USDA Natural Resources Conservation Service

Ecological site R056BY102MN
Wet Meadow

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General information

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

MLRA notes

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

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

Classification relationships

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

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

Ecological site concept

The Wet Meadow ecological site is generally located in depressions and on low-lying flats and swales on lake plains and till-floored lake plains and floodplains. Slopes are typically less than 1 percent. The soil is very deep. It is poorly drained - a seasonal high-water table is typically within a depth of 1.5 feet during the months of April through June; in depressions, it is frequently ponded (typically <1.5) from March into July. Generally, redox features are within a depth of 18 inches. Hydrology (surface and sub-surface) is the primary factor used in identifying this site. All textures are included in the site.

Associated sites

R056BY084MN	**Clayey** This site occurs on higher, linear slopes on lake plains. The surface layer and subsoil layers form a ribbon >2 inches long. It is >30 inches to redoximorphic features.
R056BY088MN	**Loamy Overflow** This site occurs on flood plains steps. The surface and subsoil layers form a ribbon 1 to 2 inches long. It is deeper than 30 inches to redoximorphic features.
R056BY094MN	**Loamy** This site occurs on higher, linear slopes on lake plains. The surface layer and subsoil layers form a ribbon 1 to 2 inches long. It is >30 inches to redoximorphic features.
R056BY087MN	**Limy Subirrigated** This site occurs on rims of Wet Meadow sites and adjacent flats. The soils range in texture from sandy to clayey. All textures are included in the site. They are highly calcareous within a depth of 16 inches and have redoximorphic features at a depth of 18 to 30 inches.

R056BY096MN	**Subirrigated Sands** This site occurs somewhat higher on the landscape on sand plains. The subsoil does not form a ribbon. It is >30 inches to redoximorphic features.
R056BY095MN	**Subirrigated** This site occurs on flats and in slight depressions with occasional, brief ponding. It has redoximorphic features at a depth of 18 to 30 inches. All textures are included in this site.
R056BY101MN	**Shallow Marsh** This site occurs in deep depressions which have frequent ponding through most of the growing season. All textures are included in this site.
R056BY104MN	**Choppy Sands** This site occurs in areas of sand dunes. The soil is excessively drained with slopes >15%.

Similar sites

R056BY095MN	**Subirrigated** This site occurs on flats and in slight depressions with occasional, brief ponding. It has redoximorphic features at a depth of 18 to 30 inches. All textures are included in this site.
R056BY101MN	**Shallow Marsh** This site occurs in deep depressions which have frequent ponding through most of the growing season. All textures are included in this site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Carex pellita* (2) *Calamagrostis stricta ssp. inexpansa*

Physiographic features

This site typically occurs in depressions and on low-lying flats, depressions, and swales on lake plains, till-floored lake plains and flood plains. Slope is typically less than 1 percent.

Table 2. Representative physiographic features

Landforms	(1) Flat (2) Lake plain > Depression (3) Swale (4) Flood plain
Flooding duration	Brief (2 to 7 days)
Flooding frequency	None to occasional
Ponding duration	Brief (2 to 7 days) to very long (more than 30 days)
Ponding frequency	Occasional to frequent
Elevation	229–451 m
Slope	0–1%
Ponding depth	0–30 cm
Water table depth	0–46 cm
Aspect	Aspect is not a significant factor

Climatic features

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

Table 3. Representative climatic features

Frost-free period (characteristic range)	103-108 days
Freeze-free period (characteristic range)	133-136 days
Precipitation total (characteristic range)	559-584 mm
Frost-free period (actual range)	102-110 days
Freeze-free period (actual range)	132-137 days
Precipitation total (actual range)	559-610 mm
Frost-free period (average)	106 days
Freeze-free period (average)	135 days
Precipitation total (average)	584 mm

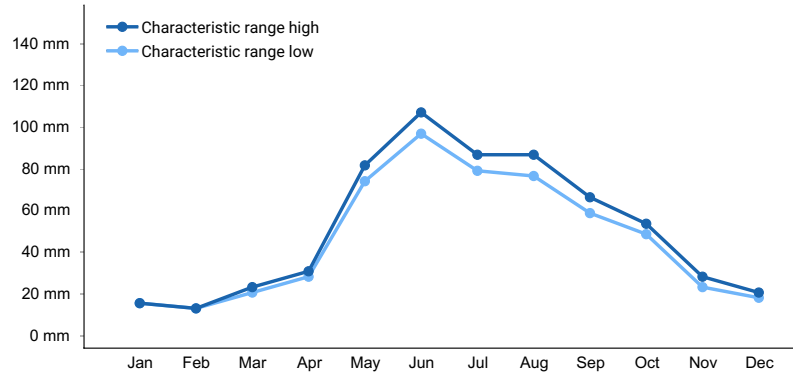


Figure 1. Monthly precipitation range

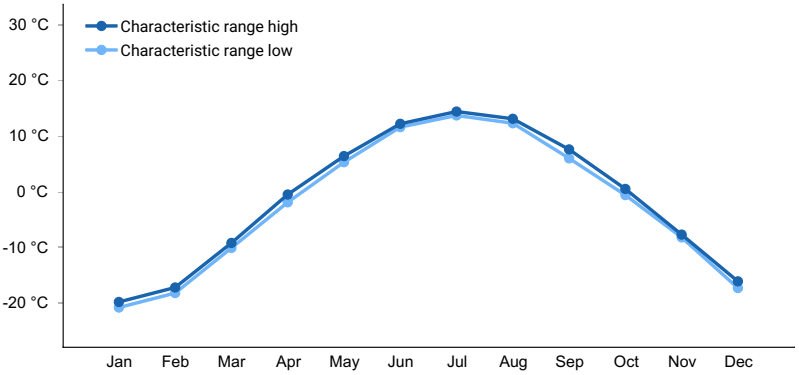


Figure 2. Monthly minimum temperature range

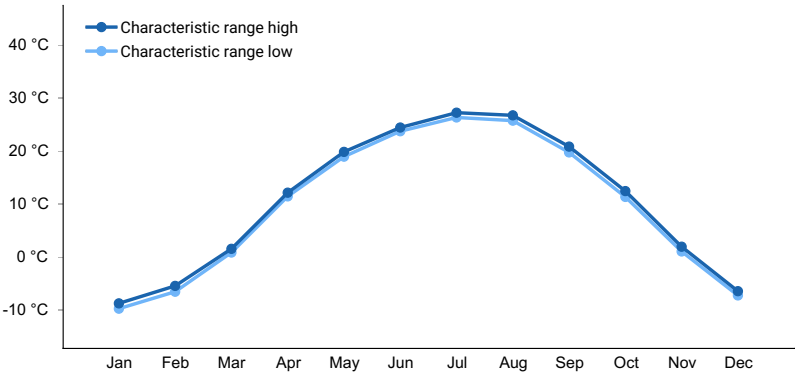


Figure 3. Monthly maximum temperature range

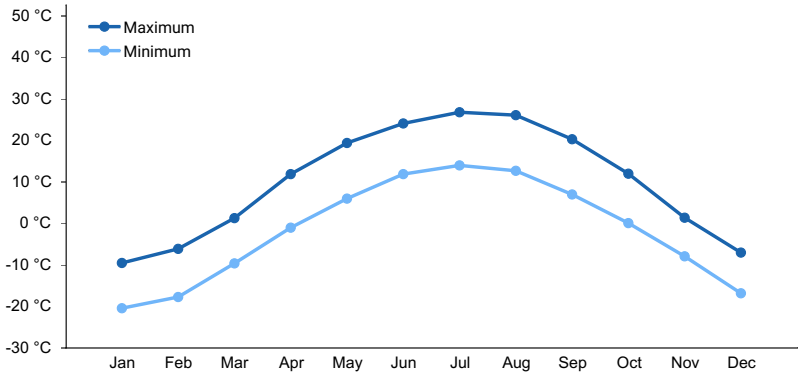


Figure 4. Monthly average minimum and maximum temperature

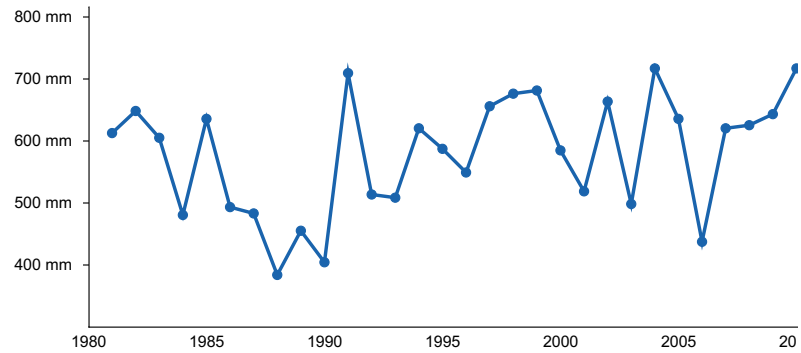


Figure 5. Annual precipitation pattern

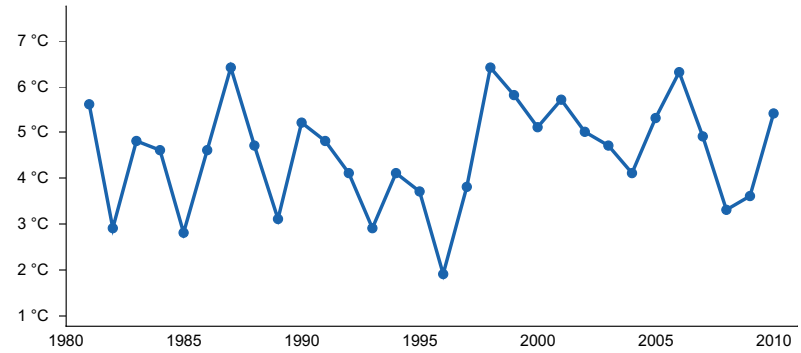


Figure 6. Annual average temperature pattern

Climate stations used

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

Influencing water features

This site is poorly drained. Many areas of this site receive additional water as surface runoff from adjacent uplands. Under normal climatic conditions, the soils in depressions are frequently ponded in April through June (into July for some soils). Depth of ponding typically is less than 1.5 feet during these months. In mid and late summer, ponded water commonly is not evident except after heavy rains. Ponding is typically rare or occasional on flats and swales; where present, ponding is less than 1 foot deep. Soils in this site occurring on flood plains have occasional, brief to frequent, long flooding.

When not ponded, a seasonal high water table typically fluctuates with precipitation events between the surface and a depth of 1.5 feet during the months of April through June and is typically within a depth 3.5 feet through the

remainder of the growing season. Some of the soils in this site have endosaturation (apparent water table) and some have episaturation (perched water table above a subsoil layer with low or moderately low saturated hydraulic conductivity).

Surface infiltration ranges from moderately slow to rapid. Saturated hydraulic conductivity typically ranges from very low to high; some soils have a coarser-textured substratum with very high saturated hydraulic conductivity.

Wetlands receive water from different sources including ground water movement. Recharge wetlands (Wet Meadow) have groundwater flow predominantly away from the wetland moving toward or into a discharge wetland basin. Flowthrough wetlands have groundwater flowing away from the wetland basin but is balanced with water flowing into the basin.

Due to the potential high rate of surface evaporation, areas of this site without frequent ponding are at risk of becoming saline if vegetative cover is reduced or removed.

Water loss is primarily through evapotranspiration and lateral movement into (and evaporation from) adjacent soils. During periods of drought or extreme wetness, water table fluctuations will also have an impact on depth of ponding, especially in sandy soils. During periods of drawdown (e.g. prolonged drought), soil and water chemistry may significantly impact the soil/water/vegetation dynamics of the site (see Site Development and Testing Plan).

Fluctuations in specific conductance are less pronounced during average or normal water conditions than during periods of excessive water depth or extreme drought. The approximate normal and extreme range in specific conductance (micromhos/cm3) of surface water in plant communities that are indicators of differences in average salinity are as follows:

Plant Community Normal Range (micromhos/cm3 Electroconductivity (dS/m)
Fresh <40 - 500 0.5
Slightly brackish 500 - 2,000 0.5 to 2.0
Moderately brackish 2,000 - 5,000 2.1 to 5.0
Brackish 5,000 - 15,000 5.1 to 15.0
Sub-saline 15,000 - 45,000 15.1 to 45.0
Saline 45,000 -100,000 > 45.0

Soils in these depressions are considered temporary wetlands; however, during wetter than normal climate cycles, these soils may have seasonal ponding.

Wetland description

Wetland Description: Cowardin, et. al. 1979
System: Palustrine
Subsystem: N/A
Class: Emergent
Sub-class: Persistent

Soil features

Soils associated with Wet Meadow ES are predominantly in the Mollisol, Entisol, and Vertisol orders. These soils were developed under wetland vegetation. They formed in glaciolacustrine sediments, glaciolacustrine sediments over till, and glaciofluvial deposits.

The common feature of soils in this site are inundation or near-surface saturation in the early part of the growing season. The soils are very deep and poorly drained. Some are in depressions and potholes that are ponded from April through June (some soils into July); some are on low-flying flats which have prolonged saturation in the spring; and some are on flood plains with occasional or frequent flooding with brief or long duration. Since hydrology (surface and sub-surface) is the primary factor used in identifying this site, all textures are included. Therefore, soil physical properties associated with texture vary widely.

Soil reaction typically is moderately acid to moderately alkaline (pH 6.6 to 8.4).

This site should show no evidence of rills, wind-scoured areas, or pedestaled plants. The soil surface is stable and intact. In some soils, sub-surface layers are non-restrictive to water movement; in other soils a layer of clay accumulation slows water movement and prolongs surface ponding. The soil/water/plant relationship is strongly influenced by ponded/and or saturated conditions.

Major soil series correlated to the Wet Meadow site are: Augsburg, Aquents, Boash, Borup, Colvin, Espelie, Grano, Grygla, Hamar, Hangaard, Hedman, Kratka, Lamoure, Mavie, Nielsville, Percy, Rockwell, Roliss, Rosewood, Smiley, Strandquist, Strathcona, Syrene, Thiefriver, Vallers, Woodslake, and Wyandotte.

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

Table 4. Representative soil features

Parent material	(1) Glaciolacustrine deposits (2) Till (3) Glaciofluvial deposits
Surface texture	(1) Loam (2) Fine sandy loam (3) Loamy fine sand
Drainage class	Poorly drained
Permeability class	Moderately slow to rapid
Depth to restrictive layer	99–203 cm
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	11.18–17.53 cm
Soil reaction (1:1 water) (0-25.4cm)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–15%
Subsurface fragment volume >3" (Depth not specified)	0–3%

Ecological dynamics

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

Prior to European influence, the historical disturbance regime for MLRA 56 included frequent fires, both anthropogenic and natural in origin. Most fires, however, were anthropogenic fires set by Native Americans. Native Americans set fires in all months except perhaps January. These fires occurred in two peak periods, one from March-May with the peak in April and another from July-November with the peak occurring in October. Most of these fires were scattered and of small extent and duration. The grazing history would have involved grazing and browsing by large herbivores such as American bison, elk, and whitetail deer. Herbivory by small mammals, insects, nematodes and other invertebrates are also important factors influencing the production and composition of the communities. Grazing and fire interaction, particularly when coupled with drought events, influenced the dynamics discussed and displayed in the following state and transition diagram and descriptions.

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

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

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

State 1: Reference State represents the natural range of variability that dominated the dynamics of this ecological site prior to European influence. Dynamics of the state were largely determined by variations in climate and weather (e.g. drought) as well as that of fire (e.g. timing, frequency), and grazing by native herbivores (e.g. frequency, intensity, selectivity). Due to those variations, the Reference State is thought to have shifted temporally and spatially between three Plant Community Phases. These communities were generally dominated by herbaceous vegetation (i.e. graminoids); however, willows, bog birch, and other shrubs were often present in small amounts.

Presently the primary disturbances are due to the widespread introduction of exotic species, concentrated livestock grazing, lack of fire, and perhaps long-term non-use and no fire. Because of these changes (particularly the widespread occurrence of exotic species), as well as other environmental changes, the Reference State is becoming increasingly rare, but may still be found within tracts of intact natural vegetation (i.e. rangeland). The presence of exotic species on the site precludes it from being placed in the Reference State. It must then be placed in one of the other states, most commonly State 2: Native/Invaded State (T1A).

State 2: Native/Invaded State: Colonization of the site by exotic species results in a transition from State 1: Reference State to State 2: Native/Invaded State (T1A). This transition was probably inevitable, and often resulted from colonization by exotic cool-season grasses, such as Kentucky bluegrass, smooth brome, quackgrass, and/or redtop, which have been particularly and consistently invasive under extended periods of non-use and no fire. Forbs such as field sowthistle, leafy spurge, and Canada thistle are also known to invade the site.

Three community phases have been identified for this state and are similar to the three community phases in the Reference State but have now been invaded by exotic cool-season grasses. These exotic cool-season grasses can be expected to increase. As that increase occurs, plants more desirable to wildlife and livestock may decline. A decline in forb diversity can also be expected. Under non-use or minimal use management mulch increases and may become a physical barrier to plant growth. It also changes the micro-climate near the soil surface, and may alter infiltration, nutrient cycling, and biological activity near the soil surface. As a result, these factors coupled with shading cause desirable native plants to have increasing difficulty remaining viable and recruitment declines.

To slow or limit the invasion of these exotic grasses or other exotic plants, it is imperative that managerial options (e.g. prescribed grazing, prescribed burning) be carefully constructed and evaluated with respect to that objective. If management does not include measures to control or reduce these exotic plants, the transition to State 4: Invaded State should be expected (T2B). The threshold to this transition is reached when the exotic cool-season grasses exceed 30% of the plant community and native grasses represent less than 40% of the community. Small and scattered willows may also be on the site. These willows may become dominant, particularly under extended periods of no use and no fire which may lead to a transition to State 3: Wooded State (T2A).

Maintenance of ecological sites on the periphery of the Wet Meadow sites are critical to the ecological integrity/functioning of the wetland ecosystem. If a buffer zone (50 feet minimum) is not maintained, an increase in eutrophication, sedimentation rate, and invasion by exotic species can be expected. For more information on buffer widths please refer to the Gilbert et.al. (2006) in the references section.

To slow or limit the invasion of these exotic species and their hybrids, it is imperative that managerial options (e.g.

prescribed grazing, prescribed burning, maintaining intact buffers) be carefully constructed and evaluated with respect to that objective. If management does not include measures to control or reduce these exotic cool-season grasses, the transition to State 4: Invaded State should be expected (T2B).

State 3: Wooded State
This state historically existed as small willows/bog birch scattered across the site when precipitation, fire frequency, and other factors enabled them to colonize or encroach on the site. A marked increase in non-use management and active fire suppression since European influence has enabled this state to expand and become more widespread. One community phase has been identified and often results from extended periods of non-use or very light grazing and no fire (T2A). Brush control, perhaps followed by a successful range planting, may lead to State 2: Native/Invaded State (R3A).

State 4: Invaded State. The threshold for this state is reached when the exotic cool-season grasses exceed 30% of the plant community and native grasses represent less than 40% of the community. One plant community phase has been identified for this state.

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

Once the state is well established, prescribed burning and prescribed grazing techniques have been largely ineffective in suppressing or eliminating the exotic cool-season grasses even though some short-term reductions may appear successful. However, assuming there is an adequate component of native grasses to respond to treatments, a restoration pathway to State 2: Native/Invaded State (R4A) may be accomplished with the implementation of long-term prescribed grazing in conjunction with prescribed burning. Shrubs (e.g. willows, bog birch) may become dominant on this site, particularly under extended periods of no use and no fire which may lead to a transition to State 3: Wooded State (T4A).

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

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

Initially, due to extensive bare ground and a preponderance of shallow rooted annual plants, infiltration is low and the potential for soil erosion is high. Plant species richness may be high, but overall diversity (i.e. equitability) is typically low, with the site dominated by a relatively small assemblage of species. Due to the lack of native perennials and other factors, restoring the site with the associated ecological processes is difficult. However, a successful range planting may result in something approaching State 2: Native/Invaded State (R5A). Following seeding, prescribed grazing, prescribed burning, haying, and the use of herbicides will generally be necessary to achieve the desired result and control weeds, some of which may be noxious weeds. A failed range planting and/or secondary succession will lead to State 4: Invaded State (R5B).

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

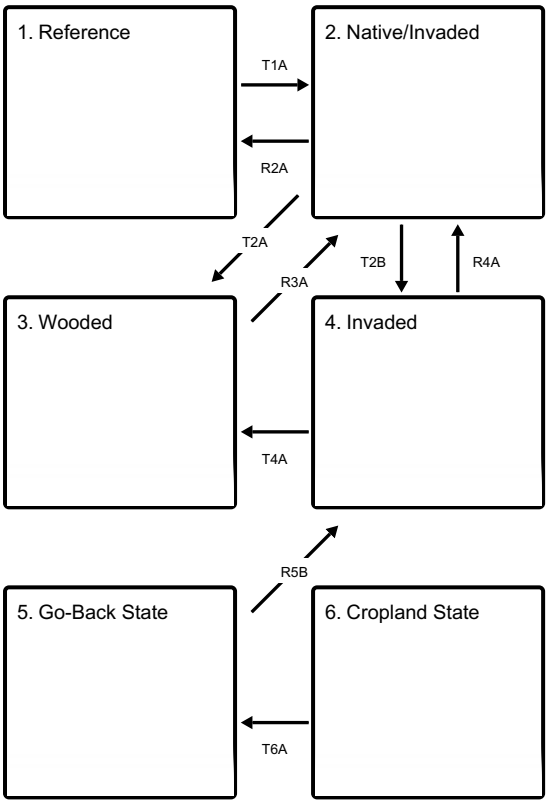
When the management goal is to maintain an existing plant community phase or restore to another phase within the

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.

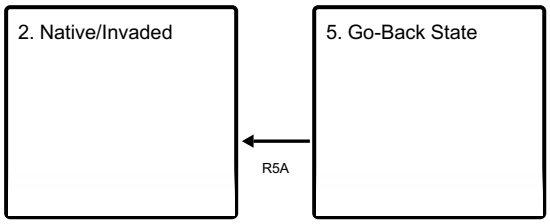
The plant community phase composition table(s) has been developed from the best available knowledge including research, historical records, clipping studies, and inventory records. As more data are collected, plant community species composition and production information may be revised.

State and transition model

Ecosystem states



States 2 and 5 (additional transitions)



T1A - Colonization by exotic species

R2A - Mechanical brush control and prescribed burning

T2A - No use and no fire

T2B - Increase and extent of exotic species

R3A - Brush control, perhaps followed by range planting

R4A - Prescribed burning and prescribed grazing

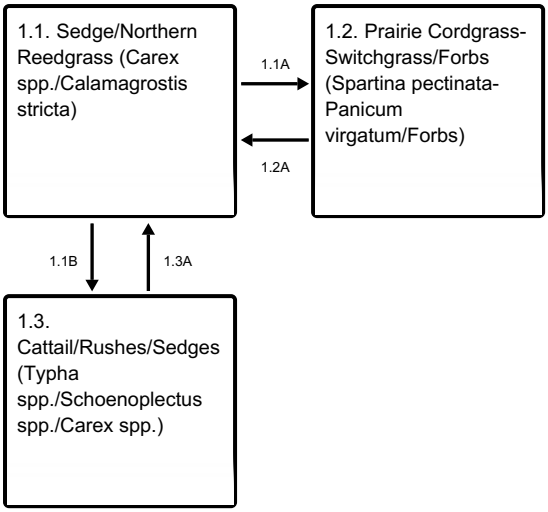
T4A - No use and no fire

R5A - Successful range planting

R5B - Failed range planting

T6A - Cessation of annual cropping

State 1 submodel, plant communities



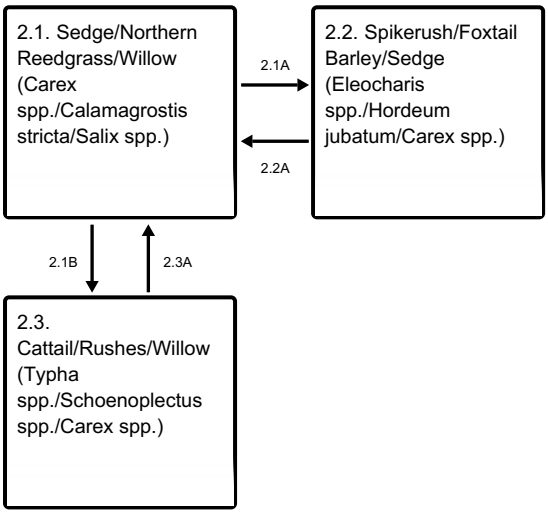
1.1A - Prolonged drought

1.1B - Prolonged periods of above average precipitation

1.2A - Return to average precipitation and historic disturbance regime

1.3A - Return to average precipitation and historic disturbance regime

State 2 submodel, plant communities



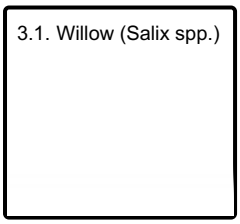
2.1A - Prolonged drought and increased pressure and/or mechanical disturbance

2.1B - Prolonged periods of above average precipitation

2.2A - Return to average precipitation and historic disturbance regime

2.3A - Return to average precipitation and historic disturbance regime

State 3 submodel, plant communities



State 4 submodel, plant communities

4.1. Exotic Grasses/Foxtail Barley/Sedge/Willow

State 5 submodel, plant communities

5.1. Annual/Pioneer Perennial/Exotics

State 1
Reference

This state is typically dominated by cool-season grass-likes and grasses with minor amounts of warm-season grasses in association with a variety of forbs and a few scattered and small shrubs, particularly willows. It represented the natural range of variability that dominates 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 cause the community to shift both spatially and temporally between three community phases. Today the primary disturbance is a lack of fire, physical impacts of livestock grazing, mechanical harvest, and water level fluctuations including hydrological manipulations. In some instances, the mechanical harvest (haying) of these sites has similar impacts on the willows as fire, limiting their size and extent within the plant community. Because of the changes in disturbances, invasion by exotic species, and other factors, the reference state is becoming increasingly rare, but may be encountered within tracts of native vegetation. Small and scattered willows (e.g. sandbar, Bebb), bog, birch, and other shrubs may be present in communities of this state, particularly in the eastern portions of this MLRA under extended periods of no use and no fire management. Unless brush control methods are implemented (e.g. prescribed burning intervals of 3-5 years), the willows may become dominant. Left unchecked, this may lead to State 2: Native/Invaded State (e.g. Community Phases 2.1 or 2.3) and perhaps on to State 3: Wooded State.

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

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

Dominant plant species

- willow (*Salix*), shrub
- bog birch (*Betula pumila*), shrub
- woolly sedge (*Carex pellita*), grass
- northern reedgrass (*Calamagrostis stricta ssp. inexpansa*), grass
- switchgrass (*Panicum virgatum*), grass
- fowl bluegrass (*Poa palustris*), grass
- prairie cordgrass (*Spartina pectinata*), grass
- rough bugleweed (*Lycopus asper*), other herbaceous
- western dock (*Rumex aquaticus*), other herbaceous
- Canada germander (*Teucrium canadense*), other herbaceous
- wild mint (*Mentha arvensis*), other herbaceous

Community 1.1
Sedge/Northern Reedgrass (Carex spp./Calamagrostis stricta)

This community evolved with grazing by large herbivores, occasional prairie fires, and relatively frequent ponding events; it can be found on areas that are properly managed with grazing and/or prescribed burning and, sometimes, on areas receiving occasional short periods of rest. Woolly sedge is typically the dominant grass-like species, while northern reedgrass is the dominant grass. A variety of sedges and rushes occur throughout this community as well as switchgrass and fowl bluegrass. Key forbs include rough bugleweed, western dock, Canada germander, and mints. Small scattered willows, bog birch, and perhaps other shrubs are also often present. This plant community phase is diverse, stable, and productive. The high water table/shallow ponding (ponding < 18 inches) supplies much of the moisture for plant growth. The diversity in plant species allows for the variability of both the fluctuations of water table and reoccurring ponding. Annual production will vary from about 4200-6200 pounds per acre with grasses and grass-likes, forbs, and shrubs contributing about 80%, 15%, and 5% respectively. This community represents the plant community phase upon which interpretations are primarily based and is described in the “Plant Community Composition and Group Annual Production” portion of this ecological site description.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	4461	4954	5912
Forb	247	729	729
Shrub/Vine	–	146	308
Total	**4708**	**5829**	**6949**

Community 1.2
Prairie Cordgrass-Switchgrass/Forbs (Spartina pectinata-Panicum virgatum/Forbs)

This plant community phase is occurs during prolonged drought, and is characterized by a shift from the mid-statured grass-likes and grasses such as woolly sedge and Northern reedgrass to species which would more often be associated with slightly drier sites (i.e. Subirrigated ecological site) such as prairie cordgrass, switchgrass, and mat muhly. Spikerush and mountain rush are the dominant grass-likes. Common forbs include blackeyed Susan, goldenrods, Canada anemone, ragworts and swamp verbena. Small scattered willows, bog birch, and other shrubs may also be present.

Community 1.3
Cattail/Rushes/Sedges (Typha spp./Schoenoplectus spp./Carex spp.)

This plant community phase is characterized by an increase in the more flood tolerant species such as cattails and rushes. Small areas of open water may be present. Dominant species would include broadleaf cattail, common threesquare, softstem bulrush, common spikerush, duckweed, knotweed, and bladderwort. Woolly sedge and northern reedgrass are still present but in reduced amounts scattered across the site. Small and scattered willows (e.g. sandbar willow), bog birch, and perhaps other shrubs may also be present in this community, particularly under extended periods of no use and no fire management. Unless brush control techniques are implemented (e.g. burn interval of 3-5 years), the willows may become dominant. Left unchecked, this may lead to State 3: Wooded State via State 2: Native/Invaded State (Community Phases 2.1 or 2.3).

Pathway 1.1A
Community 1.1 to 1.2

Community Phase Pathway 1.1 to 1.2 occurs during prolonged drought leading to a drop in the water table, resulting in a marked increase in spikerush and foxtail barley along with a corresponding decrease in sedges and northern reedgrass.

Pathway 1.1B

Community 1.1 to 1.3

Community Phase Pathway 1.1 to 1.3 occurs during prolonged periods of above average precipitation, leading to a rise in the water table and increased ponding frequency and duration. This results in a marked decrease in sedges and northern reedgrass along with a corresponding increase in cattail, rushes, and willows.

Pathway 1.2A
Community 1.2 to 1.1

Community Phase Pathway 1.2 to 1.1 occurs with a return to average precipitation and historic disturbance regime leading a rise in the water table. This results in a marked increase in sedges and northern reedgrass along with a corresponding decrease in prairie cordgrass and switchgrass.

Pathway 1.3A
Community 1.3 to 1.1

Community Phase Pathway 1.3 to 1.1 occurs with the return to average (or below) precipitation and historic disturbance regime over several years leading to a drop in the water table and decreased ponding duration and frequency. As a result, the community shifts from cattails, rushes, and sedges to sedges and northern reedgrass.

State 2
Native/Invaded

This state is similar to State 1: Reference State but has now been colonized by the exotic cool-season grasses, commonly Kentucky bluegrass, smooth brome, quackgrass, and/or redtop which are now present in small amounts. Field sowthistle, leafy spurge, and Canada thistle are also known to invade the site. Although the state is still dominated by native grasses, an increase in these exotic cool-season grasses can be expected. The exotic cool-season grasses can be quite invasive on the site and are particularly well adapted to heavy grazing. They also often form monotypic stands. As these exotic cool-season grasses increase, both forage quantity and quality become increasingly restricted to late spring and early summer due to the monotypic nature of the stand even though annual production may increase. Native forbs generally decrease in production, abundance, diversity, and richness compared to that of State 1: Reference State. These exotic cool-season grasses have been particularly and consistently invasive under extended periods of no-use and no fire. To slow or limit the invasion of these exotic grasses it is imperative that managerial options (e.g. prescribed grazing, prescribed burning) be carefully constructed and evaluated with respect to that objective. If management does not include measures to control or reduce these exotic cool-season grasses the transition to State 3: Invaded State should be expected. Small and scattered willows (e.g. sandbar, Bebb) may also be present, particularly under extended periods of no use and no fire management. Unless brush control methods are implemented (e.g. prescribed burning of 3-5 year intervals), the willows may become invasive, and the eventual transition to State 3: Wooded State can be expected (T2A). Annual production of this state can be quite variable, in large part due to the amount of exotic cool-season grasses. Annual production may, however, range from 4600-5800 pounds per acre.

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

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

summer vs. fall) should be adjusted to account for differences in annual growing conditions and applied during windows of opportunity to best shift the competitive advantage to the native species.

Dominant plant species

- sandbar willow (*Salix interior*), shrub
- Bebb willow (*Salix bebbiana*), shrub
- woolly sedge (*Carex pellita*), grass
- northern reedgrass (*Calamagrostis stricta ssp. inexpansa*), grass
- switchgrass (*Panicum virgatum*), grass
- fowl bluegrass (*Poa palustris*), grass
- smooth brome (*Bromus inermis*), grass
- redtop (*Agrostis gigantea*), grass
- bulrush (*Schoenoplectus*), other herbaceous
- rough bugleweed (*Lycopus asper*), other herbaceous
- western dock (*Rumex aquaticus*), other herbaceous
- Canada germander (*Teucrium canadense*), other herbaceous
- wild mint (*Mentha arvensis*), other herbaceous
- field sowthistle (*Sonchus arvensis*), other herbaceous
- leafy spurge (*Euphorbia esula*), other herbaceous
- Canada thistle (*Cirsium arvense*), other herbaceous

Community 2.1
Sedge/Northern Reedgrass/Willow (Carex spp./Calamagrostis stricta/Salix spp.)

This Community Phase is similar to Community Phase 1.1 but has been colonized by exotic cool-season grasses, often Kentucky bluegrass, smooth brome, redtop, and/or quackgrass. However, these exotics are present in smaller amounts with the community still dominated by native grasses. Field sowthistle, leafy spurge, and Canada thistle are also known to invade the site. Small and scattered willows (e.g. sandbar willow) are also present, particularly under non-use and no fire management. Unless a brush control program is implemented (e.g. prescribed burning at 3-5 year intervals), the willows may become invasive, eventually leading to the transition to State 3: Wooded State (T2A). Annual production can be quite variable, in part due to variations in the invasion by exotic cool-season grasses. However, annual production may be in the range of 4600-5800 pounds per acre.

Table 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	4853	4925	5464
Forb	247	729	729
Shrub/Vine	56	175	308
Total	**5156**	**5829**	**6501**

Community 2.2
Spikerush/Foxtail Barley/Sedge (Eleocharis spp./Hordeum jubatum/Carex spp.)

Increased grazing pressure and associated disturbances (e.g. trampling) have resulted in increased bare ground compared to Community Phase 2.1. The community can be characterized by an increase in disturbance tolerant species such as spikerush, foxtail barley, muhly, Mountain rush, curly dock, verbena and annual forbs. Sedges and northern reedgrass are still present but in reduced amounts. Willows, if present, may become more conspicuous. Redtop, if present, will increase in this phase.

Community 2.3
Cattail/Rushes/Willow (Typha spp./Schoenoplectus spp./Carex spp.)

This plant community phase is characterized by an increase in the more flood tolerant species such as cattails and rushes. Dominant species would include broadleaf cattail, American threesquare, softstem bulrush, common

spikerush, duckweed, knotweed, and bladderwort. Exotic species such as narrowleaf cattail and hybrid cattail are also present. Woolly sedge and northern reedgrass are still present but in reduced amounts scattered across the site. Small areas of open water may also be present. Small and scattered willows (e.g. sandbar, Bebb) are often present, particularly under no use and no fire management. Unless a brush control program is implemented (e.g. prescribed burning at 3-5 year intervals), the willows may become invasive, eventually leading to the transition to State 3: Wooded State (T2A).

Pathway 2.1A
Community 2.1 to 2.2

Community Phase Pathway 2.1 to 2.2 occurs during prolonged drought and increased grazing pressure and associated disturbances. This lowers the seasonal water table, potentially shifting the plant community to those species more often associated with a Subirrigated ecological site and may increase soil salinity." This shift may be further compounded by an increase in grazing intensity and frequency due to the decline in available forage on adjacent upland sites. The shift in the plant community is driven as much by the actual physical impact of the grazing animals (e.g. root shearing, trampling) as it is from the grazing itself. This pathway can also be initiated on smaller areas by the physical disturbance of motorized vehicle traffic or concentrated livestock activities such as that associated with dugouts, creep feeders, and the like.

Pathway 2.1B
Community 2.1 to 2.3

Community Phase Pathway 2.1 to 2.3 occurs during prolonged periods of above average which raises the water table and increases ponding frequency and duration. This shifts the plant community to the more flood tolerant species such as cattails, rushes, and willows.

Pathway 2.2A
Community 2.2 to 2.1

Community Phase Pathway 2.2 to 2.1 occurs with the return to average precipitation and historic disturbance regime. This leads to a marked increase in sedge, northern reedgrass, and willow with a corresponding decrease in spikerush and foxtail barley.

Pathway 2.3A
Community 2.3 to 2.1

Community Phase Pathway 2.3 to 2.1 occurs with the return to average (or below) precipitation and disturbance regime. Reduced ponding duration and frequency shifts the plant community from cattails, rushes, and willows to sedges, northern reedgrass, and willows. An increase in grazing and fire frequency can lead to greater declines in cattails. This pathway is initiated by a return to normal or below normal precipitation regime over a period of several years. Reduced ponding duration and frequency shifts the plant community to sedge/ northern reedgrass. Increased fire along with grazing will negatively impact cattails, favoring sedge/northern reedgrass.

State 3
Wooded

This state is characterized by a dominance (both visually and in production) of willow species and a greatly reduced herbaceous understory. Remnant sedges still dominate the herbaceous portion of the state but shade tolerant invasives, such as Kentucky bluegrass and/or redtop, may also be present.

Characteristics and indicators. As shrubs increase in size and density, canopy cover increases which alters micro-climate and reduces fine fuel amounts resulting in reduced fire intensity and frequency. Diversity and production of herbaceous understory is reduced as canopy cover increases.

Dominant plant species

- sandbar willow (*Salix interior*), shrub
- Bebb willow (*Salix bebbiana*), shrub

- white meadowsweet (*Spiraea alba*), shrub
- sedge (*Carex*), grass
- rush (*Juncus*), grass

Community 3.1
Willow (Salix spp.)

This plant community phase is dominated by sandbar and Bebb willow. Other shrubs species may include white meadowsweet. Herbaceous production is greatly reduced due to shading, with various sedges and rushes still dominating the remnant herbaceous community. Willow height may exceed six feet. As willows mature, herbaceous production may decline to less than 500 pounds per acre. Bare ground is minimal (less than 2%) due to plant litter accumulation from willow leaves. Once established, this plant community is very resilient and resistant to change. The lack of fine fuels in the understory and high degree of shading makes the application of prescribed fire very difficult, if not impossible, without some type of mechanical pretreatment a year to two prior to the burn. Some type of treatment which would reduce the willow canopy and allow the remnant herbaceous community to produce adequate fine fuel loads to permit the repeated application of prescribed fire may begin to shift the plant community toward State 2: Native/Invaded State.

State 4
Invaded

This state is the result of invasion and dominance by the exotic cool-season grasses, commonly Kentucky bluegrass, smooth brome, redtop, and/or quackgrass. Canada thistle, field sowthistle, leafy spurge, and exotic strains or hybrids of reed canarygrass and hybrid cattail are also known to invade the site. The exotic cool-season grasses can be quite invasive on the site and are particularly well adapted to heavy grazing. They also often form monotypic stands. As these exotic cool-season grasses increase, both forage quantity and quality become increasingly restricted to late spring and early summer due to the monotypic nature of the stand even though annual production may increase. Native forbs generally decrease in production, abundance, diversity, and richness compared to that of State 1: Reference State. Common forbs often include goldenrod, sunflower, and Indianhemp. Willows and white meadowsweet may also be present. Once the state is well established, prescribed burning and grazing techniques have been largely ineffective in suppressing or eliminating these three species even though some short-term reductions may appear successful. Annual production of this state may vary widely, in part due to variations in the extent of invasion by exotic cool-season grasses

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

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

Dominant plant species

- redtop (*Agrostis gigantea*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- quackgrass (*Elymus repens*), grass
- reed canarygrass (*Phalaris arundinacea*), grass
- foxtail barley (*Hordeum jubatum*), grass
- spikerush (*Eleocharis*), grass
- green muhly (*Muhlenbergia ramulosa*), grass
- curly dock (*Rumex crispus*), other herbaceous
- Canada thistle (*Cirsium arvense*), other herbaceous
- leafy spurge (*Euphorbia esula*), other herbaceous
- field sowthistle (*Sonchus arvensis*), other herbaceous

Community 4.1

Exotic Grasses/Foxtail Barley/Sedge/Willow

This plant community phase is characterized by an increase in disturbance tolerant exotic grasses such as Kentucky bluegrass, quackgrass, redtop, and/or smooth brome in association with foxtail barley, sedges, and willows (e.g. sandbar, Bebb). Exotic strains and/or hybrids of reed canarygrass may also increase and become the dominant species. If soil salinity increases due to lack of plant cover and increased bare ground, foxtail barley may be a major component. Native species such as spikerush, muhly, mountain rush, curly dock, and other native forbs are often present. Canada thistle, leafy spurge and field sowthistle are exotic forbs known to invade the site

State 5
Go-Back State

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

Dominant plant species

- Kentucky bluegrass (*Poa pratensis*), grass
- smooth brome (*Bromus inermis*), grass
- redtop (*Agrostis gigantea*), grass
- quackgrass (*Elymus repens*), grass
- leafy spurge (*Euphorbia esula*), other herbaceous
- Canada thistle (*Cirsium arvense*), other herbaceous
- field sowthistle (*Sonchus arvensis*), other herbaceous

Community 5.1
Annual/Pioneer Perennial/Exotics

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

State 6
Cropland State

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

Dominant plant species

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

Transition T1A
State 1 to 2

This is the transition from the State 1: Reference State to the State 2: Native/Invaded State. This is often due to the introduction and establishment of exotic cool-season grasses, typically Kentucky bluegrass, smooth brome, quackgrass, and/or redtop. Canada thistle and field sowthistle are also known to invade the site. This transition is probably inevitable and corresponds to a decline in native warm-season and cool-season grasses. The threshold between states is crossed when exotic species became established on the site. This transition may be exacerbated

by chronic season-long or heavy late season grazing. Extended periods of no use and no fire is often associated with the a marked increase in willows which may become dominant. If no action is taken to limit the increase in willows, a further transition to State 3: Wooded State may be expected.

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

Restoration pathway R2A
State 2 to 1

This is the restoration from State 2: Native/Invaded State to State 1: Reference State may be accomplished through the implementation of mechanical brush control and prescribed burning, sediment removal, successful buffe or upland restoration. In the absence of invasive species, prescribed burning in combination with mechanical treatment and/or herbicide treatment, would reduce the willow component to Reference State levels. This restoration pathway is not applicable when exotic invasive species are present in the plant community or the surrounding upland has been previously or is currently cropped.

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).

Conservation practices

Brush Management
Prescribed Burning
Herbaceous Weed Control

Transition T2A
State 2 to 3

This transition from State 2: Native/Invaded State to State 3: Wooded State occurs during extended periods of no use and no fire. This enables the willows (e.g. sandbar, Bebb) to increase in the size and extent. The transition may be facilitated by periods of above average precipitation. Sporadic attempts to shift the plant community back to the Reference State through the use of prescribed burning and/or mechanical treatment causes the willow to re-sprout with multiple stems and, ultimately, may hasten the transition. Experience would indicate the threshold occurs when willows attain a height of greater than 30 inches and become multi-stemmed. At this point, the willows begin to suppress herbaceous production and limit fire intensity. If a fire does occur, it does not generate adequate heat to kill the willow or, if it top-kills the willow, re-sprouting results in an even thicker stand.

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

Context dependence. Societal norms have accepted woody invasion as positive for wildlife habitat, carbon sequestration, aesthetics, etc. Livestock managers may not understand the loss of production due to woody

invasion and loss of native grass species. Wildlife managers may need to manage woody habitat for exotic wildlife species such as ring-necked pheasants instead of sharp-tailed grouse or other grassland nesting birds intolerant to woody species invasion.

Transition T2B
State 2 to 4

This transition from the State 2: Native/Invaded State to State 4: Invaded State generally occurs as exotic species expand and begin to dominate the site. This is often due to exotic cool-season grasses such as quackgrass, Kentucky bluegrass, redtop, and/or smooth brome. However, hybrid cattail, exotic strains and hybrids of reed canarygrass, Canada thistle, field sowthistle, and leafy spurge are also known to invade the site. Studies indicate that a threshold may exist in this transition when Kentucky bluegrass exceeds 30% of the plant community and native grasses represent less than 40% of the plant community composition. Similar thresholds may exist for other exotic species. This transition may occur under a wide range of managerial conditions ranging from non-use and no fire to heavy season-long grazing (primarily Kentucky bluegrass).

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

Restoration pathway R3A
State 3 to 2

This restoration pathway from State 3: Wooded State to State 2: Native/Invaded State can be accomplished with brush control. Initial use of herbicides and/or mechanical brush control to reduce willows will permit adequate fine fuel loads to establish, permitting the application of prescribed fire to further control sprouting. However, depending upon level of remnant native grasses and forbs, a range planting may also be necessary to re-establish the herbaceous plant community. A combination of mechanical brush management, chemical treatment, and prescribed burning is necessary to remove the willows and, if necessary, to prepare the seedbed for a successful range planting. Once this is accomplished, it may be possible using selected plant materials and agronomic practices to approach something very near the functioning of State 2: Native/Invaded State. Application of chemical herbicides and the use of mechanical seeding methods using adapted varieties of the dominant native grasses are possible and can be successful. The application of several prescribed burns may be needed at relatively short intervals in the early phases of this restoration process, in part because of sprouting of the willows following one burn. After establishment of the native plant species, management objectives must include the maintenance of those species, the associated reference state functions, and continued treatment of exotic grasses. Due to the resprouting nature of willows, repeated treatments may be necessary to complete the restoration. Following the removal of woody species, other restoration practices such as range planting, prescribed burning, and prescribed grazing may be necessary to complete the restoration. The prescribed grazing should include adequate recovery periods following each grazing event and stocking levels which match the available resources. If properly implemented, this will help suppress any exotic cool-season grasses on the site.

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

Conservation practices

Prescribed Grazing
Herbaceous Weed Control

Restoration pathway R4A
State 4 to 2

This restoration pathway from State 4: Invaded State to State 2: Native/Invaded State may be accomplished with the implementation of long-term prescribed grazing and prescribed burning, assuming there is an adequate component of native grasses to respond to the treatments. Successful restoration along Restoration Pathway R4A is dependent upon management of the buffer or adjacent upland eliminating sedimentation and nutrient loading to the Wet Meadow ecological site and limiting invasive species movement from the adjacent upland sites. Both prescribed grazing and prescribed burning are likely necessary to successfully initiate this restoration pathway, the success of which depends upon the presence of a remnant population of native grasses in Community Phase 4.1. That remnant population, however, may not be readily apparent without close inspection. The application of several prescribed burns may be needed at relatively short intervals in the early phases of this restoration process, in part because thew willows will resprout following one burn. Early season prescribed burns have been successful; however, fall burning may also be an effective technique. The prescribed grazing should include adequate recovery periods following each grazing event and stocking levels which match the available resources. If properly implemented, this will shift the competitive advantage from the exotic cool-season grasses to the native cool-season grasses.

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

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing
Herbaceous Weed Control

Transition T4A
State 4 to 3

This transition from State 4: Invaded State to State 3: Wooded State is characterized by extended periods of no use and no fire. This enables willows (e.g. sandbar, Bebb) to increase in density and size, and eventually dominate the vegetation of the site.

Restoration pathway R5A
State 5 to 2

This restoration from State 5: Go-back State to State 2: Native/Invaded State can be accomplished with a successful range planting. Following seeding, prescribed grazing, prescribed burning, haying, or use of herbicides will generally be necessary to achieve the desired result and control any noxious weeds. It may be possible using selected plant materials and agronomic practices to approach something very near the functioning of State 2: Native/Invaded State. Application of chemical herbicides and the use of mechanical seeding methods using adapted varieties of the dominant native grasses are possible and can be successful. After establishment of the native plant species, prescribed grazing should include adequate recovery periods following each grazing event and stocking levels which match the available resources, and management objectives must include the maintenance of those species, the associated reference state functions, and continued treatment of exotic grasses.

Restoration pathway R5B
State 5 to 4

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

Transition T6A
State 6 to 5

This transition from any plant community to State 5: Go-Back State. Most commonly, it is associated with the cessation of cropping without the benefit of restoration efforts, 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, such as development of a tillage induced compacted layer, erosion, fertility (degree of eutrophication), and sedimentation herbicide/pesticide carryover. Thus, soil conditions should be assessed when considering restoration techniques.

Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Gass-Likes**			2331–2914	
	woolly sedge	CAPE42	*Carex pellita*	1749–2331	–
	shortbeak sedge	CABR10	*Carex brevior*	874–1457	–
	wheat sedge	CAAT2	*Carex atherodes*	874–1457	–
	Sartwell's sedge	CASA8	*Carex sartwellii*	58–291	–
	Bicknell's sedge	CABI3	*Carex bicknellii*	58–291	–
	bottlebrush sedge	CAHY4	*Carex hystericina*	58–291	–
	fox sedge	CAVU2	*Carex vulpinoidea*	58–291	–
	smoothcone sedge	CALA12	*Carex laeviconica*	58–291	–
	upright sedge	CAST8	*Carex stricta*	58–291	–
	water sedge	CAAQ	*Carex aquatilis*	58–291	–
	rigid sedge	CATE6	*Carex tetanica*	58–291	–
	limestone meadow sedge	CAGR3	*Carex granularis*	58–291	–
2	**Cool-Season Grasses**			1457–2040	
	northern reedgrass	CASTI3	*Calamagrostis stricta ssp. inexpansa*	874–1749	–
	fowl bluegrass	POPA2	*Poa palustris*	58–291	–
	prairie wedgescale	SPOB	*Sphenopholis obtusata*	0–175	–
	American sloughgrass	BESY	*Beckmannia syzigachne*	0–117	–

	American sloughgrass	BECY	*Beckmannia syzigachne*	0–117	
	reed canarygrass	PHAR3	*Phalaris arundinacea*	0–117	–
3	**Warm-Season Grasses**			291–874	
	prairie cordgrass	SPPE	*Spartina pectinata*	58–291	–
	switchgrass	PAVI2	*Panicum virgatum*	58–175	–
	Grass, perennial	2GP	*Grass, perennial*	0–117	–
	Mexican muhly	MUME2	*Muhlenbergia mexicana*	0–58	–
	mat muhly	MURI	*Muhlenbergia richardsonis*	0–58	–
	spiked muhly	MUGL3	*Muhlenbergia glomerata*	0–58	–
4	**Other Grass-Likes**			58–291	
	mountain rush	JUARL	*Juncus arcticus ssp. littoralis*	58–291	–
	spikerush	ELEOC	*Eleocharis*	58–175	–
	spikesedge	KYLLI2	*Kyllinga*	58–175	–
	common threesquare	SCPUB	*Schoenoplectus pungens var. badius*	0–58	–
	Torrey's rush	JUTO	*Juncus torreyi*	0–58	–
	cloaked bulrush	SCPA8	*Scirpus pallidus*	0–58	–
	Dudley's rush	JUDU2	*Juncus dudleyi*	0–58	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–58	–
Forb					
5	**Forb**			583–874	
	Canadian anemone	ANCA8	*Anemone canadensis*	58–117	–
	flat-top goldentop	EUGRG	*Euthamia graminifolia var. graminifolia*	58–117	–
	hempnettle	GALEO	*Galeopsis*	58–117	–
	American water horehound	LYAM	*Lycopus americanus*	58–117	–
	rough bugleweed	LYAS	*Lycopus asper*	58–117	–
	wild mint	MEAR4	*Mentha arvensis*	58–117	–
	white panicle aster	SYLAL4	*Symphyotrichum lanceolatum ssp. lanceolatum var. lanceolatum*	58–117	–
	Canada germander	TECA3	*Teucrium canadense*	58–117	–
	northern bog violet	VINE	*Viola nephrophylla*	58–117	–
	dogbane	APOCY	*Apocynum*	0–58	–
	swamp milkweed	ASIN	*Asclepias incarnata*	0–58	–
	smooth horsetail	EQLA	*Equisetum laevigatum*	0–58	–
	Great Plains white fringed orchid	PLPR4	*Platanthera praeclara*	0–58	–
	water knotweed	POAM8	*Polygonum amphibium*	0–58	–
	tall cinquefoil	POAR7	*Potentilla arguta*	0–58	–
	swamp smartweed	POHY2	*Polygonum hydropiperoides*	0–58	–
	alkali buttercup	RACY	*Ranunculus cymbalaria*	0–58	–
	western dock	RUAQ	*Rumex aquaticus*	0–58	–
	blue skullcap	SCLA2	*Scutellaria lateriflora*	0–58	–
	hedgenettle	STACH	*Stachys*	0–58	–
	narrowleaf cattail	TYAN	*Typha angustifolia*	0–58	–
	swamp verbena	VEHA2	*Verbena hastata*	0–58	–

	Forb, native	2FN	*Forb, native*	0–58	–
Shrub/Vine					
6	**Shrubs**			0–291	
	sandbar willow	SAIN3	*Salix interior*	0–58	–
	willow	SALIX	*Salix*	0–58	–
	Bebb willow	SABE2	*Salix bebbiana*	0–58	–
	meadow willow	SAPE5	*Salix petiolaris*	0–58	–
	dwarf birch	BENA	*Betula nana*	0–58	–
	white meadowsweet	SPAL2	*Spiraea alba*	0–58	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–58	–

Table 8. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Grass & Grass-Likes**			4080–4663	
	woolly sedge	CAPE42	*Carex pellita*	1749–2331	–
	shortbeak sedge	CABR10	*Carex brevior*	874–1457	–
	wheat sedge	CAAT2	*Carex atherodes*	874–1457	–
	Sartwell's sedge	CASA8	*Carex sartwellii*	58–291	–
	Bicknell's sedge	CABI3	*Carex bicknellii*	58–291	–
	bottlebrush sedge	CAHY4	*Carex hystericina*	58–291	–
	fox sedge	CAVU2	*Carex vulpinoidea*	58–291	–
	smoothcone sedge	CALA12	*Carex laeviconica*	58–291	–
	upright sedge	CAST8	*Carex stricta*	58–291	–
	water sedge	CAAQ	*Carex aquatilis*	58–291	–
	rigid sedge	CATE6	*Carex tetanica*	58–291	–
	limestone meadow sedge	CAGR3	*Carex granularis*	58–291	–
2	**Cool-Season Grasses**			1457–2040	
	northern reedgrass	CASTI3	*Calamagrostis stricta ssp. inexpansa*	874–1749	–
	fowl bluegrass	POPA2	*Poa palustris*	58–291	–
	prairie wedgescale	SPOB	*Sphenopholis obtusata*	0–175	–
	American sloughgrass	BESY	*Beckmannia syzigachne*	0–117	–
3	**Warm-Season Grasses**			291–874	
	prairie cordgrass	SPPE	*Spartina pectinata*	58–291	–
	switchgrass	PAVI2	*Panicum virgatum*	58–175	–
	Grass, perennial	2GP	*Grass, perennial*	0–117	–
	Mexican muhly	MUME2	*Muhlenbergia mexicana*	0–58	–
	mat muhly	MURI	*Muhlenbergia richardsonis*	0–58	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	0–58	–
4	**Other Grass-Likes**			58–291	
	mountain rush	JUARL	*Juncus arcticus ssp. littoralis*	58–175	–
	spikerush	ELEOC	*Eleocharis*	58–175	–
	Grass-like (not a true	2GL	*Grass-like (not a true grass)*	0–117	

	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–117	–
	common threesquare	SCPU10	*Schoenoplectus pungens*	0–58	–
	Torrey's rush	JUTO	*Juncus torreyi*	0–58	–
	cloaked bulrush	SCPA8	*Scirpus pallidus*	0–58	–
	Dudley's rush	JUDU2	*Juncus dudleyi*	0–58	–
5	**Exotic Cool-Season Grasses**			58–291	
	quackgrass	ELRE4	*Elymus repens*	0–291	–
	redtop	AGGI2	*Agrostis gigantea*	0–291	–
	reed canarygrass	PHAR3	*Phalaris arundinacea*	0–291	–
Forb					
6				583–874	
	Canadian anemone	ANCA8	*Anemone canadensis*	58–117	–
	flat-top goldentop	EUGRG	*Euthamia graminifolia var. graminifolia*	58–117	–
	hempnettle	GALEO	*Galeopsis*	58–117	–
	American water horehound	LYAM	*Lycopus americanus*	58–117	–
	rough bugleweed	LYAS	*Lycopus asper*	58–117	–
	wild mint	MEAR4	*Mentha arvensis*	58–117	–
	water knotweed	POAM8	*Polygonum amphibium*	58–117	–
	white panicle aster	SYLAL4	*Symphyotrichum lanceolatum ssp. lanceolatum var. lanceolatum*	58–117	–
	Canada germander	TECA3	*Teucrium canadense*	58–117	–
	northern bog violet	VINE	*Viola nephrophylla*	58–117	–
	dogbane	APOCY	*Apocynum*	0–58	–
	swamp milkweed	ASIN	*Asclepias incarnata*	0–58	–
	smooth horsetail	EQLA	*Equisetum laevigatum*	0–58	–
	Great Plains white fringed orchid	PLPR4	*Platanthera praeclara*	0–58	–
	tall cinquefoil	POAR7	*Potentilla arguta*	0–58	–
	swamp smartweed	POHY2	*Polygonum hydropiperoides*	0–58	–
	alkali buttercup	RACY	*Ranunculus cymbalaria*	0–58	–
	western dock	RUAQ	*Rumex aquaticus*	0–58	–
	blue skullcap	SCLA2	*Scutellaria lateriflora*	0–58	–
	hedgenettle	STACH	*Stachys*	0–58	–
	narrowleaf cattail	TYAN	*Typha angustifolia*	0–58	–
	broadleaf cattail	TYLA	*Typha latifolia*	0–58	–
	swamp verbena	VEHA2	*Verbena hastata*	0–58	–
	Forb, native	2FN	*Forb, native*	0–58	–
7	**Exotic Forbs**			58–291	
	Canada thistle	CIAR4	*Cirsium arvense*	0–291	–
	leafy spurge	EUES	*Euphorbia esula*	0–291	–
	field sowthistle	SOAR2	*Sonchus arvensis*	0–291	–
	Forb, introduced	2FI	*Forb, introduced*	0–291	–
Shrub/Vine					
8				58–291	

	sandbar willow	SAIN3	*Salix interior*	58–291	–
	willow	SALIX	*Salix*	0–58	–
	Bebb willow	SABE2	*Salix bebbiana*	0–58	–
	meadow willow	SAPE5	*Salix petiolaris*	0–58	–
	bog birch	BEPU4	*Betula pumila*	0–58	–
	white meadowsweet	SPAL2	*Spiraea alba*	0–58	–
	Shrub, other	2S	*Shrub, other*	0–58	–

Inventory data references

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

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	11/21/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

2. **Presence of water flow patterns:**

---

3. **Number and height of erosional pedestals or terracettes:**

---

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

---

5. **Number of gullies and erosion associated with gullies:**

---

6. **Extent of wind scoured, blowouts and/or depositional areas:**

---

7. **Amount of litter movement (describe size and distance expected to travel):**

---

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

---

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

---

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

---

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

---

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

---

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

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

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

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

17. **Perennial plant reproductive capability:**