USDA Natural Resources Conservation Service

Ecological site R054XY021ND
Claypan

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.

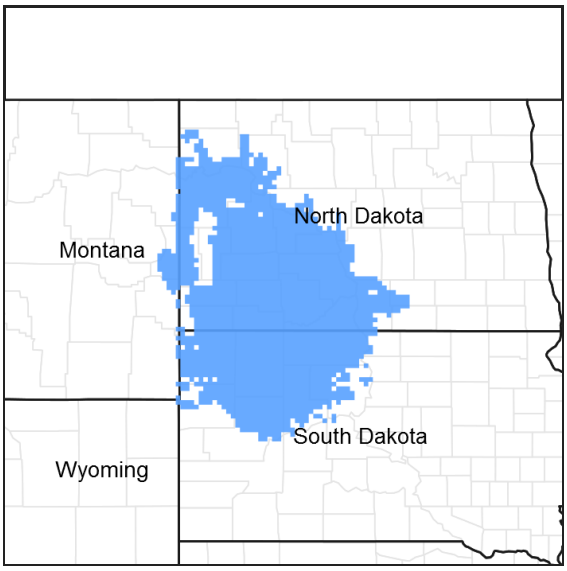


Figure 1. Mapped extent

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.

MLRA notes

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

Revision Note- Entering revised ESD into ESIS- 5/17/2010 Megan Baxter

Classification relationships

Level IV Eco-regions of the Conterminous United States: 43a – Missouri Plateau.

Associated sites

R054XY020ND	**Clayey**
R054XY022ND	**Closed Depression**
R054XY024ND	**Saline Lowland**
R054XY031ND	**Loamy**
R054XY033ND	**Thin Claypan**
R054XY038ND	**Thin Loamy**

Similar sites

R054XY022ND	**Closed Depression** [Poorly drained clayey soils with sodic subsoils and with noticeable redoximorphic features within depressions. Ponds periodically with no apparent water table. Indicator species: dominated by western wheatgrass with alkaligrass and foxtail barley intermixed, forb indicator is western dock, no shrubs. This site does have similar subsoil but is flooded periodically, a lot more production, more western wheatgrass but no blue grama.]
R054XY031ND	**Loamy** [Does not receive additional moisture. Found on dry uplands upslope from loamy terraces or loamy overflow sites, down slope from thin loamy or shallow loam sites; similar landscape position as sandy, sands, clayey sites. Will ribbon greater than 1 inch and up to 2 inches. Indicator species: western wheatgrass, green needlegrass and blue grama, with fringed sagewort and western snowberry or silver sagebrush being the dominant shrubs. This site has more production, more green needlegrass and shrubs, less blue grama, deeper soils, no sodic subsoils layer.]
R054XY020ND	**Clayey** [Does not receive additional moisture. Found on dry uplands, upslope from loamy or clayey terraces or loamy overflow sites, down slope from thin loamy, shallow loamy or shallow clayey sites. Similar landscape position as sandy, sands, and loamy sites. Will ribbon greater than 2 inches. Indicator species: dominated by of western wheatgrass and green needlegrass. This site has more production, more green needlegrass, less blue grama, deeper soils, no sodic subsoils layer.]
R054XY030ND	**Shallow Loamy** [Somewhat excessively drained soils > 10 and < 20 inches to sedimentary bedrock restricting root penetration. Surface layer ribbons > 1 but < 2 inches. Upslope from thin loamy or loamy sites and sometimes down slope form very shallow ecological sites. Indicator species: little bluestem, plains muhly, needle grasses and sideoats grama, with dotted gayfeather, pasqueflower and purple coneflower, and shrubs like broom snakeweed. This site has little bluestem, plains muhly, sideoats grama, more green needlegrass, less blue grama and needleandthread, similar production, different restrictive layer.]
R054XY027ND	**Sandy Claypan** [Well drained soils on uplands and terraces that don’t receive extra moisture with a dense sodic subsoil below 6 inches with salts below 16 inches. Subsoil will ribbon up to 1 inch. Indicator species are western wheatgrass intermixed with areas of prairie sandreed both dominating with an understory of needleandthread and blue grama, heath aster, cudweed sagewort and western yarrow along with fringed sagewort. This site has more production, more prairie sandreed and threadleaf sedge, soil texture is coarser but with similar sodic subsoils layer.]
R054XY033ND	**Thin Claypan** [Well drained soils on uplands or terraces that don’t receive extra moisture with a dense sodic subsoil above 6 inches and with salts above 16 inches restricting root penetration. Usually found in micro relief within Claypan sites, indicator species are western wheatgrass, Sandberg’s bluegrass with an understory of blue grama and buffalograss, heath aster, cudweed sagewort and western yarrow along with a few shrubs of fringed sagewort, cactus and Gardner's saltbush. This site has a shallower sodic subsoils layer, less production, similar species, more blue grama, less needleandthread & green needlegrass.]
R054XY028ND	**Shallow Clayey** [Some what excessively well drained soils more than 10 less than 20 inches to unweathered shales that restricts root penetration. Upslope of clayey site, surface layer will ribbon greater than 2 inches, upslope of clayey ecological sites. Indicator species: western wheatgrass dominates with little bluestem, plains muhly and sideoats grama, gayfeather. This site has more little bluestem, plains muhly, sideoats grama, more green needlegrass, less blue grama and needleandthread, similar production, different restrictive layer.]

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Pascopyrum smithii* (2) *Bouteloua gracilis*

Physiographic features

This site occurs on gently undulating to rolling sedimentary uplands.

Table 2. Representative physiographic features

Landforms	(1) Alluvial fan (2) Alluvial flat (3) Hill
Flooding frequency	None
Ponding frequency	None
Elevation	488–1,097 m
Slope	0–25%
Water table depth	122–183 cm
Aspect	Aspect is not a significant factor

Climatic features

MLRA 54 is considered to have a continental climate – cold winters and hot summers, low humidity, light rainfall, and much sunshine. Extremes in temperature are characteristic. The climate is the result of this MLRA's location in the geographic center of North America. There are few natural barriers on the northern Great Plains. The air masses move unobstructed across the plains and account for rapid changes in temperature.
Annual precipitation ranges from 14 to 18 inches per year. The normal average annual temperature is about 42° F. January is the coldest month with average temperatures ranging from about 13° F (Beach, ND) to about 16° F (Bison, SD). July is the warmest month with temperatures averaging from about 69° F (Beach, ND) to about 72° F (Timber Lake, SD). The range of normal average monthly temperatures between the coldest and warmest months is about 57° F. This large annual range attests to the continental nature of this MLRA's climate. Hourly winds are estimated to average about 11 miles per hour annually, ranging from about 13 miles per hour during the spring to about 10 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 native cool-season plants begins in late March and continues to early to mid July. Native warm-season plants begin growth in mid May and continue to the end of August. Green up of cool-season plants can occur in September and October when adequate soil moisture is present.

Table 3. Representative climatic features

Frost-free period (average)	127 days
Freeze-free period (average)	148 days
Precipitation total (average)	406 mm

Climate stations used

- (1) FT YATES 4 SW [USC00323207], Fort Yates, ND
- (2) DUPREE [USC00392429], Dupree, SD
- (3) SIDNEY [USC00247560], Sidney, MT
- (4) HETTINGER [USC00324178], Hettinger, ND

Influencing water features

No significant water features influence this site.

Soil features

The common features of soils in this site are the silty clay to clay textured subsoils and slopes of 0 to 15 percent. The soils in this site are moderately well to well drained and formed in soft siltstone, shales and alluvium. The fine

sandy loam to clay loam surface layer is 4 to 15 inches thick. The extremely hard clayey Btn horizon has round-topped or “bun shaped” columnar structure. These Btn horizons are high in sodium. The soils have moderate to slow infiltration rate and very slow saturated hydraulic conductivity. This site should show slight to no evidence of rills, wind scoured areas or pedestalled plants. Water flow paths are broken, irregular in appearance or discontinuous with numerous debris dams or vegetative barriers. The soil surface is stable and intact.

These soils are mainly susceptible to water erosion. The hazard of water erosion increases on slopes greater than about 9 percent. Loss of the soil surface layer can result in a shift in species composition and/or production.

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 sites:
North Dakota http://www.nd.nrcs.usda.gov/
South Dakota http://www.sd.nrcs.usda.gov/
Montana http://www.mt.nrcs.usda.gov/

Table 4. Representative soil features

Parent material	(1) Alluvium–shale (2) Residuum–siltstone
Surface texture	(1) Loam (2) Silt loam (3) Clay loam
Family particle size	(1) Clayey
Drainage class	Moderately well drained to well drained
Permeability class	Very slow to slow
Soil depth	20–61 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	5.08–12.7 cm
Calcium carbonate equivalent (0-101.6cm)	0–10%
Electrical conductivity (0-101.6cm)	8–16 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	15–25
Soil reaction (1:1 water) (0-101.6cm)	5.1–9
Subsurface fragment volume <=3" (Depth not specified)	0–20%
Subsurface fragment volume >3" (Depth not specified)	0–10%

Ecological dynamics

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 Reference Plant Community Phase 1.1, Western Wheatgrass/Blue Grama/Needlegrass. 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.

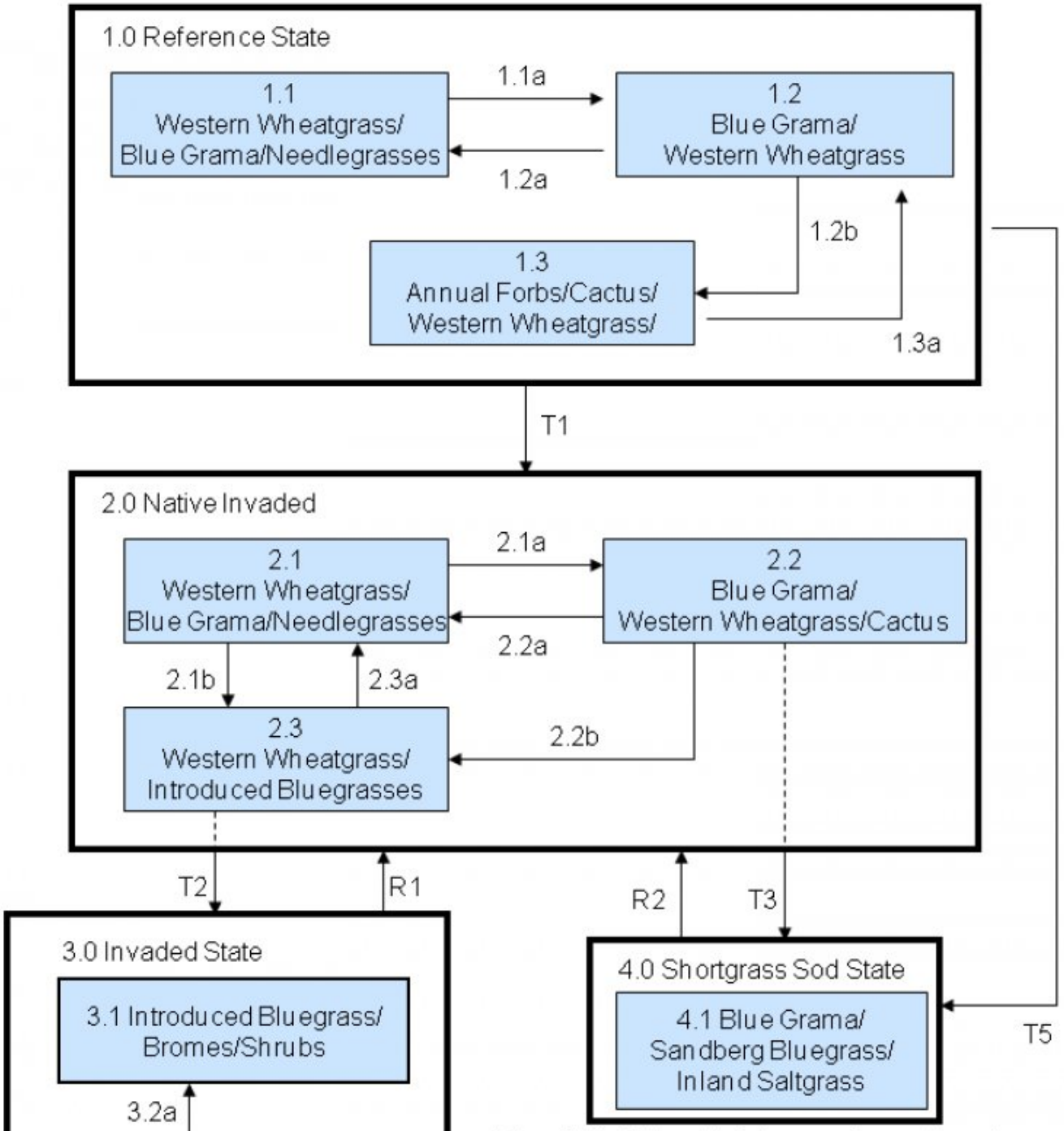
The natural disturbance regime consisted of frequent fires caused both by natural and Native American ignition sources. These fires occurred during any season of the year, but were concentrated in the spring and late summer or early fall. Lightning fires occurred most frequently in July and August while 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 and the use of fencing and reliable water sources have radically changed the disturbance regime of this site. Heavy continuous grazing and/or continuous seasonal (spring) grazing, without adequate recovery periods following each grazing occurrence causes this site to depart from the Reference State. Blue grama and buffalograss will begin to increase. Western wheatgrass will increase initially and then begin to decrease. Green needlegrass will decrease in frequency and production. In time, heavy continuous grazing will likely cause blue grama and buffalograss to dominate and pioneer perennials, annuals, and club moss (in its range) to increase. This plant community is relatively stable and the competitive advantage prevents other species from establishing. This plant community is less productive than the Reference State. Runoff increases and infiltration will decrease. Soil erosion will be minimal. 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 Kentucky bluegrass and/or smooth bromegrass.

Due to a general invasion of exotic species (such as Kentucky bluegrass and smooth bromegrass) across the MLRA within this site, returning to the 1.1 Western Wheatgrass/Blue Grama/Needlegrasses Plant Community Phase may not be possible. Today, the 2.1 Western Wheagrass/Blue Grama/Needlegrasses Plant Community Phase 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 – wildfire followed by intense grazing, prolonged drought; **1.2a** – return to normal disturbance regime, normal precipitation; **1.2b** – heavy grazing near water source, short term prairie dog occupation, short term drought; **1.3a** – removal of disturbances; **T1** – introduction of non-native species; **2.1a** – continuous season-long or seasonal grazing and/or drought; **2.2a** – prescribed grazing; **2.1b, 2.2b, T2** – non-use, no fire; **2.3 a** – prescribed grazing, prescribed burning with prescribed grazing; **3.2a** – Prescribed grazing, seeding, pest management; **R1** – Prescribed burning, prescribed grazing with herbicides or range seeding; **R2** – herbicides and range seeding; **T3** – heavy continuous season-long grazing; **T4** – cropped go-back; **T5** – prolonged, intense disturbance associated with perennial water sources, long term prairie dog occupation

State 1
Reference

This state represented the natural range of variability that dominated the dynamics of this ecological site. This state was dominated by cool season grasses. 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. Cool season species decline and a corresponding increase in warm season grasses will occur.

Community 1.1
Western Wheatgrass/Blue Grama/Needlegrass

This is considered to be the Reference Plant Community upon which most interpretations are based. This community evolved with grazing by large herbivores and occasional prairie fire. The potential vegetation is about 82% grasses or grass-like plants, 12% forbs, 5% shrubs and 1% cryptograms. Cool-season grasses dominated the site, but warm-season short grasses were also prevalent. Western wheatgrass was the dominant grass. Other grasses and grass-like plants occurring on the site included blue grama, needleandthread, buffalograss, green needlegrass, Sandberg bluegrass, inland saltgrass and sedges. Significant forbs included silverleaf scurfpea, cudweed sagewort and white prairie aster. Silver and/or big sagebrush were the principal shrubs and occurred in a randomly scattered mosaic. Other shrubs included winterfat, fringed sagewort and in some locations, Gardner's saltbush. This plant community was well adapted to the Northern Great Plains climatic conditions. Individual species varied greatly in production depending on growing conditions (timing and amount of precipitation and temperature). Community dynamics, nutrient cycle, water cycle and energy flow functioned properly. Plant litter was properly distributed with very little movement off-site. Natural plant mortality was very low. The diversity in plant species allowed for high drought tolerance. Good vegetative cover coupled with moderate available water capacity provided for a favorable soil-water-plant relationship.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	1031	1480	1922
Forb	78	143	207
Shrub/Vine	11	49	90
Moss	–	9	22
Total	**1120**	**1681**	**2241**

Figure 7. Plant community growth curve (percent production by month). ND5402, Missouri Slope, Native Grasslands, Cool/Warm-season Mix. Cool-season/warm-season dominant.

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

Community 1.2
Blue Grama/Western Wheatgrass

This plant community evolved under continuous seasonal grazing or from over utilization during extended drought periods possibly due to proximity to permanent or seasonal water sources. The potential plant community was made up of approximately 75 percent grasses and grass-like species, 10 percent forbs, and 15 percent shrubs. Dominant grass and grass-like species included blue grama, western wheatgrass, sedges, and buffalograss. Grasses of secondary importance included green needlegrass, needleandthread, inland saltgrass, and sideoats grama. Forbs commonly found in this plant community included cudweed sagewort, goldenrod, heath aster, scurfpea, and western yarrow. Dominant shrubs included brittle cactus, plains pricklypear, broom snakeweed, and fringed sagewort. This plant community had similar plant composition to 2.2 Blue Grama/Western Wheatgrass Plant Community Phase (refer to the plant composition tables). The main difference is that this plant community phase did not have the presence of non-native invasive species such as Kentucky bluegrass and smooth bromegrass.

Community 1.3

Annual Forbs/Cactus/Western Wheatgrass

This plant community developed under continuous heavy grazing or other excessive disturbances (e.g., heavy use areas, defoliation by rodents, etc.). This plant community would have had a “weedy” appearance due to the domination by annual forbs. However, remnant populations of the other species would still have been present, permitting a return to phases 1.2 and 1.1 given adequate time and a return to normal disturbance regime. Due to its disturbance tolerance, western wheatgrass would have been the dominant grass. Other grass species would include blue grama, buffalograss and red threeawn. When compared to phase 1.1, this plant community would have had more bare ground, less litter cover, higher soil surface temperatures and lowered infiltration rates due to shifts in plant community function-structural group composition. Production would have been reduced by 25 – 50 percent of phase 1.1.

Pathway 1.1a
Community 1.1 to 1.2

Heavy continuous grazing associated with proximity to perennial water sources or a combination of disturbances such as extended periods of below average precipitation coupled with periodic heavy grazing would have shifted this community to the 1.2 Blue Grama/Western Wheatgrass Plant Community Phase.

Pathway 1.2a
Community 1.2 to 1.1

Return to normal weather and disturbance regime including periodic light to moderate grazing possibly including periodic rest would have returned this plant community to the 1.1 Western Wheatgrass/Needlegrass/Bluestem Plant Community Phase.

Pathway 1.2b
Community 1.2 to 1.3

Long term heavy grazing resulting from proximity to permanent water combined with short term drought or occupation by prairie dogs would have further reduced the less grazing tolerant species and permitted the annual forbs and highly grazing/drought tolerant species to increase.

Pathway 1.3a
Community 1.3 to 1.2

A removal of the excessive disturbances and a return to normal precipitation cycle would have permitted this plant community to shift back towards phase 1.2 and ultimately, back to a community resembling plant phase 1.1.

State 2
Native/Invaded

This state represents the more common range of variability that exists with higher levels of grazing management but in the absence of periodic fire followed by short-term intensive grazing. This state is dominated by cool- and warm-season grasses. 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. Cool-season species can decline and a corresponding increase in short, warm-season grasses will occur.

Community 2.1
Western Wheatgrass/Green Needlegrass/Blue Grama

This plant community phase is similar to 1.1 Western Wheatgrass/Blue Grama/ Needlegrass Plant Community Phase, but it also contains minor amounts of non-native invasive grass species such as Kentucky bluegrass and smooth bromegrass (up to about 5 percent by air-dry weight). The potential plant community was made up of approximately 75 percent grasses and grass-like species, 10 percent forbs, and 15 percent shrubs. The community is dominated by cool-season grasses with warm-season grasses being subdominant. Western wheatgrass is the dominant grass. Other grasses and grass-like plants occurring on the site include blue grama, needleandthread, buffalograss, green needlegrass, Sandberg bluegrass, inland saltgrass and sedges. Significant forbs include

silverleaf scurfpea, cudweed sagewort and heath aster. Silver and/or big sagebrush are the principal shrubs and occur in a randomly scattered mosaic. Other shrubs include, winterfat, fringed sagewort and in some locations, Gardner's saltbush. In spite of the small amount of non-native species included within this plant community, it is still resilient and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought tolerance. This is a sustainable plant community in regards to site/soil stability, watershed function, and biologic integrity. The amount of non-native species present within this phase is not significant enough to impact the ecological processes. Items such as energy flow, bare ground, litter amount, production, plant reproduction, and soil erosion are similar to what would be expected for phase 1.1.

Figure 8. Plant community growth curve (percent production by month). ND5402, Missouri Slope, Native Grasslands, Cool/Warm-season Mix. Cool-season/warm-season dominant.

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

Community 2.2
Blue Grama/Western Wheatgrass/Cactus

This plant community evolves under continuous seasonal grazing or from over utilization during extended drought periods. The potential plant community is made up of approximately 70 percent grasses and grass-like species, 20 percent forbs, and 10 percent shrubs. Dominant grass and grass-like species include blue grama, western wheatgrass, sedges, and buffalograss. Grasses of secondary importance include needleandthread, inland saltgrass, and Sandberg bluegrass. Forbs commonly found in this plant community include cudweed sagewort, goldenrod, heath aster, scurfpea, and western yarrow. Dominant shrubs include broom snakeweed, fringed sagewort with cactus occurring on the western and southern portions of the MLRA. When compared to the Western Wheatgrass/Blue Grama/ Needlegrass Plant Community Phase (1.1), blue grama and buffalograss increase while western wheatgrass, green needlegrass, needleandthread, and prairie sandreed decrease. Production is reduced 40 to 60% of phase 2.1. Energy capture shifts to early to mid summer as the blue grama increases. Litter amounts decrease but as blue grama increases, bare ground will decrease. Infiltration will be reduced and runoff will increase. This plant community is moderately resistant to change. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term overgrazing. If the herbaceous component is intact, it tends to be resilient if the disturbance is not long-term.

Figure 9. Plant community growth curve (percent production by month). ND5404, Missouri Slope, Warm-season Dominant, Cool-season Subdominant. Short warm-season dominant, mid cool-season subdominant & club moss..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	1	5	20	38	25	8	3	0	0	0

Community 2.3
Western Wheatgrass/Introduced Bluegrasses

This community phase is represented by a dominance of western wheatgrass and introduced cool season grasses such as Kentucky and Canada bluegrass. Lack of disturbance allows plant litter to accumulate, reducing the amount of sunlight to the soil surface, giving the competitive advantage to the shade tolerant bluegrasses. In addition to the bluegrasses and western wheatgrass, other native cool season species would still be present but in reduced numbers and vigor. Forbs such as cudweed sagewort, silverleaf scurfpea, and Missouri goldenrod would be present as well as shrubs such as fringed sagewort and broom snakeweed. Energy capture for this phase is reduced and has shifted to early and mid spring. Litter amounts have increased and the plant litter is no longer in contact with the soil surface. Soil erosion is still minimal while infiltration has been reduced due to increase in shallow rooted bluegrasses and reduction in number and vigor of bunch grasses. Non-native species comprise from 30 to 40 percent of the production occurring in this phase, with overall production being 80 to 100 percent of that occurring in phase 2.1. Excessive disturbance in the form of heavy, season-long grazing will result in similar plant community composition. As a result of the repeated, intense defoliation, plant litter will not accumulate. However, the plant community will still shift to one dominated by western wheatgrass with lesser amounts of Kentucky bluegrass. This community phase will also be represented by a strong forb component such as western yarrow,

Missouri goldenrod and rose pussytoes This plant community phase represents an “at risk” community. Weather conditions and/or management actions which favor the expansion of the non-native bluegrasses can result in a quick transition of this phase across a threshold towards the Invaded State (State 3).

Figure 10. Plant community growth curve (percent production by month). ND5406, Missouri Slope, Introduced Cool-season Grasses. Introduced cool-season grasses.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	3	10	35	35	5	2	8	2	0	0

Pathway 2.1a
Community 2.1 to 2.2

Continuous season-long or seasonal grazing which includes grazing at moderate to heavy stocking levels at the same time of year each year, or a combination of disturbances such as extended periods of below average precipitation coupled with periodic heavy grazing will shift this community to the 2.2 Blue Grama/Western Wheatgrass Plant Community Phase.

Pathway 2.1b
Community 2.1 to 2.3

Complete rest from grazing and no fire events will initiate this pathway as will heavy, continuous season-long grazing. Lack of disturbance will allow plant litter to accumulate shifting the competitive advantage to the shade tolerant bluegrasses while over grazing will favor the very grazing tolerant Kentucky bluegrass. These two extremes in management can result in a shift towards 2.3 Western Wheatgrass/Introduced Bluegrasses.

Pathway 2.2a
Community 2.2 to 2.1

Implementation of prescribed grazing which allows for adequate recovery time between grazing periods and alternating season of use will shift the competitive advantage away from the short statured grazing tolerant species to the mid statured cool season grasses and towards 2.1 Western Wheatgrass/Blue Grama/Needlegrasses.

Pathway 2.2b
Community 2.2 to 2.3

Complete rest from grazing and no fire events will initiate this pathway. As plant litter accumulates, the competitive advantage is shifted from the native species to the more shade tolerant invasive cool season grasses.

Pathway 2.3a
Community 2.3 to 2.1

Implementation of prescribed grazing which allows for adequate recovery time between grazing periods and alternating season of use and/or prescribed burning (in the case of excessive plant litter) will shift the competitive advantage away from the short statured grazing tolerant species to the mid statured cool season grasses and towards 2.1 Western Wheatgrass/Blue Grama/Needlegrasses.

State 3
Invaded

This state is the result of invasion and dominance of Kentucky bluegrass and/or smooth brome. This state is characterized by these two species and an increasing thatch layer that effectively blocks introduction of other plants into the system. Once the 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 these two species. These events may reduce the dominance of the sodgrasses, but due to the large amount of rhizomes in the soil there is no opportunity for the native species to establish and dominate before the sodgrasses rebound and again dominate the system.

Community 3.1
Introduced Bluegrass/Bromes/Shrubs

This plant community develops after an extended period of 15 years or more of non-use by herbivores and exclusion of fire. This plant community is dispersed throughout the pasture, encircling spot grazed areas, and areas distant from water sources. This is a typical pattern found in properly stocked pastures grazed season-long. Plant litter accumulates in large amounts as this community develops. Litter buildup reduces plant vigor and density, and seedling recruitment declines. Eventually litter levels become abundant enough to crowd out living plants and reduce plant density. Annual and/or biennial forbs, annual grasses, and cryptogams commonly fill these interspaces. Due to a lack of tiller stimulation and sunlight, native bunchgrasses typically develop dead centers and native rhizomatous grasses are limited to small colonies. Heavy litter covers shorter understory species (i.e. short grasses and sedges) restricting their ability to capture adequate sunlight for photosynthesis. Vigor and diversity of native plants are reduced. Non-native grasses, such as Kentucky bluegrass, crested wheatgrass, and smooth bromegrass tend to invade and may dominate this plant community. Other grasses present include western wheatgrass, thickspike wheatgrass, needleandthread and Sandberg bluegrass. The common forbs include sweetclover, cudweed sagewort and western yarrow. Silver sagebrush is the principal shrub. This plant community is resistant to change without prescribed grazing or fire. The combination of both grazing and fire is most effective in moving this plant community towards State 2. Soil erosion is low. Compared to the Reference State (State 1), infiltration is reduced to the lower root zone while runoff is similar to that expected for the Reference State. This plant community tends to be moisture loving and usually tends to utilize the spring moisture quickly causing forage base to become dry and unpalatable early in the summer. Once this plant community is reached, time and external resources will be needed to see any immediate recovery in the diversity of the site.

Figure 11. Plant community growth curve (percent production by month). ND5406, Missouri Slope, Introduced Cool-season Grasses. Introduced cool-season grasses.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	3	10	35	35	5	2	8	2	0	0

State 4
Shortgrass Sod

This plant community results from heavy continuous season-long grazing due to proximity to perennial water sources or from over utilization during extended drought periods.

Community 4.1
Blue Grama/Sandberg Bluegrass/Inland Saltgrass

This plant community evolved under heavy continuous season-long grazing or from over utilization during extended drought periods. The potential plant community is made up of approximately 70 percent grasses and grass-like species, 10 percent forbs, and 20 percent shrubs. Dominant grasses typically include blue grama and Sandberg bluegrass, inland saltgrass and buffalograss. Kentucky bluegrass may also be present in very minor amounts. Grass and grass-like species of secondary importance include sedge and western wheatgrass. Native cool season bunchgrasses have been eliminated from the community. Forbs commonly found in this plant community include cudweed sagewort, sweetclover, and western yarrow. Dominant shrubs include brittle cactus, fringed sagewort, and broom snakeweed. When compared to the Western Wheatgrass//Blue Grama Plant/Needlegrasses Community Phase (1.1), blue grama and buffalograss are dominant on this plant community. Cool-season grasses have decreased significantly. The herbaceous species present are well adapted to grazing intense grazing levels. This plant community is less productive than most other phases. The thick sod prevents other species from reestablishing. Lack of litter and reduced plant vigor causes higher soil temperatures, poor water infiltration rates, and high evapotranspiration which gives blue grama and other short, warm-season grasses a competitive advantage over most other grasses. Soil erosion will be minimal due to the sod forming habit of blue grama and inland saltgrass. This plant community is relatively stable and very resistant to change.

Figure 12. Plant community growth curve (percent production by month). ND5405, Missouri Slope, Warm-season Short Grass. Warm-season, short grass dominant, and some sedge.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	1	7	18	33	26	10	4	1	0	0

Transition T1
State 1 to 2

This is the transition from the native grass dominated reference state to a state that has been invaded by introduced cool-season grass species. When propagules of Kentucky bluegrass or some other non-native species are present, this transition occurs as natural and/or management actions favor a decline in the composition of warm and cool season native grasses and an increase in cool-season sodgrasses. This transition is 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 chronic season-long or heavy late season grazing. Complete rest from grazing and suppression of fire can also lead to this transition. The threshold between states is crossed when Kentucky bluegrass, Canada bluegrass, smooth brome, crested wheatgrass and/or other introduced species become established on the site. In some cases, these introduced species are part of functional/structural groups that were not present in the Reference State.

Transition T2
State 2 to 3

Complete rest from grazing and elimination of fire are the two major contributors to this transition, especially when smooth brome is present. Preliminary studies 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. The opportunity for high intensity spring burns is severely reduced by early green up and increased moisture and humidity at the soil surface and grazing pressure cannot cause a reduction in sodgrass dominance. Production is limited to the sod forming species. Infiltration continues to decrease and runoff increases, energy capture into the system is restricted to early season low producing species. Nutrient cycling is limited by root depth of the dominate species.

Restoration pathway R1
State 3 to 2

Long-term prescribed grazing (moderate stocking levels coupled with adequate recovery periods, or other grazing systems intended to treat specific species dominance, or periodic light to moderate stocking levels possibly including periodic rest) may lead this plant community phase over a threshold to the 2.0 Native Invaded Grass State. Pest management (i.e., herbicide) may also be needed to suppress cool-season invasive grasses. This will likely take a long period of time, possibly up to 10 years or more, and recovery may not be attainable. Success depends on whether native reproductive propagules, which may not always be readily visible, remain intact on the site.

Conservation practices

Prescribed Grazing
Integrated Pest Management (IPM)

Restoration pathway R2
State 4 to 2

Significant intervention is required to shift plant community phase 4.1 into the Native Invaded State. The application of herbicides combined with range seeding or mechanical treatment combined with range seeding may be necessary to achieve this shift. A high level of grazing management would be required after these inputs in order to maintain the resulting plant community and prevent its return to community phase 4.1 or 3.1.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1				336–504	
	western wheatgrass	PASM	*Pascopyrum smithii*	336–504	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–168	–
2				168–252	
	blue grama	BOGR2	*Bouteloua gracilis*	168–252	–
3				168–336	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	84–252	–
	green needlegrass	NAVI4	*Nassella viridula*	84–168	–
	Sandberg bluegrass	POSE	*Poa secunda*	34–84	–
4	**Other Native Perennials**			84–168	
	Grass, perennial	2GP	*Grass, perennial*	17–84	–
	plains reedgrass	CAMO	*Calamagrostis montanensis*	0–84	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	34–84	–
	saltgrass	DISP	*Distichlis spicata*	17–50	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	17–50	–
	dropseed	SPORO	*Sporobolus*	0–17	–
5	**Grass-Likes**			34–118	
	needleleaf sedge	CADU6	*Carex duriuscula*	17–84	–
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–50	–
	threadleaf sedge	CAFI	*Carex filifolia*	17–34	–
Forb					
7	**Forbs**			84–202	
	white heath aster	SYER	*Symphyotrichum ericoides*	17–34	–
	Forb (herbaceous, not grass nor grass-like)	2FORB	*Forb (herbaceous, not grass nor grass-like)*	0–34	–
	Forb, perennial	2FP	*Forb, perennial*	0–34	–
	common yarrow	ACMI2	*Achillea millefolium*	17–34	–
	blanketflower	GAAR	*Gaillardia aristata*	17–34	–
	purple locoweed	OXLA3	*Oxytropis lambertii*	17–34	–
	silverleaf Indian breadroot	PEAR6	*Pediomelum argophyllum*	17–34	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	17–34	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	17–34	–
	Missouri goldenrod	SOMI2	*Solidago missouriensis*	17	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	17	–
	wavyleaf thistle	CIUN	*Cirsium undulatum*	0–17	–
	woolly plantain	PLPA2	*Plantago patagonica*	17	–
	sticky cinquefoil	POGL9	*Potentilla glandulosa*	17	–
	old man's whiskers	GETR	*Geum triflorum*	0–17	–
	rush skeletonplant	LYJU	*Lygodesmia juncea*	17	–
	leafy wildparsley	MUDI	*Musineon divaricatum*	17	–

	onion	ALLIU	*Allium*	17	–
	rosy pussytoes	ANRO2	*Antennaria rosea*	0–17	–
	Nuttall's violet	VINU2	*Viola nuttallii*	17	–
Shrub/Vine					
8	**Shrubs**			17–84	
	winterfat	KRLA2	*Krascheninnikovia lanata*	17–34	–
	Subshrub (<.5m)	2SUBS	*Subshrub (<.5m)*	0–34	–
	silver sagebrush	ARCA13	*Artemisia cana*	0–34	–
	prairie sagewort	ARFR4	*Artemisia frigida*	17–34	–
	big sagebrush	ARTR2	*Artemisia tridentata*	0–34	–
	Nuttall's saltbush	ATNU2	*Atriplex nuttallii*	17–34	–
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–34	–
	spinystar	ESVIV	*Escobaria vivipara var. vivipara*	17	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	17	–
	brittle pricklypear	OPFR	*Opuntia fragilis*	0–17	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–17	–
Moss					
9	**Crytogams**			0–17	
	lesser spikemoss	SEDE2	*Selaginella densa*	0–17	–

Animal community

Animal Community – Grazing Interpretations
This site is well adapted to managed grazing by domestic livestock. The predominance of herbaceous plants across all plant community phases best lends these sites to grazing by cattle but other domestic grazers with differing diet preferences may also be a consideration depending upon management objectives. Often, the current plant community does not 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

Water is the principal factor limiting herbage production on this site. The site is dominated by soils in hydrologic group D, with localized areas in hydrologic group C. Infiltration varies from moderate to slow and runoff potential varies from medium to very high depending on soil hydrologic group and ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. An exception would be where short grasses form a dense sod and dominate the site. Areas where ground cover is less than 50% have the greatest potential to have reduced infiltration and higher runoff (refer to Section 4, NRCS National Engineering Handbook for runoff quantities and hydrologic curves).

Recreational uses

This site provides hunting opportunities for upland game species. The wide variety of plants which bloom from spring until fall have an esthetic value that appeals to many visitors.

Other products

Seed harvest of native plant species can provide additional income on

Inventory data references

Information presented here has been derived from NRCS clipping and other inventory data. Also, field knowledge of range-trained personnel was used. All descriptions were peer reviewed and/or field tested by various private, state and federal agency specialist. Those involved in developing this site description include: Dennis Froemke, NRCS Range Management Specialist; Jeff Printz, NRCS State Range Management Specialist; L. Michael Stirling, NRCS Range Management Specialist; Stan Boltz, NRCS Range Management Specialist; Josh Saunders, NRCS Range Management Specialist; Darrell Vanderbusch, NRCS Resource Soil Scientist; Michael D. Brand, State Land Dept. Director Surface Management; David Dewald, NRCS State Biologist; and Brad Podoll, NRCS Biologist.
Data Source Number of Records Sample Period State County
SCS-RANGE-417 18 1971 – 2007 SD Perkins,Corson, Harding, Meade, Ziebach
ND-CONS-20 1 2001 ND Dunn

Other references

High Plains Regional Climate Center, University of Nebraska, 830728 Chase Hall, Lincoln, NE 68583-0728. (http://hprcc.unl.edu)
USDA, NRCS. National Water and Climate Center, 101 SW Main, Suite 1600, Portland, OR 97204-3224. (http://www.wcc.nrcs.usda.gov)
USDA, NRCS. National Range and Pasture Handbook, September 1997
USDA, NRCS. National Soil Information System, Information Technology Center, 2150 Centre Avenue, Building A, Fort Collins, CO 80526. (http://nasis.nrcs.usda.gov)
USDA, NRCS. 2001. The PLANTS Database, Version 3.1 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.
USDA, NRCS, Various Published Soil Surveys.

Contributors

Jeff Printz
Jeff Printz And Stan Boltz
Jeff Printz/Stan Boltz

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)	J. Printz, S. Boltz, R. Kilian, D. Froemke, M. Rasmusson
Contact for lead author	jeff.printz@nd.usda.gov
Date	05/09/2011
Approved by	Jeff Printz
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills should not be present.

---

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

3. **Number and height of erosional pedestals or terracettes:** Not evident on slopes < 8%. Erosional pedestals may be present with small terracettes present at debris dams on slopes 9%.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is 25 to 45%.

5. **Number of gullies and erosion associated with gullies:** Active gullies should not be present.

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

7. **Amount of litter movement (describe size and distance expected to travel):** Little to no plant litter movement. If litter movement occurs, it is only for a short distance.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Plant cover and litter is at 45% or greater of soil surface and maintains soil surface integrity. Stability class anticipated to be 5 or greater.

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.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Moderate plant canopy (50 to 70% maximum), deeper surface layer and a healthy plant community contribute to reduced runoff. Infiltration rates are very slow to slow.

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 would be expected except for the naturally occurring claypan within 6 to 14 inches of the soil surface which restricts root penetration.

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: Mid stature cool-season rhizomatous grass > mid stature, cool-season bunch grasses >

    Sub-dominant: short stature, warm-season grass > forbs >

    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):** Some plant mortality and decadence (less than 5%) is expected on this site.

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

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Representative value of 1500 lbs/ac with a range of 1000 lbs/ac to 2000 lbs/ac (air dry weight) depending upon growing conditions.

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, Kentucky bluegrass, smooth bromegrass

17. **Perennial plant reproductive capability:** No limitations.