USDA Natural Resources
Conservation Service

Ecological site R056AY087ND
Limy Subirrigated

Accessed: 05/18/2024

General information

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

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.

Classification relationships

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

Associated sites

R056AY095ND	**Subirrigated**
R056AY101ND	**Shallow Marsh**
R056AY102ND	**Wet Meadow**

Similar sites

R056AY095ND	**Subirrigated**

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon gerardii* (2) *Sorghastrum nutans*

Physiographic features

This site occurs on level and nearly level uplands.

Table 2. Representative physiographic features

Landforms	(1) Outwash plain (2) Delta plain (3) Lake plain
Flooding frequency	None
Ponding frequency	None
Elevation	198–305 m
Slope	0–3%

Water table depth	46–107 cm
Aspect	Aspect is not a significant factor

Climatic features

MLRA 56 is considered to have a continental climate – cold winters and relatively hot summers, low to moderate humidity, light rainfall, and much sunshine. Extremes in temperature may also abound. The climate is the result of this MLRA's location near the geographic center of North America. There are few natural barriers on the northern Great Plains and air masses move freely across the plains and account for rapid changes in temperature.

Annual precipitation typically ranges from 18 to 23 inches per year. The average annual temperature is about 40°F. January is the coldest month with average temperatures ranging from about 1°F (Pembina, North Dakota (ND)) to about 11°F (Wheaton, Minnesota (MN)). July is the warmest month with temperatures averaging from about 68°F (Pembina, ND) to about 73°F (Wheaton, MN). The range of normal average monthly temperatures between the coldest and warmest months is about 65°F. This large annual range attests to the continental nature of this area's climate. Winds are estimated to average about 13 miles per hour annually, ranging from about 15 miles per hour during the spring to about 11 miles per hour during the summer. Daytime winds are generally stronger than nighttime and occasional strong storms may bring brief periods of high winds with gusts to more than 50 miles per hour.

Growth of cool season plants begins in early to mid March, slowing or ceasing in late June. Warm season plants begin growth about mid May and continue to early or mid September. Green up of cool season plants may occur in September and October when adequate soil moisture is present.

Table 3. Representative climatic features

Frost-free period (average)	148 days
Freeze-free period (average)	127 days
Precipitation total (average)	533 mm

Influencing water features

This site has a persistent water table which strongly influences the production of the site, but does not greatly influence the species present. Most of the dominant species are typical upland plants.

Soil features

These are very deep, somewhat poorly drained, moderately coarse to moderately fine textured soils. These soils have a calcareous subsoil. Saturated hydraulic conductivity is moderately rapid to moderately slow and available water capacity is low to high. Salinity is none to slight. Soils on this site are moderately to highly susceptible to wind erosion. This site is on flats and swales on lake plains, outwash plains, and delta plains. Slope ranges from 0 to 3 percent. This site should show no evidence of rills, wind scoured areas or pedestalled plants. No water flow paths are seen on this site. The soil surface is stable and intact. Sub-surface soil layers are non-restrictive to water movement and root penetration.

Major soil series correlated to this ecological site can be found in Section II of the Natural Resources Conservation Service Field Office Technical Guide or the following web site:
http://www.nrcs.usda.gov/technical/efotg/

Table 4. Representative soil features

Surface texture	(1) Loamy fine sand (2) Silty clay
Family particle size	(1) Sandy
Drainage class	Somewhat poorly drained

Permeability class	Very slow to very rapid
Surface fragment cover <=3"	0–5%
Surface fragment cover >3"	0–1%
Available water capacity (0-101.6cm)	7.62–22.86 cm
Calcium carbonate equivalent (0-101.6cm)	0–45%
Electrical conductivity (0-101.6cm)	0–4 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–5
Soil reaction (1:1 water) (0-101.6cm)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–10%
Subsurface fragment volume >3" (Depth not specified)	0–1%

Ecological dynamics

The site developed under Northern Great Plains The site developed under Northern Great Plains climatic conditions, and included natural influence of large herding herbivores and frequent fire. Changes will occur in the plant communities due to weather fluctuations and/or management actions. Under adverse impacts, a slow decline in vegetative vigor and composition will occur. Under favorable conditions the site has the potential to resemble the reference state. Interpretations for this site are based on the Indiangrass/Big Bluestem/Little Bluestem Plant Community Phases (1.1). The Reference State has been determined by study of rangeland relic areas, areas protected from excessive disturbance, and areas under long-term rotational grazing regimes. Trends in plant community dynamics ranging from heavily grazed to lightly grazed areas, seasonal use pastures, and historical accounts also have been considered. Community phases, community pathways, states, transitions, thresholds and restoration pathways have been determined through similar studies and experience.

The natural disturbance regime consisted of frequent fires caused both by natural and Native American ignition sources. These fires occurred during any season of the year, but were concentrated in the spring and late summer or early fall. Lightening fires occurred most frequently in July and August while fires started by Native Americans occurred in April, September and October. Large ungulate grazing was heavy and occurred often, but usually for short durations. Grazing may have been severe when occurring after a fire event. The grazing and fire interaction especially when
coupled with drought events, set up the dynamics discussed and displayed in the following state and transition diagram and descriptions.

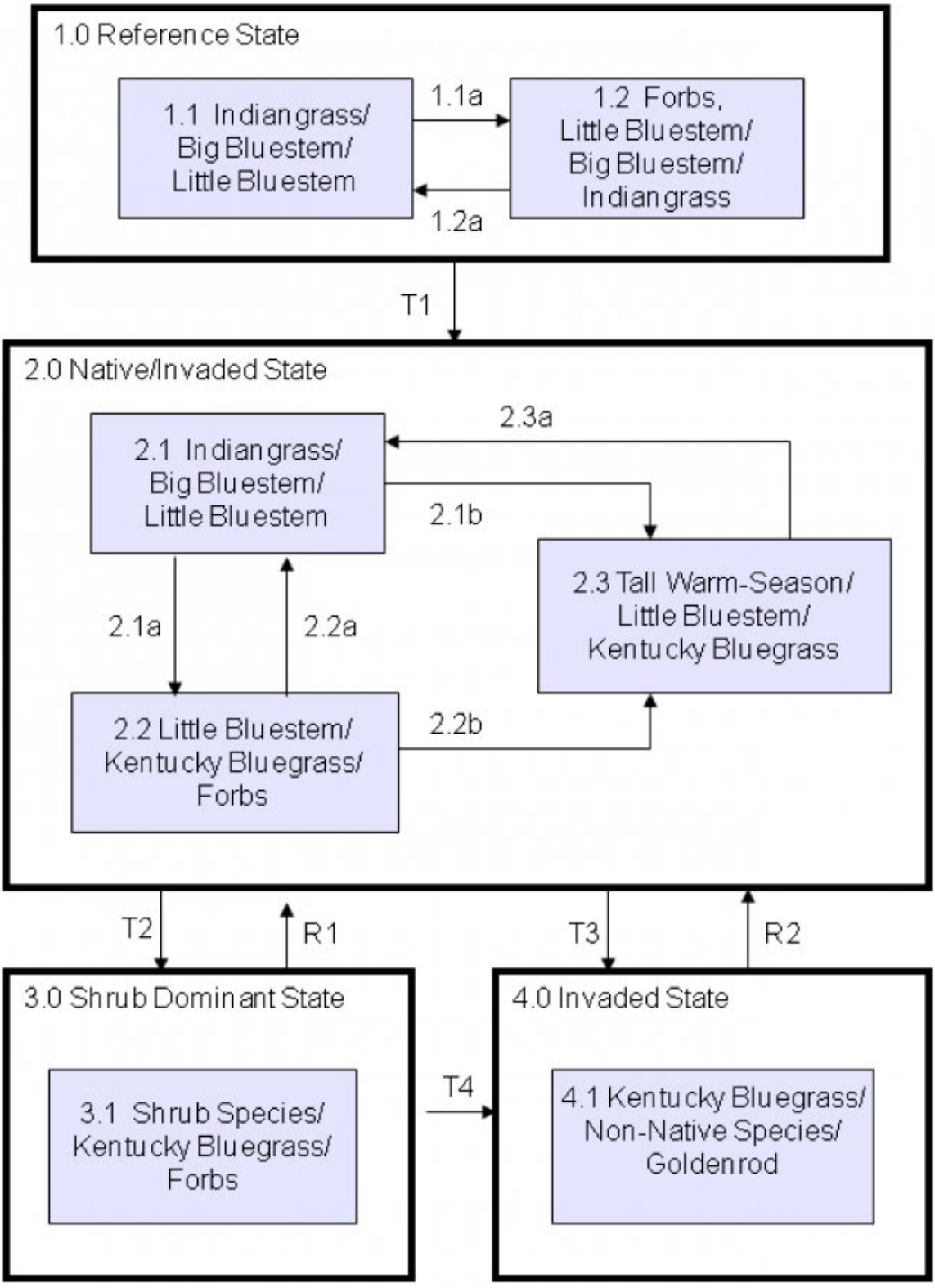
This ecological site has been grazed by domestic livestock since introduced into the area. The introduction of domestic livestock, elimination of fire, and the use of fencing and reliable water sources have radically changed the disturbance regime of this site. Livestock grazing without adequate recovery periods following each grazing occurrence causes this site to depart from the reference plant community. Big bluestem and Indiangrass will decrease in frequency and production. Little bluestem, forbs, and Kentucky bluegrass if present; will begin to increase. In time, heavy continuous grazing will cause Kentucky bluegrass and redtop to dominate and forbs to increase. The resulting plant community is relatively stable and competitive advantage prevents other species from establishing. Extended periods of non-use and/or lack of fire will result in a plant community having high litter levels, which favors an increase in shrubs such as western snowberry, a reduction in warm-season grasses with a corresponding increase in Kentucky bluegrass and/or redtop.

Due to a general invasion of exotic species (such as Kentucky bluegrass and smooth bromegrass) across the MLRA within his site, returning to the 1.1 Indiangrass/Big Bluestem/Little Bluestem Plant Community Phase may

not be possible. Today, the 2.1 Indiangrass/Big Bluestem/Little Bluestem Plant Community Phases most resembles the 1.1 Reference Plant Community Phase in appearance and function.

Following the state and transition diagram are narratives for each of the described states and community phases. These may not represent every possibility, but they are the most prevalent and repeatable states/community phases. The plant composition tables shown below have been developed from the best available knowledge at the time of this revision. As more data are collected, some of these community phases and/or states may be revised or removed, and new ones may be added. The main purpose for including the descriptions here is to capture the current knowledge and experience at the time of this revision.

State and transition model



1.1a – Reduced precipitation, increased disturbance; **1.2a-** Return to normal precipitation and disturbance; **T1** – altered disturbance regime and introduction of non-native species; **2.1a** – heavy grazing without adequate recovery periods; **2.2a, 2.3a**– Prescribed grazing and prescribed fire; **2.1b, 2.2b** – removal of fire and grazing; **T2** – No fire; **T3** – cropped go-back, heavy grazing or extended periods of non-disturbance; **T4** – Brush control, prescribed fire; **R1** – Brush control, range seeding, prescribed fire and prescribed grazing; **R2** – Range seeding, prescribed fire, prescribed grazing

State 1
Reference

This state represents the natural range of variability that dominated the dynamics of this ecological site. This state was diverse, stable, productive and well adapted to the Northern Great Plains. The high water table supplied much of the moisture for plant growth. Plant litter was properly distributed with little movement and natural plant mortality was very low. This was a sustainable state in terms of soil stability, watershed function and biologic integrity. This state was dominated by warm-season grasses, with lesser amounts of cool-season grasses and a wide variety of forbs. The primary disturbance mechanisms for this site in the reference condition included periodic 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. Mid and tall statured grass species could have declined with a corresponding increase in short statured warm-season grasses and cool-season grass-like species occurring. Periods of above normal precipitation would have shifted this plant community to one dominated by prairie cordgrass, northern reedgrass, switchgrass, sedges and spikerush.

Community 1.1
Indiangrass/Big Bluestem/Little Bluestem

This community phase was the most dominant both temporally and spatially. The prevailing climate and weather patterns favored the development of this community phase dominated by tall and mid warm-season and mid cool-season grasses such as Indiangrass, big bluestem, little bluestem and porcupine grass. Other grass and grass-like species included switchgrass, prairie cordgrass, sideoats grama, Canada wildrye, slender wheatgrass and sedge. A wide variety of native perennial forbs were present. Interpretations are based primarily on this plant community phase. Grasses and grass-likes make up 85 to 95 percent, forbs 5 to 15 percent and shrubs 1 to 5 percent of the plant community composition by weight. This plant community phase is further described in the “Plant Community Composition and Group Annual Production” portion of this ecological site description. Bare ground would have been less than 5 percent, with litter cover averaging 80 to 90 percent and in contact with soil surface. Energy capture would have occurred from late spring through late summer. Soil stability would have averaged 5.5 or higher. Infiltration rates would have averaged 4 inches per hour or more due to high percent of bunchgrasses and deep rooted, tall statured, warm season grasses present in the plant community.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	3088	4096	4859
Forb	230	471	729
Shrub/Vine	45	141	241
Total	**3363**	**4708**	**5829**

Figure 7. Plant community growth curve (percent production by month). ND5605, Red River Valley of the North, warm-season dominant.. Warm-season dominant..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	1	4	18	36	29	10	2	0	0	0

Community 1.2
Forbs/Little Bluestem/Big Bluestem/Indiangrass

Although still dominated by grasses (65 to 75 percent of the production), the appearance of this plant community phase would have been altered by the diverse mixture of forbs resulting from the fire event and the increased grazing pressure following the burn. Dominant grasses would have included little bluestem, switchgrass, prairie cordgrass, big bluestem, and Indiangrass. Showy forbs such as tall gayfeather, sunflowers, showy deathcamas, black-eyed Susan, goldenrods, and American Licorice, would have dominated the visual appearance of the site, constituting 20 to 30 percent of the site production. The amount of bare ground would have been similar to the

reference plant community while litter cover would have been reduced. Infiltration rates would have been reduced slightly but would return to reference state condition as the plant community recovered from the disturbances. Nutrient cycling may have improved slightly over the reference plant community due to the effects of the burn and the lower carbon to nitrogen ratio of the resulting fresh vegetation.

Pathway 1.1a
Community 1.1 to 1.2

Spring fire followed by intense grazing by native ungulates characterized this pathway. This level of grazing intensity resulted in a slight reduction in the more grazing sensitive species such as Indiangrass. The spring fire would have also resulted in an increase in the number and extent of forbs. The increase in grazing pressure as a result of the fire would have lasted several growing seasons. Similar plant community composition changes would have occurred as a result of drought coupled with grazing and possibly fire.

Pathway 1.2a
Community 1.2 to 1.1

A return normal disturbance intervals (fire, grazing and precipitation) would have permitted the tall statured warm-season grasses to regain dominance, both visually and by weight.

State 2
Native/Invaded

This state is very similar to the reference state in appearance and function. The invasion of introduced species has altered the natural range of variability for this ecological site. This state still has a strong component of warm-season grass species, but invasive introduced cool-season sodgrasses are now present in all community phases of this state. The primary disturbance mechanisms for this state include grazing by domestic livestock and infrequent fires. Grazing coupled with weather events dictate the dynamics that occur within this state. Fire could still play an important role, but is typically suppressed or applied in a manner which does not mimic the historical disturbance regime (frequency and timing). The warm-season native grasses can decline and an increase in introduced sod grasses will occur.

Community 2.1
Indiangrass/Big Bluestem/Little Bluestem

This community phase most closely resembles the Reference State in appearance and ecological functions (e.g., hydrologic, biotic and soil/site stability). The warm-season grass dominated community is maintained with grazing systems that allow for adequate recovery periods following grazing events, and potentially the combination of grazing and prescribed burning which closely mimics the natural disturbance regime. This community phase is dominated by tall and mid warm-season grasses. Indiangrass, big bluestem, switchgrass, little bluestem, and sideoats grama and mid cool-season grasses such as porcupine grass, Canada wildrye, and slender wheatgrass. Other grass and grass-like species include northern reedgrass, prairie cordgrass, mat muhly, prairie wedgescale, sedge and spikerush. A variety of native perennial forbs is present but; in total, represent only a small portion of the plant community by weight. The basic difference between this community phase and 1.1 of the Reference State is the presence of minor amounts of introduced cool-season grasses such as Kentucky bluegrass, quackgrass and redtop. Introduced forbs such as sweetclover, black medic and leafy spurge may also be present. This is likely a naturally nitrogen deficient plant community, but perhaps less so than the Reference State. A change in the nutrient cycle and biological activity on this ecological site possibly due to the introduction of non-native species may be a causative factor leading to the eventual dominance of cool-season introduced grasses in the Invaded State (State 3).

Table 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	3088	4096	4859
Forb	230	471	729
Shrub/Vine	45	141	241
Total	**3363**	**4708**	**5829**

Figure 9. Plant community growth curve (percent production by month). ND5605, Red River Valley of the North, warm-season dominant.. Warm-season dominant..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	1	4	18	36	29	10	2	0	0	0

Community 2.2
Little Bluestem/Kentucky Bluegrass/Forbs

This community phase is characterized by a shift from the tall warm-season grasses to the more grazing tolerant mid statured warm-season bunchgrass and introduced cool-season sod formers. In the early stages of this community phase, little bluestem will initially increase along with the increase of introduced cool-season grasses. In many situations with inadequate recovery periods, the little bluestem will also begin to decline over time, facilitating the change to the Invaded State. Significant grass and grass-like species include little bluestem, porcupine grass, slender wheatgrass, switchgrass, prairie cordgrass and Kentucky bluegrass and sedge. Other grasses present include sideoats grama, northern reedgrass, mat muhly and scratchgrass. Indiangrass and big bluestem are still present in minor amounts. The common forbs include American licorice, cudweed sagewort, goldenrods, silverleaf scurfpea, and western yarrow. Western snowberry and prairie rose are the principal shrubs. This community phase is often dispersed throughout the pasture, in an overgrazed/undergrazed pattern, typically referred to as patch grazing. Some areas (overgrazed) will exhibit the impacts of heavy use, while other areas (undergrazed) will have a build-up of litter and a high amount of plant decadence. This is a typical pattern found in properly stocked pastures grazed season-long. In the undergrazed patches, litter buildup reduces plant vigor and density, and native seedling recruitment declines. Due to a lack of tiller stimulation and sunlight, native bunchgrasses typically develop dead centers and native rhizomatous grasses are limited to small colonies. In the overgrazed patches, plant vigor is reduced and the competitive advantage goes towards the grazing tolerant short statured species such as Kentucky bluegrass. Litter amounts are reduced, and energy capture shifts to slightly earlier in the growing season due to a decline in the warm-season grass component. The timing of energy capture shifts from early to mid summer to spring and early summer. Nutrient cycling and infiltration is slightly reduced as the rooting depth and structure of the vegetation decreases with the change in functional and structural groups. Plant community diversity is reduced with a loss of native forb diversity and minor grass components. Soil erosion is low, soil stability matches that of the reference plant community. This community phase is approaching the threshold which could readily transition to the Invaded State. If management is significantly altered, this community phase can still be reverted back to the Indiangrass/Big Bluestem/Little Bluestem Plant Community Phase 2.1. Grazing management that allows for adequate recovery periods will tend to restore the ecological functions of this site. Fire can play a role in reducing

the introduced cool-season species. The combination of properly applied grazing management and prescribed fire may be the most effective method to move this community phase towards a community resembling the reference plant community.

Figure 10. Plant community growth curve (percent production by month). ND5603, Red River Valley of the North, warm-season/cool-season co-dominant.. Cool-season, warm-season co-dominant..

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 2.3
Kentucky Bluegrass/Tall Warm-Season/Little Bluestem

The removal of disturbances has allowed the plant community to shift to one visually dominated by Kentucky bluegrass with remnant tall warm-season species still represented within the plant community. Kentucky bluegrass constitutes 20 to 30 percent of the annual production with tall and mid statured warm-season native grasses such as Indiangrass, switchgrass, little bluestem, and sideoats grama constituting at least 40 percent of the annual production. Native forbs such as Maximilian sunflower, goldenrods, Heath aster, western yarrow, western ragweed, cudweed sagewort are present along with introduced forbs such as sweet clover and black medic. Shrubs species include western snowberry and prairie rose. Annual production is similar to the reference plant community. Energy capture has shifted to more early spring to midsummer due to the invasion of cool-season sod formers. Bare ground is less than 1 percent and associated with rodent activity. Litter cover (extent) is similar to the reference plant community however the depth has increased to greater than 5 inches and is not in contact with the soil surface. This community phase is approaching the threshold which could readily transition to the Invaded State. If management is significantly altered, this community phase can still be reverted back to the Indiangrass/Big Bluestem/Little Bluestem Plant Community Phase 2.1. Grazing management that allows for adequate recovery periods will tend to restore the ecological functions of this site. Fire can play a role in reducing the introduced cool-season species. The combination of properly applied grazing management and prescribed fire may be the most effective method to move this community phase towards a community resembling the reference plant community.

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

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

Pathway 2.1a
Community 2.1 to 2.2

This community pathway is triggered by a change in the natural disturbance regime, most often caused by heavy grazing without adequate recovery periods. Inadequate recovery periods between grazing events is especially damaging to the tall warm-season grasses. As the vigor of these dominant species is reduced, the more grazing

tolerant native and introduced species gain a competitive advantage. Included with areas affected by a lack of adequate recovery periods may be areas that receive little or no grazing, which may also lead to the increase of introduced cool-season species.

Pathway 2.2a
Community 2.2 to 2.1

This community pathway is initiated by implementation of prescribed grazing management which includes adequate recovery periods following each grazing event, stocking levels which match the available resources, and application of prescribed fire. If properly implemented, this will shift the competitive advantage from the introduced cool-season species to the tall and mid warm-season grass species.

Conservation practices

Prescribed Burning
Prescribed Grazing

Pathway 2.2b
Community 2.2 to 2.3

Little Bluestem/Kentucky Bluegrass/Forbs

Kentucky Bluegrass/Tall Warm-Season/Little Bluestem

The removal of all disturbances (grazing and fire) will initiate this pathway. The lack of disturbance results in an accumulation of plant litter which alters the micro climate at the soil surface and limits the amount of sunlight reaching the plant crowns. This shifts the competitive advantage to the shade tolerant introduced species such as Kentucky bluegrass.

Pathway 2.3a
Community 2.3 to 2.1

This community pathway is initiated by implementation of prescribed grazing management which includes adequate recovery periods following each grazing event, stocking levels which match the available resources, and application of prescribed fire. If properly implemented, this will shift the competitive advantage from the introduced cool-season species to the tall and mid warm-season grass species.

Conservation practices

Prescribed Burning
Prescribed Grazing

State 3
Shrub Dominant

Visually, this state is characterized by a dominance of shrubs and an understory of introduced cool-season sod forming grasses. Once established, this state is very stable and resistant to change.

Community 3.1
Shrub Species/Kentucky Bluegrass/Forbs

Visually, this community phase is characterized by a dominance of shrubs such as willow, spirea, western snowberry and an understory of introduced cool-season sod forming grass such as Kentucky bluegrass and forbs such as western ragweed, goldenrods, and cudweed sagewort. Native grasses may be still present but in greatly

reduced numbers, below that which would allow for recovery. Overall annual production is reduced due to the lack of tall and mid statured warm-season grasses. Energy capture has shifted to spring and early summer. Use by domestic livestock is greatly reduced due to shrub component.

State 4
Invaded

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

Community 4.1
Kentucky Bluegrass/Non-Native Species/Goldenrod

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

Figure 12. Plant community growth curve (percent production by month). ND5601, Red River Valley of the North, cool-season dominant.. Cool-season dominant..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	3	8	24	45	10	3	5	2	0	0

Transition T1
State 1 to 2

This was the transition from the native warm-season grass dominated reference state to a state that has been invaded by introduced species. When propagules of non-native species such as Kentucky bluegrass are present, this transition occurs as natural and/or management actions favored a decline in the composition of warm-season rhizomatous grasses and an increase in cool-season sodgrasses. This transition was compounded by a change in the historic grazing and fire regime where native herbivores would follow periodic fires with grazing. This historic grazing/fire sequence has largely been replaced by season-long grazing. Complete rest from grazing and suppression of fire can also hasten this transition. The threshold between states was crossed when Kentucky bluegrass, smooth bromegrass, redtop and other introduced species became established on the site. These species occupy functional/structural groups that were not present in the Reference State.

Transition T2
State 2 to 3

Transition from Native/Invaded State (State 2)to the Shrub Dominated State (State 3) The elimination of fire is the major contributor to this transition. The opportunity for high intensity spring burns is severely reduced by early green up, and increased moisture and humidity at the soil surface. Plant litter accumulation tends to favor the more shade tolerant introduced grass species such as Kentucky bluegrass and shrubs such as snowberry and willow. Studies indicate that soil biological activity is altered, and this shift apparently exploits the soil microclimate and encourages growth of the introduced grass species. Preliminary studies would tend to indicate the primary threshold may exist when Kentucky bluegrass exceeds 30% of the plant community and native grasses represent less than 40% of the plant community composition. A secondary threshold occurs when the extent of the shrub component begins to

decrease herbaceous production, further reducing fire behavior. Once this threshold is crossed fire alone is no longer an effective tool for restoring the herbaceous portion of the plant community.

Transition T3
State 2 to 4

Transition from Native/Invaded State (State 2) to the Invaded State (State 4) This transitional pathway is triggered by extended rest, heavy grazing without adequate recovery periods, or “go-back” after cropping. Under heavy grazing, the very grazing tolerant introduced species have the competitive advantage. The opportunity for high intensity spring burns (which can serve to reduce the introduced cool-season species) is severely reduced by early green up and the lack of fuel. The nutrient cycle is impaired due to the lack of available carbon for soil biota due to accumulation in the surface layer root mat. This results in reduced soil biological activity. Studies indicate that soil biological activity is altered, and this shift apparently exploits the soil microclimate and encourages growth of the introduced grass species. Extended periods of non-use can also initiate this transition. The accumulation of plant litter shifts the competitive advantage to the shade tolerant introduced species. The lack of sunlight reaching the crowns of the remnant warm season grasses puts them at a further competitive disadvantage. This “non-use” and “over-use” often occurs within close proximity to each other in properly stocked pastures with low animal densities. Previously cropped areas which are not seeded to properly adapted species but allowed to “go-back” will also develop this plant community phase. Failed plantings, or plantings which are not properly managed with prescribed grazing and prescribed burning after establishment, will also follow this pathway. Once the threshold is crossed, a change in grazing management alone cannot cause a reduction in sodgrass dominance. Preliminary studies would tend to indicate this threshold may exist when Kentucky bluegrass exceeds 30% of the plant community and native grasses represent less than 40% of the plant community composition.

Restoration pathway R1
State 3 to 2

Restoration Pathway from Shrub Dominated State (State 3) to Native/Invade State (State 2) Herbicide and mechanical brush control combined with proper seedbed preparation and range seeding may restore this plant community to something resembling the Native/Introduced State (State 2.0). Intensive management with prescribed grazing and fire will be required after seeding to prevent the re-establishment of introduced sod forming species.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

Transition T4
State 3 to 4

Transition from Shrub Dominated State (State 3)to the Invaded State (State 4) This transition is initiated by the removal of shrubs species from plant community phase 3.1 by use of mechanical treatments, herbicide treatments, and prescribed fire. Due to the sprouting nature of the shrubs occupying this community phase, multi treatments may be necessary. The removal of the shrub component will result in a transitional shift to plant community phase 4.1.

Restoration pathway R2
State 4 to 2

Restoration Pathway from Introduced State (State 4) to Native Invaded State (State 2) This pathway requires intensive restoration practices including prescribed burning, multiple herbicide treatments for seedbed preparation, and range seeding with adapted species. Intensive management will be required after seeding to prevent the re-establishment of introduced sod forming species.

Conservation practices

Prescribed Burning
Prescribed Grazing

Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall Warm-Season Grasses**			942–1648	
	Indiangrass	SONU2	*Sorghastrum nutans*	942–1412	–
	big bluestem	ANGE	*Andropogon gerardii*	706–1177	–
	switchgrass	PAVI2	*Panicum virgatum*	471–942	–
	prairie cordgrass	SPPE	*Spartina pectinata*	0–235	–
2	**Mid Warm-Season Grasses**			235–1177	
	little bluestem	SCSC	*Schizachyrium scoparium*	706–1177	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	235–471	–
	prairie dropseed	SPHE	*Sporobolus heterolepis*	47–235	–
3	**Cool-Season Grasses**			235–471	
	porcupinegrass	HESP11	*Hesperostipa spartea*	235–471	–
	green needlegrass	NAVI4	*Nassella viridula*	0–235	–
	Canada wildrye	ELCA4	*Elymus canadensis*	47–235	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	47–235	–
	northern reedgrass	CASTI3	*Calamagrostis stricta ssp. inexpansa*	47–141	–
	western wheatgrass	PASM	*Pascopyrum smithii*	47–141	–
4	**Other Native Grasses**			47–235	
	Grass, perennial	2GP	*Grass, perennial*	47–471	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–188	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	47–141	–
	mat muhly	MURI	*Muhlenbergia richardsonis*	47–94	–
	prairie wedgescale	SPOB	*Sphenopholis obtusata*	47–94	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–47	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–47	–
	scratchgrass	MUAS	*Muhlenbergia asperifolia*	0–47	–
5	**Grass-likes**			47–235	
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–235	–
	sedge	CAREX	*Carex*	47–141	–
	spikerush	ELEOC	*Eleocharis*	47–94	–
Forb					
6	**Forbs**			235–706	
	Forb, native	2FN	*Forb, native*	47–235	–
	Indianhemp	APCA	*Apocynum cannabinum*	47–141	–
	Norwegian cinquefoil	PONO3	*Potentilla norvegica*	47–141	–

	western marbleseed	ONBEO	*Onosmodium bejariense var. occidentale*	47–94	–
	prairie groundsel	PAPL12	*Packera plattensis*	47–94	–
	Lewis flax	LILE3	*Linum lewisii*	47–94	–
	palespike lobelia	LOSP	*Lobelia spicata*	47–94	–
	rough bugleweed	LYAS	*Lycopus asper*	0–94	–
	prairie violet	VIPE2	*Viola pedatifida*	47–94	–
	meadow zizia	ZIAP	*Zizia aptera*	47–94	–
	blackeyed Susan	RUHI2	*Rudbeckia hirta*	47–94	–
	Canada goldenrod	SOCA6	*Solidago canadensis*	47–94	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–94	–
	purple prairie clover	DAPU5	*Dalea purpurea*	47–94	–
	smooth horsetail	EQLA	*Equisetum laevigatum*	47–94	–
	downy gentian	GEPU5	*Gentiana puberulenta*	47–94	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	47–94	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	47–94	–
	pussytoes	ANTEN	*Antennaria*	47–94	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–47	–
	common goldstar	HYHI2	*Hypoxis hirsuta*	0–47	–
	tall blazing star	LIAS	*Liatris aspera*	0–47	–
	flat-top goldentop	EUGR5	*Euthamia graminifolia*	0–47	–
	Virginia strawberry	FRVI	*Fragaria virginiana*	0–47	–
	closed bottle gentian	GEAN	*Gentiana andrewsii*	0–47	–
	whorled milkweed	ASVE	*Asclepias verticillata*	0–47	–
	bluebell bellflower	CARO2	*Campanula rotundifolia*	0–47	–
	western yarrow	ACMIO	*Achillea millefolium var. occidentalis*	0–47	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–47	–
	Canadian anemone	ANCA8	*Anemone canadensis*	0–47	–
	white prairie aster	SYFA	*Symphyotrichum falcatum*	0–47	–
	New England aster	SYNO2	*Symphyotrichum novae-angliae*	0–47	–
	blue-eyed grass	SISYR	*Sisyrinchium*	0–47	–
	mountain deathcamas	ZIEL2	*Zigadenus elegans*	0–47	–
	stiff goldenrod	OLRI	*Oligoneuron rigidum*	0–47	–
	cinquefoil	POTEN	*Potentilla*	0–47	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–47	–
Shrub/Vine					
7	**Shrubs**			47–235	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–141	–
	leadplant	AMCA6	*Amorpha canescens*	47–141	–
	rose	ROSA5	*Rosa*	47–141	–
	willow	SALIX	*Salix*	0–47	–

Table 8. Community 2.1 plant community composition

				Annual Production	Foliar Cover

Group	Common Name	Symbol	Scientific Name	(Kg/Hectare)	(%)
Grass/Grasslike					
1	**Tall Warm-Season Grasses**			942–1648	
	Indiangrass	SONU2	*Sorghastrum nutans*	942–1412	–
	big bluestem	ANGE	*Andropogon gerardii*	706–1177	–
	switchgrass	PAVI2	*Panicum virgatum*	471–942	–
	prairie cordgrass	SPPE	*Spartina pectinata*	0–235	–
2	**Mid Warm-Season Grasses**			235–1177	
	little bluestem	SCSC	*Schizachyrium scoparium*	706–1177	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	235–471	–
	prairie dropseed	SPHE	*Sporobolus heterolepis*	47–235	–
3	**Cool-Season Grasses**			235–471	
	porcupinegrass	HESP11	*Hesperostipa spartea*	235–471	–
	green needlegrass	NAVI4	*Nassella viridula*	0–235	–
	Canada wildrye	ELCA4	*Elymus canadensis*	47–235	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	47–235	–
	northern reedgrass	CASTI3	*Calamagrostis stricta ssp. inexpansa*	47–141	–
	western wheatgrass	PASM	*Pascopyrum smithii*	47–141	–
4	**Other Native Grasses**			47–235	
	Grass, perennial	2GP	*Grass, perennial*	47–471	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–188	–
	marsh muhly	MURA	*Muhlenbergia racemosa*	47–141	–
	creeping bentgrass	AGST2	*Agrostis stolonifera*	0–141	–
	Kentucky bluegrass	POPR	*Poa pratensis*	47–141	–
	prairie wedgescale	SPOB	*Sphenopholis obtusata*	47–94	–
	mat muhly	MURI	*Muhlenbergia richardsonis*	47–94	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	0–47	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–47	–
	scratchgrass	MUAS	*Muhlenbergia asperifolia*	0–47	–
5	**Grass-likes**			47–235	
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–235	–
	sedge	CAREX	*Carex*	47–141	–
	spikerush	ELEOC	*Eleocharis*	47–94	–
Forb					
6	**Forbs**			235–706	
	Forb, native	2FN	*Forb, native*	47–235	–
	Indianhemp	APCA	*Apocynum cannabinum*	47–141	–
	Norwegian cinquefoil	PONO3	*Potentilla norvegica*	47–141	–
	blackeyed Susan	RUHI2	*Rudbeckia hirta*	47–94	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–94	–
	western marbleseed	ONBEO	*Onosmodium bejariense var. occidentale*	47–94	–
	prairie groundsel	PAPL12	*Packera plattensis*	47–94	–

	Canada goldenrod	SOCA6	*Solidago canadensis*	47–94	–
	prairie violet	VIPE2	*Viola pedatifida*	47–94	–
	meadow zizia	ZIAP	*Zizia aptera*	47–94	–
	purple prairie clover	DAPU5	*Dalea purpurea*	47–94	–
	smooth horsetail	EQLA	*Equisetum laevigatum*	47–94	–
	downy gentian	GEPU5	*Gentiana puberulenta*	47–94	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	47–94	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	47–94	–
	Lewis flax	LILE3	*Linum lewisii*	47–94	–
	palespike lobelia	LOSP	*Lobelia spicata*	47–94	–
	rough bugleweed	LYAS	*Lycopus asper*	0–94	–
	pussytoes	ANTEN	*Antennaria*	47–94	–
	stiff goldenrod	OLRI	*Oligoneuron rigidum*	0–47	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–47	–
	common goldstar	HYHI2	*Hypoxis hirsuta*	0–47	–
	tall blazing star	LIAS	*Liatris aspera*	0–47	–
	horsetail	EQUIS	*Equisetum*	0–47	–
	flat-top goldentop	EUGR5	*Euthamia graminifolia*	0–47	–
	Virginia strawberry	FRVI	*Fragaria virginiana*	0–47	–
	closed bottle gentian	GEAN	*Gentiana andrewsii*	0–47	–
	western yarrow	ACMIO	*Achillea millefolium var. occidentalis*	0–47	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–47	–
	Canadian anemone	ANCA8	*Anemone canadensis*	0–47	–
	mountain deathcamas	ZIEL2	*Zigadenus elegans*	0–47	–
	white prairie aster	SYFA	*Symphyotrichum falcatum*	0–47	–
	New England aster	SYNO2	*Symphyotrichum novae-angliae*	0–47	–
	whorled milkweed	ASVE	*Asclepias verticillata*	0–47	–
	blue-eyed grass	SISYR	*Sisyrinchium*	0–47	–
	cinquefoil	POTEN	*Potentilla*	0–47	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–47	–
Shrub/Vine					
7	**Shrubs**			47–235	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–141	–
	leadplant	AMCA6	*Amorpha canescens*	47–141	–
	rose	ROSA5	*Rosa*	47–141	–
	willow	SALIX	*Salix*	0–47	–

Animal community

This site is adapted to managed grazing by domestic livestock provided caution is exercised when soils are saturated. The predominance of herbaceous plants across most 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 entirely 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.

Hydrological functions

-- Under Development –

Recreational uses

-- Under Development –

Wood products

-- Under Development –

Other products

-- Under Development –

Other information

-- Under Development –

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. Those involved in developing this site description include: Stan Boltz, NRCS State Rangeland Management Specialist; Bernadette Braun, USFS Rangeland Management Specialist; Stacey Swenson, USFS Rangeland Management Specialist; Jeff Printz, NRCS State Rangeland Management Specialist; Dr. Kevin Sedivec, Extension Rangeland Management Specialist; Dr. Shawn Dekeyser, North Dakota State University; Rob Self, The Nature Conservancy; Lee Voigt, NRCS Area Rangeland Management Specialist; Dr. Mark Gonzales, USFS Hydrologist; David Dewald, NRCS State Biologist; Keith Anderson, NRCS Soil Scientist, Fred Aziz; NRCS Area Resource Soil Scientist; and Steve Sieler, NRCS Soil Scientist.

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Contributors

Jeff Printz

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)	Lee Voigt, Bernadette Braun, Jeff Printz
Contact for lead author	Jeff.printz@nd.usda.gov 701-530-2080
Date	02/07/2012
Approved by	Jeff Printz
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None.

2. **Presence of water flow patterns:** None.

3. **Number and height of erosional pedestals or terracettes:** None.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 5% or less. Bare ground usually associated with rodent activity.

5. **Number of gullies and erosion associated with gullies:** None.

6. **Extent of wind scoured, blowouts and/or depositional areas:** None.

7. **Amount of litter movement (describe size and distance expected to travel):** No plant litter movement observable.

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

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Use soil series description for depth, color and structure of A horizon/surface layer.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Combination of shallow and deep rooted species (mid & tall rhizomatous and tufted perennial cool- and warm-season grasses) with fine and coarse roots positively influences infiltration.

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

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: Tall, warm-season grasses > mid, warm-season grasses >

    Sub-dominant: Forbs > mid, cool-season grasses >

    Other: Grass-likes = shrubs

    Additional: Due to differing root structure and distribution, Kentucky bluegrass and smooth bromegrass do not fit into reference plant community F/S groups.

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** None.

14. **Average percent litter cover (%) and depth (in):** Plant litter is In contact with soil surface.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Ranges from 3000 to 5200 lbs/ac air dry depending upon growing conditions with a representative value (RV) of 4200 lbs./acre air dry.

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 weeds, Kentucky bluegrass, smooth bromegrass, redtop.

17. **Perennial plant reproductive capability:** All species exhibit high vigor relative to climatic conditions. Do not rate based solely on seed production. Perennial grasses should have vigorous rhizomes or tillers.