree. Bald eagles use the Missouri River system, including Lakes Sakakawea and Oahe, and associated tributaries. Mature trees, including cottonwoods, provide nesting sites adjacent to aquatic and upland foraging sites.

Dakota skipper: The extreme northern portion of this MLRA provides limited Dakota skipper habitat. Dakota skipper

habitat within MLRA 54 is considered Type B habitat. Type B habitat is described as rolling native-prairie terrain over gravelly glacial moraine deposits dominated by bluestems and needlegrasses with the likely presence of bluebell bellflower, wood lily, blacksamson echinacea, upright prairie coneflower, and blanket flower. The United States Fish and Wildlife Service lists two critical habitat units within the MLRA in McKenzie County, North Dakota.

Golden eagle: The Lake Sakakawea breaks, bluffs, and rock outcroppings within the northwest portion of the MLRA are key areas for golden eagle nesting. Grasslands, shrublands, and black-tailed prairie dog towns are used for foraging.

Black-footed ferret: Black-footed ferrets have been reintroduced as an experimental population in the southern portion of the MLRA located on the Cheyenne Sioux Indian Reservation. Since reintroduction between 1991 and 1996, black-footed ferrets have been documented on the Standing Rock Sioux Indian Reservation approximately 20 miles north of the reintroduction site. Black-footed ferrets rely exclusively on prairie dog towns for shelter, breeding, and food sources (prairie dogs and other species within the town).

Least tern (Interior): Least terns are found on the Missouri River system in MLRA 54. Sparsely vegetated sandbars within the free-flowing portions of the Missouri River or shorelines of Lake Oahe and Sakakawea are used for nesting and foraging.

Species of Concern within the MLRA:

The 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 the South Dakota State Wildlife Action Plan (2014); and “species listed as threatened, endangered, or petitioned” under the Endangered Species Act within MLRA 54 at the time this section was developed:

Invertebrates: Dakota skipper, little white tiger beetle, monarch butterfly, Ottoe skipper, regal fritillary, yellow-banded bumble bee, and western bumble bee.

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

Mammals: Big and little brown bats, long-eared bat, long-legged bat, northern long-eared bat, Townsend’s big-eared bat, western small-footed bat, black-footed ferret, black-tailed prairie dog, dwarf shrew, gray wolf, hispid pocket mouse, Merriam’s shrew, northwestern moose, sagebrush vole, silver-haired bat, and swift fox.

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

Fish and Mussels: Blue sucker, burbot, flathead chub, fragile papershell, northern redbelly dace, paddlefish, pallid sturgeon, pearl dace, pink papershell, shortnose gar, sickle-fin chub, 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 that support a dominance of herbaceous vegetation (Loamy/Clayey) 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 should 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; for example, alteration of a grazing regime within a Loamy Overflow 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 must 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 site's capabilities to provide sustainable habitat. Managers also should 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 (rarely found intact) 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. The following chart provides preferred vegetative stature heights and sensitivity to woody vegetation encroachment.

To see the charts, click on the hyperlink:
https://efotg.sc.egov.usda.gov/references/public/ND/54_Very_Shallow_Narrative_FINAL_Ref_FSG.pdf

Very Shallow Wildlife Habitat Interpretation:

Very Shallow ecological sites are characterized by soils which have soft weathered bedrock within a depth of 10 inches, or gravelly sand within a depth of 14 inches, or are 10 to 20 inches deep to porcelanite (scoria). Associated ecological sites include Claypan, Sandy, Loamy, Shallow Loamy, Thin Claypan, Limy Residual, Badland Fan, and Shallow Gravel. This complex of ecological sites provides habitat for many edge-sensitive grassland bird species. Also, in the Killdeer Mountains, the Upland Hardwood Forest ecological site is associated with the Very Shallow site. Very Shallow habitat features have a significant amount of bare soil compared to the associated ecological sites. Dependent upon the degree of shrub invasion, Very Shallow ecological sites support species of conservation priority, such as the short-horned lizard.

Very Shallow ecological sites may be found in four plant community states (1.0 Reference State, 2.0 Native/Invaded State, 3.0 Invaded State, and 4.0 Go-Back State). Multiple plant community phases exist within States 1.0 and 2.0. These states occur primarily in response to grazing, drought, and non-use. Secondary influences include fire and anthropogenic disturbances.

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 either the T1A Transitional Pathway to Native/Invaded State 2.0 or T2A Transitional Pathway to Invaded State 3.0 thresholds. Native wildlife generally benefits from a heterogeneous grassland, in stature and plant composition, found in Community Phases 1.1 and 2.1 that include diverse grass and forb species with varying stature and density. Plant Community Phases 1.3 and 2.3 have an increase in shrubs including creeping juniper, buffaloberry, and skunkbush sumac. As shrub density increases, grassland nesting bird and reptile use decreases.

Success along Restoration Pathway R3A from State 3.0 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 on ecological sites within the mobility limits of the species. Species with limited mobility, such as Dakota skippers, must exist near the plant community to utilize restored sites. Mobile species, such as grassland-nesting birds, can more easily locate isolated, restored plant communities.

Plant community phases within the State 3.0 show dramatically increased homogeneity of exotic cool-season grasses and further reduction in native forbs. Reduced forb diversity limits insect populations, negatively affecting foraging opportunities for grassland-nesting birds. Very Shallow sites can have pockets of buffaloberry and creeping juniper which, when in high enough density, may impact shrub intolerant grassland nesting birds. Increased exotic-grass litter can limit access to bare ground by nesting insects. 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 State 3.0.

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.

1.0 Reference State

Community Phase 1.1 Little Bluestem-Needlegrasses/Sedges/*Bare Ground*: This plant community provides quality habitat for species benefiting from sparse vegetation with a significant amount of bare ground. 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 and forb species in this community favors grazers and mixed- feeders (animals selecting grasses as well as forbs and shrubs).

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

This site has potential for Dakota skipper foraging habitat in the northern portion of the MLRA, since it does provide little bluestem as a host plant. Very shallow, xeric soil conditions are not conducive for Dakota skipper reproduction. Regal fritillary habitat is limited due to the rarity of Nuttall's violet and prairie violets. Monarch butterflies may use flowering forbs on this site; however, few milkweed species are found on this site to support breeding and larvae development. The Very Shallow ecological site does not provide habitat for the little white tiger beetles which prefer large, active Choppy Sands ecological sites or sand beaches for the Ottoe Skipper which prefers mid- to tall-statured grasses. Bumblebees and other native bees utilize forbs as a nectar source and bare ground for nesting sites in bunchgrasses. Bare ground provides habitat for ground nesting bees. 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 foraging and escape habitats favored by short- to midgrass- nesting birds. Plant statures may be suitable for McCown’s longspur, especially during periods of drought or management (such as rotational grazing or fire) that results in defoliation along Community Phase Pathway 1.1A. This site is not conducive to burrowing animals, limiting potential use by burrowing owls. The low, scattered shrubs present in the plant community phase should not impact woody vegetation-sensitive bird species.

Grassland birds positively correlated with bare ground - including chestnut-collared longspur, grasshopper sparrow, and McCown’s longspur - may use this site. This plant community provides suitable foraging areas for sharp-tailed grouse broods. Limited stature and 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 (hispid pocket mouse), rodents, jackrabbits, pronghorn, and deer (white-tailed and mule). This site

provides limited thermal and escape cover for large ungulates and cervids.

Amphibians and Reptiles: This ecological site and associated plant communities provide habitat for short-horned lizard and smooth green snakes that utilize short grasses with bare soil.

Fish and Mussels: This ecological site is not directly associated with streams, rivers, or water bodies. Associated ecological sites, such as Loamy Overflow, can receive run-on hydrology from Very Shallow sites. Management on these interconnected sites may have limited, secondary effects on aquatic species.

Community Phase 1.2 Sedges/Fobs/*Bare Ground*: Multiyear drought with or without heavy, long- term grazing (via Community Phase Pathway 1.1A) will switch this plant community from cool- and warm-season bunchgrasses to disturbance tolerant species (such as Fendler threeawn, sand dropseed, sedges, and forbs). Bare ground increases with a possible increase in lesser spikemoss.

Invertebrates: Provides similar life requisites as Community Phase 1.1; however, heavy grazing may cause an increase in disturbance tolerant forbs reducing available pollen and nectar. Heavy grazing may also reduce or change the timing of forb flowering.

Birds: This plant community provides limited nesting and foraging habitats favored by shortgrass- nesting birds. A shift to shorter plant stature along Community Phase Pathway 1.1A benefits McCown's longspur, chestnut-collared longspur, and horned lark. Species that prefer midgrass stature may not be successful. In years with reduced precipitation or heavy grazing, nesting recruitment for short-grass nesting birds may be compromised. Landscape position along with light to moderate cover and diverse prey populations provide good hunting opportunities for grassland raptors.

Mammals: An increase in short statured vegetation, such as sedges, and heavy grazing reduces thermal and escape cover for mammals.

Amphibians and 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-Needlegrasses/Sedges/Shrubs: Decreased fire frequency (via Community Pathway 1.1B from Community Phase 1.1) or average growing conditions, reduced fire frequency, and grazing (via Community Pathway 1.2B from Community Phase 1.2) will increase warm-season sod-forming grasses and cool-season bunchgrasses. However, the reduction in fire frequency will increase shrubs such as creeping juniper, skunkbush sumac, and buffaloberry.

Invertebrates: Dependent on shrub dominance, invertebrate use may become limited on sites dominated by creeping juniper but may increase during the buffaloberry and skunkbrush sumac flowering period. Season long bloom periods may be diminished due to the shrub dominance with a reduction in forbs.

Birds: Increase in shrubs will decrease use by woody-sensitive grassland nesting bird species.

Mammals: Suitable food, thermal, protective, and escape cover (reduction in litter) for most mammals become limited when dominated by creeping juniper but may increase with shrubs such as buffaloberry. The loss of diversity of grasses and forbs reduces nutrition levels for small and large herbivores including voles, mice, rodents, jackrabbits, pronghorn, and deer.

Amphibians/Reptiles: Loss of bare ground and increase in shrubs limits use by short-horned lizard and smooth green snakes that utilize short grasses with bare soil.

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

Community Phase 1.4 Annual Forbs/*Bare Ground*/Blue Grama/Sedges (Prairie Dog Town): This plant community phase is characterized by grazing-tolerant species and annual forbs. Prairie dog occupation will shift the plant community to increased annual forbs and grazing tolerant perennial grasses. Perennial forbs stature and abundance are being replaced by short-statured annual forbs. Bare ground increases while litter amounts and

infiltration rates decline as soil surface temperatures increase. This short-statured plant community is resilient, retaining sufficient grazing-sensitive native species to return to 1.3 Community Phases (via Community Phase Pathway 1.4A).

Invertebrates: A switch to annual forbs from perennial forbs may not have a significant impact to invertebrates but may reduce season-long nectar producing plants for pollinators. Season-long nectar sources may be found on adjacent plant communities or ecological sites for mobile species. Increased bare ground and prairie dog burrow sites provide increased nesting sites for bumble bees and other ground-nesting insects.

Birds: This very short-statured phase, driven by continued over-grazing or prairie dog occupation, is favored by burrowing owls, chestnut-collared longspur, and McCown's longspur. Prairie dog towns provide abundant prey populations for grassland raptors. The lack of grass and forb stature limits use by many bird species. Managing this phase along Community Phase Pathway 1.3A can be an economical and successful method to restore high quality habitat for many grassland-nesting birds.

Mammals: Suitable food, thermal, shelter, and escape cover (reduction in litter) for most mammals becomes limited. The loss of diversity of grasses and forbs reduces nutrition levels for small and large herbivores including rodents, white-tailed jackrabbits, and deer. Grazers, such as pronghorn, use prairie dog towns for foraging and loafing. Managing this phase along Community Phase Pathway 1.3A can be an economical and successful method to restore habitat.

Amphibians/Reptiles: Provides similar life requisites as Community Phase 1.1. Prairie dog towns provide habitat for both amphibians and reptiles. Tiger salamanders, prairie rattlesnakes, and other snake species will use the burrow systems of prairie dogs for shelter and denning.

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

2.0 Native/Invaded State

Community Phase 2.1 Little Bluestem-Needlegrasses/Sedges/*Bare Ground*: This plant community develops through Transition Pathway T1A, due to changes in management and the presence of exotic, cool-season grasses. Lack of fire, chronic season-long or heavy late-season grazing, or complete rest from grazing allows cool-season exotic grasses to establish. The threshold between States 1.0 and 2.0 is crossed when Kentucky bluegrass, crested wheatgrass, 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 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 and 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 Sedges/Forbs/*Bare Ground*: Continuous, heavy season-long grazing or heavy seasonal grazing, with or without drought, along Community Phase Pathway 2.1A shifts the competitive edge to more disturbance tolerant species. Bare ground increases along with a possible increase in lesser spikemoss leading to loss of little bluestem and needlegrasses. A shift to sedges and bare ground reduces the diversity of this plant community. Prescribed grazing along with average growing conditions following Community Phase Pathway 2.2A is an efficient, effective method to regain the warm- and cool-season grass and forb diversity components in Community Phase 2.1.

Invertebrates: The reduction of native forbs and increase in bare ground and lesser spikemoss limit foraging and nesting sites for all pollinators. Continuous, heavy season-long grazing or heavy seasonal grazing may reduce ground-nesting site availability.

Birds: Provides similar life requisites as Community Phase 1.2.

Mammals: Suitable food, thermal, protective, and escape cover (reduction in litter) for most mammals become limited. The loss of diversity of grasses and forbs reduces nutrition levels for small and large herbivores including voles, mice, rodents, jackrabbits, pronghorn, and deer.

Amphibians and 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 Blue Grama-Needlegrasses/Sedges/Shrubs: This plant community develops through Community Phase Pathway 2.1B due to a decrease in fire frequency and a series of above normal precipitation years. The competitive edge shifts towards a shrub component dominated by creeping juniper, skunkbush sumac, and buffaloberry. Native grasses and forbs still dominate the herbaceous layer.

Invertebrates: Provides similar life requisites as Community Phase 1.3.

Birds: Provides similar life requisites as Community Phase 1.3.

Mammals: Provides similar life requisites as Community Phase 1.3, except for loss of hispid pocket mouse habitat.

Amphibians/Reptiles: Provides similar life requisites as Community Phase 1.3.

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

Community Phase 2.4 Annual Forbs/*Bare Ground*/Blue Grama/Sedges: (Prairie Dog Town): This plant community is a result of ecological services provided by long-term black-tailed prairie dog occupation coupled with the introduction of exotic cool-season grasses and annual forbs along Community Phase Pathway 2.3B or 2.2C. Black-tailed prairie dogs provide primary ecological services to transition to and maintain Plant Community Phase 2.4. Utilizing one or more tools in Community Phase Pathway 2.4A (e.g., removal of black- tailed prairie dogs, control of exotic perennial forbs, implementation of prescribed grazing) can move this community back to Phase 2.3, but this may require significant management and economic inputs.

Invertebrates: The loss of native forb diversity limits use by all pollinators. However, invasive forbs may provide limited seasonal use, dependent on bloom period. Bare ground, burrows, and short plant stature provide nest sites for bumblebees and other ground-nesting insects. Burrowing owls place dung around their burrow entrance, attracting dung beetles and other insects as a food source.

Birds: Burrowing owl and McCown’s longspur rely on the stature and composition that this plant community provides. Presence of black-tailed prairie dogs provided diverse prey populations for grassland raptors including burrowing owls, prairie falcons, and ferruginous hawks. Burrowing owls nest in abandoned prairie dog burrows.

Mammals: Suitable food, thermal, protective, and escape cover (reduction in litter) for most mammals becomes limited. The loss of grass and forb diversity reduces nutrition levels for small and large herbivores including voles, mice, rodents, white-tailed jackrabbits, cottontail rabbits, and deer. Except for black-tailed prairie dog, this plant community provides little habitat for mid-sized or small herbivores. Nonetheless, black-tailed prairie dog towns provide important habitat for many mammal species including small rodents. Grazers, such as pronghorn, use prairie dog towns for foraging and loafing.

Amphibians/Reptiles: Prairie dog towns provide habitat for both amphibians and reptiles. Tiger salamanders, prairie rattlesnakes, and other snake species may use the burrow systems of prairie dogs for shelter and denning.

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/Shrubs: Community Phase Pathway T2A is

characterized by non-use or low intensity (<20% utilization) 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 (>30%) of exotic cool-season grasses, such as Kentucky bluegrass and crested wheatgrass. This state may have an increase in shrubs such as creeping juniper, rose, and buffaloberry. Restoration Pathway R3A requires remnant amounts of native warm- and cool-season grasses and forbs.

The remnant native community needs frequent prescribed burns and high levels of grazing management targeting the exotic, cool-season grasses to improve competitiveness and increase vigor and density. Without intensive management, the remnant native plants will not increase adequately to transition back to State 2.0. 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: Increase in exotic cool-season grasses begins to limit use by beneficial insects provided in States 1.0 and 2.0. Bare ground will be present in lesser amounts than 1.1 but some bare ground will be present due to the bunch type growth feature of exotic, cool-season, crested wheatgrass providing bare soil for ground nesting pollinator species. The lack of nectar- producing forbs may limit forage opportunities for bumblebees, regal fritillary, monarch butterfly, and other pollinating species. However, shrubs such as rose and buffaloberry provide nectar for pollinating insects.

Birds: The increase dominance of exotic cool-season Kentucky bluegrass and crested wheatgrass along with the increase in shrubs, such as creeping juniper and buffaloberry, limits habitat and life requisites for most obligate grassland-nesting birds.

Mammals: Provides similar life requisites as Community Phase 1.3.

Amphibians and Reptiles: Provides similar life requisites as Community Phase 1.3.

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

4.0 Go-Back State

Community Phase 4.1 Annual/Pioneer Perennial/Exotics: 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, birds and their young. However, this droughty site will not produce a dense weed cover.

Successful restoration of native species along Transition Pathway R4B results in a native grass and forb community in State 2.0. Failed restoration to native species through Restoration Pathway R4A results in Invaded State 3.0. The response by wildlife species will be dependent upon plant community composition, vegetative stature, patch size, and management activities (such as prescribed grazing, burning, inter-seeding, haying, or noxious weed control).

Animal Community – 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. “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 % Use Description
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

Available water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group A; however, some soils are in group B. Infiltration varies from medium to very rapid; runoff potential varies from low to high depending on surface texture, slope percent, slope shape, and ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. An example of an exception would be where shortgrasses form a strong sod and dominate the site. Dominance by blue grama and/or sedge will result in reduced infiltration and increased runoff. 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, Grand River, and Cedar River National Grasslands in South Dakota and the Little Missouri National Grasslands in North Dakota (687,398 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 (40,264 acres) in North and South Dakota with the same recreational opportunities as the USFS lands.

The United States Army Corps of Engineers (USAE) owns 496,162 acres of land and water located on and adjacent to Lake Sakakawea and Lake Oahe. The North Dakota and South Dakota Game and Fish Departments manage the fisheries resources. These two Missouri River reservoirs provide excellent fishing and water recreation opportunities. In addition, the United States Fish and Wildlife Service (USFWS) manages a national fish hatchery below Garrison Dam.

The USFWS manages 36,858 acres in the National Wildlife Refuge system while the North Dakota and South

Dakota wildlife management agencies manage 72,218 acres as wildlife or game management areas. The North Dakota, South Dakota, and Montana Department of Trust Lands manage 486,482 acres. These areas provide hunting, bird watching, hiking, and other outdoor recreation opportunities. North Dakota Wildlife Management Areas along the shoreline of Lake Sakakawea and the Missouri River account for 60,000 acres of the approximately 72,218 acres of land managed by the states for wildlife habitat in MLRA 54. Located in the northern portion of the MLRA, the Killdeer Mountain WMA is the largest tract of state-owned land managed for wildlife habitat at approximately 7,000 acres.

The largest refuge managed by the United States Fish and Wildlife service is Lake Ilo National Wildlife Refuge totaling approximately 4,000 acres. United States Bureau of Reclamation manages approximately 11,000 acres at Lake Tschida and 8,460 acres at Bowman-Haley Lake for fish and wildlife habitat. The National Park Service manages the Knife River Indian Village National Historic Site; the North Dakota Historical Society manages the Double Ditch Indian Village site.

Bird watching: Public and private grasslands within MLRA 54 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 include marbled godwits, upland sandpipers, willets, and sharp-tailed grouse. Publicly owned lands provide excellent birding opportunities. MLRA 54 is in the Central Flyway.

Hunting/Fishing: MLRA 54 is a fall destination for thousands of pheasant and upland game bird hunters. This MLRA also provides excellent deer (white-tailed and mule), pronghorn, and coyote hunting opportunities. Lake Sakakawea, Lake Oahe, Lake Tschida, and the Missouri River provide excellent year-round fishing opportunities. The North Dakota Game and Fish Department and South Dakota Game, Fish and Parks manage approximately 40 fishing lakes within the MLRA. Available species include yellow perch, walleye, northern pike, muskellunge, crappie, bluegill, rainbow trout, and smallmouth bass. Chinook salmon are stocked in Lake Sakakawea.

Camping: Numerous state operated campgrounds are located along the shores of Lake Sakakawea, Lake Oahe, Missouri River, and Shadehill Reservoir. Primitive camping is allowed on Grand River and Cedar River National Grasslands in South Dakota and the Little Missouri National Grasslands in North Dakota. Other numerous camping (primitive and improved) sites are available in numerous city and county parks.

Hiking/Biking/Horseback Riding: Hiking is permitted on most state and federally owned lands. Developed hiking and biking trails can be found on Harmon Lake (13.1 miles), Roughrider Trail (Morton County, 16.5 miles), Missouri River State Natural Area (5 miles), Ft. Abraham Lincoln State Park (8 miles), Cross Ranch State Park (14 miles), Grand River National Grasslands (7 miles), Lake Sakakawea State Park (5 miles), and Lewis & Clark State Park (5 miles). In addition, extensive biking and walking trails are found in local county and city parks. Ft. Abraham Lincoln State Park has 6 miles of horseback trails.

## 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

Revision Notes
This ESD was developed in 2001 from the existing North and South Dakota Range Site Descriptions, expert opinion and available data. Rangeland Health Reference Worksheet was last updated in 2011. The site concept for this ecological site has remained constant. In 2011 this ESD was revised with the current knowledge, expertise and data. In 2016, Tammy DeCock added MLRA Notes, Site Concept, Revision Notes, Site Development and Testing Plan and made minor revisions with input from key resource professionals representing several agencies in ND and SD.

Site Development and Testing Plan
• Investigation is needed on Very Shallow sites with shale beds. Slight salinity (E.C. 4 to 8) and moderate sodicity

(SAR 5 -10) are allowable on these soils. Saltgrass has been noted in association with soils – further documentation of the plant community is needed.
• NASIS revisions needed:
o Six components (2 major) of Beisigl, severely eroded (1 inch of sand over sandstone, barren) are currently assigned to Non-site. If Non-site is preferred, the series name may need to be removed (Ustipsamments or Rock Outcrop?). Otherwise, these components should be linked to Very Shallow.

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 and other federal/state agency clipping and 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.

## Other references

Bakker, K.K. 2003. The effect of woody vegetation on grassland nesting birds: an annotated bibliography. The Proceedings of the South Dakota Academy of Science 82:119-141.

Barker, W.T. and W. C. Whitman. 1988. Vegetation of the northern great plains. Rangelands 10(6): 266-272.

Bjustad, Ardell J. 1965. Vegetation measurements in relation to range condition classification on the principal range sites of southwestern North Dakota. PhD Thesis. N D State University.

Bluemle, John. North Dakota Notes No. 13, North Dakota's mountainous areas: the Killdeer Mountains and the Turtle Mountains. Accessed on web, April 10, 2017, at https://www.dmr.nd.gov/ndgs/ndnotes/ndn15-h.htm.

Bluemle. J.P. 2016. North Dakota's geologic legacy. North Dakota State University Press. 382 pages.

Brand, M. D. and H. Goetz. 1986. Vegetation of exclosures in southwestern North Dakota. Journal of Range Management 39: 434-437.

Briske, D.D. (editor). 2017. Rangeland systems – processes, management, and challenges. Springer Series on Environmental Management. 661 pages.

DeKeyser, Shawn, G. Clambey, K. Krabbenhoft and J. Ostendorf. 2009. Are changes in species composition on central North Dakota rangelands due to non-use management? Rangelands 31(6):16-19.

Dodd, J.L. 1970. Distribution and community site relations of bluebunch wheatgrass in North Dakota. PhD Thesis. N D State University. Fargo, North Dakota.

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

Dyke, S. R., S. K. Johnson, and P.T. Isakson. 2015. North Dakota state wildlife action plan - ND Game and Fish Department.

Ehrenfeld, Joan G. 2002. Effects of exotic plant invasions on soil nutrient cycling processes. Ecosystems 6:503-523.

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

Endangered and threatened wildlife and plants; designation of critical habitat for the Dakota skipper and Poweshiek skipperling; Vol. 79 No. Final Rule October 1, 2015, 50 CFR Part 17.

Flesland, J.R. 1964. Composition and structure of the salt-desert shrub type in the Badlands of western North Dakota. M.S. Thesis. ND State University.

Franzen, David. 2007. Managing saline soils in North Dakota. SF-1087. NDSU Extension Service. North Dakota State University.

Gilgert, W.; and S. Zack. 2010. Integrating multiple ecosystem services introduction ecological site descriptions; Rangelands 2010 32 (6), pp 49-54.

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

Hanson, H.C and W. Whitman. 1938. Characteristics of major grassland types in western North Dakota. Ecological Monographs. Vol. 8 No. 1: pp 57-114.

Heitschmidt, R. K., K. D. Klement, and M. R. Haferkamp. 2005. Interactive effects of drought and grazing on Northern Great Plains rangelands. Rangeland Ecology and Management 58:11-19.

Hendrickson, J.R., P. S. Johnson, M. A. Liebig, K. K. Sedivec, and G. A. Halvorson. 2016. Use of ecological sites in managing wildlife and livestock: an example with prairie dogs. Rangelands 38(1): 23-28.

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

Higgins, Kenneth F. 1984. Lightning Fires in North Dakota grasslands and in pine-savanna lands of South Dakota and Montana. Journal of Range Management 37 (1).

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

High Plains Regional Climate Center, University of Nebraska, 830728 Chase Hall, Lincoln, NE 68583- 0728. (http://hprcc.unl.edu)

Hirch, K.L. 1985. Habitat type classification of grasslands and shrublands of southwestern North Dakota. Ph.D. Thesis. ND State University.

Hopkins, D.G., M.D Sweeny, D.R. Kirby, J. L. Richardson. 1991. Effects of revegetation of surficial soil salinity on panspot soils. Journal of Range Management 44(3): 215-219.

Johnson, Sandra. 2015. Reptiles and amphibians of North Dakota. North Dakota Game and Fish Department. 64 pages.

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

Mader, E., M. Shepherd, M. Vaughan, and S.H. Black. 2011. Attracting native pollinators: protecting North America's bees and butterflies. Accessed at https://xerces.org, May 1, 2017.

Montana’s State Wildlife Action Plan. 2015. Montana Fish, Wildlife and Parks. Viewed at https://xerces.org/ on May 1, 2017.

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

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

Palit, R., G. and E.S. DeKeyser. 2022. Impacts and drivers of smooth brome (Bromus inermis Leyes.) invasion in native ecosystems. Plants: 10,3390. http://https://www.mdpi.com/2223-7747/11/10/1340

Palit, R., G. Gramig, and E.S. DeKeyser. 2021. Kentucky bluegrass invasion in the Northern Great Plains and prospective management approaches to mitigate its spread. Plants: 10,817. https://doi.org/10.3390/plants10040817

Printz, Jeffrey L. and John R. Hendrickson. 2015. Impacts of Kentucky bluegrass Invasion (Poa pratensis) on Ecological Processes in the Northern Great Plains. Rangelands 37(6): pp 226-232.

Redmann, Robert E. 1975. Production ecology of grassland plant communities in western North Dakota. Ecological Monographs 45: pp 83-106.

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

Royer, R. A., 2003. Butterflies of North Dakota: an atlas and guide. Minot State University, Minot, ND.

Sanford, R.C. 1970. Skunk bush in the North Dakota Badlands: Ecology, phytosociology, browse production, and utilization. Ph. D. Thesis. ND State University.

Seabloom, R. 2020. Mammals of North Dakota. North Dakota Institute for Regional Studies, Fargo, ND. 470 pages.

Sedivec, Kevin K., Jeffrey L. Printz. 2014. Ranchers Guide to Grassland Management IV. NDSU Extension Service publication R1707.

South Dakota Dept. of Game, Fish and Parks. 2014. South Dakota Wildlife Action Plan. Wildlife Division Report 2014-03.

Spaeth, K.E., Hayek, M.A., Toledo, D., and Hendrickson, J. 2019. Cool season grass impacts on native mixedgrass prairie species in the Northern Great Plains. America's Grassland Conference: Working Across Boundaries. The Fifth Biennial Conference on the Conservation of America's Grasslands. Bismarck, ND. 20-22 August.

Tidwell, D., D.T. Fogarty, and J.R. Weir. 2021. Woody encroachment in grasslands, a guide for understanding risk and vulnerability. Oklahoma State University, Oklahoma Cooperative Extension Service publication E-1054. 32 pages.

Toledo, D., M. Sanderson, K. Spaeth, J. Hendrickson, and J. Printz. 2014. Extent of Kentucky bluegrass and its effect on native plant species diversity and ecosystem services in the northern great plains of the United State. Invasive Plant Science and Management 7(4): 543-552.

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296.

USDA, NRCS. National Water and Climate Center. (http://www.wcc.nrcs.usda.gov)

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

USDA, NRCS. National Soil Information System, Information Technology Center. Accessed on May 1, 2017 at http://nasis.nrcs.usda.gov.

USDA, NRCS. 2001. The PLANTS Database, Version 3.1. http://plants.usda.gov. Accessed May 2, 2017.

USDA, NRCS, Various published soil surveys.

USDI BLM. Utilization Studies and Residual Measurements. Interagency Technical Reference 1734-3. 1999.

U.S. Fish and Wildlife Service. 2015. Endangered and threatened wildlife and plants; designation of critical habitat for the Dakota skipper and Poweshiek skipperling; Vol. 79 No. Final Rule October 1, 2015, 50 CFR Part 17.

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

Whitman, Warren, H. Hanson, and R. Peterson. 1943. Relation of drought and grazing to North Dakota range lands. North Dakota Agricultural Experimentation Bulletin 340.

Zaczkowski, N. K. 1972. Vascular flora of Billings, Bowman, Golden Valley, and Slope counties, North Dakota. Dissertation, ND State University.

Zimmerman, G. M. 1981. Effects of fire upon selected plant communities in the little Missouri badlands. Thesis, ND State University.

## Contributors

ND NRCS: David Dewald, Jonathan Fettig, Jody Forman, Mike Gerbig, Alan Gulsvig, Mark Hayek, Jeanne Heilig, John Kempenich, Chuck Lura, Jeff Printz, Steve Sieler, and Hal Weiser.

## Approval

Suzanne Mayne-Kinney, 3/31/2025

## Acknowledgments

NRCS would like to acknowledge the United State Forest Service (USFS) and National Park Service (NPS) for access to USFS properties and technical assistance in ESD development. USFS: Jack Dahl, Nickole Dahl, and Chad Prosser.

## 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) | M. Hayek, J. Printz, S. Boltz, R. Kilian, D. Froemke, M. Rasmusson |
| Contact for lead author | |
| Date | 03/31/2025 |
| Approved by | Jeff Printz |
| 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 when the slopes are less than 15%. When slopes exceed 15%, rills may be present but uncommon, short (less than 24 inches) and disconnected.

2. **Presence of water flow patterns:** Water flow patterns on slopes less than 15% will be uncommon, short (less than 10 feet), and disconnected with very little visible soil erosion associated with water flow pattern. On slopes greater than 15%, water flow patterns will be common, long (greater than 10 feet), disconnected with some visible soil erosion associated with the water flow patterns.

---

3. **Number and height of erosional pedestals or terracettes:** Scattered pedestals and/or terracettes would be expected on this site when slopes are less than 15%. When slopes exceed 15%, pedestals and terracettes would be common with majority associated with water flow patterns.

---

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground ranges from 40 to 50%. On slopes greater than 15%, bare ground patches would be relatively small (less than 10 inches in diameter) and disconnected. On slopes greater than 15%, bare ground patches will be slightly larger (less than 15 inches) and disconnected.

---

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.

---

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

---

7. **Amount of litter movement (describe size and distance expected to travel):** Short (less than 12 inches) movement of fine/small class of plant litter would be expected on slopes of less than 25%. Longer movement (less than 36 inches) of fine/small class of plant litter would be expected when slopes exceed 25%.

---

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Stability class averages 3 or greater in plant interspaces and 5 or greater under plant canopy.

---

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Structure is blocky or granular within the upper A-horizon. A-horizons for this ecological site range from 2 to 12 inches thick. Hue 2.5Y, 10YR, 7.5YR or redder with value of 4 or less moist or 4 to 6 dry, and chroma 3 or less moist.

---

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Mid- and short-statured bunchgrasses are dominant/subdominant and well distributed across the site. A diverse perennial forb component is a minor category and well distributed across the site.

---

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 are expected on this site. A naturally occurring rooting restriction of varying depth does occur on this site.

---

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

    Dominant: Phase 1.1:
    Mid & short C4 bunch grasses (4)

    Sub-dominant: Phase 1.1:
    Mid & short C3 bunch grasses (3)

    Other: Minor - Phase 1.1:
    Mid & short C3 rhizomatous grasses; Mid & short C4 rhizomatous grasses; Forbs; Shrub; Grass- likes.

    Trace Phase 1.1:
    Evergreen forbs

    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/54_Very_Shallow_Narrative_FINAL_Ref_FSG.pdf

---

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Rare but expected on this site with dead centers on some warm- season bunchgrasses expected (10 to 15%). Dead or dying plants/plant parts (warm-season bunchgrass and shrubs) may be common following a multi-year drought.

---

14. **Average percent litter cover (%) and depth ( in):** Plant litter cover is 10 to 35% with a depth of 0.1 to 0.25 inches) Litter is in contact with soil surface.

---

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Annual production: Annual air-dry production is 800 lbs./ac (reference value) with normal precipitation and temperatures. Low and high production years should yield 400 lbs./ac to 1200 lbs./ac, respectively.

---

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, Rocky Mountain juniper/cedar, and creeping juniper.

---

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