USDA Natural Resources Conservation Service

Ecological site R064XY040NE
Shallow

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General information

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

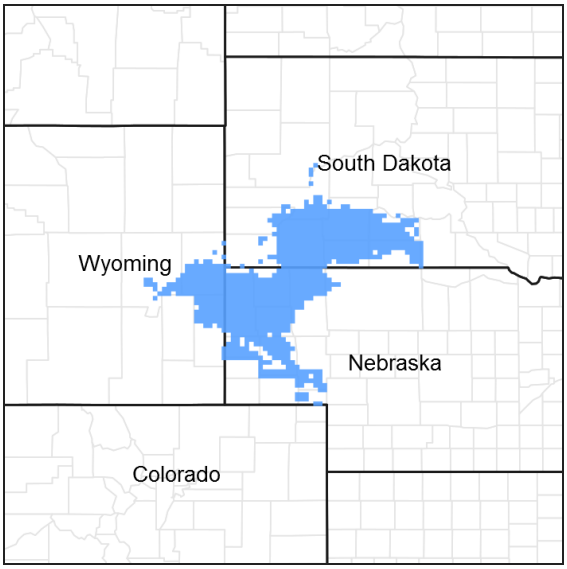


Figure 1. Mapped extent

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

MLRA notes

Major Land Resource Area (MLRA): 064X–Mixed Sandy and Silty Tableland and Badlands

The Mixed Sandy and Silty Tableland and Badlands (MLRA 64) is almost equally shared between South Dakota (42 percent) and Nebraska (41 percent), with a small portion in Wyoming (17 percent). The MLRA is 11,895 square miles. The towns of Kadoka and Pine Ridge, South Dakota; Chadron, Alliance, and Scottsbluff, Nebraska; and Lusk, Wyoming are all within the boundaries of this MLRA.

Badlands National Park, a portion of the Nebraska National Forest, and parts of the Oglala and Buffalo Gap National Grasslands, Agate Fossil Beds National Monument, Chadron State Park, Fort Robinson State Park, and the Pine Ridge Indian Reservation are in this MLRA. The Badlands are internationally renowned for their Oligocene vertebrate fossils.

The northern section of the MLRA consist of old plateaus and terraces that have been deeply eroded by wind, water, and time. The southern section consists of nearly level to broad intervalley remnants of smooth fluvial plains. These two sections are separated by the Pine Ridge escarpment. Elevations gradually increase from 2,950 feet to 5,073 feet as one moves east to west. The main drainageway through the Badlands National Park is the White River. The headwaters of both the White and Niobrara Rivers are located in MLRA 64. The Pine Ridge escarpment is located at the northernmost extent of the Ogallala Aquifer.

Tertiary continental sediments consisting of sandstone, siltstone, and claystone underlie most of the area. Many of the bedrock units in the southern third of the MLRA are covered by loess. Soils range from shallow to very deep, and from generally well-drained to excessively drained, and are loamy or sandy. The Badlands consist of stream-laid layers of silt, clay, and sand mixed with layers of volcanic ash.

Annual precipitation for the area is 14 to 20 inches. Most of the rainfall occurs as frontal storms in the spring and early summer months. This area supports a mixture of short-, mid-, and tall-statured warm- and cool-season grasses. On the Pine Ridge Escarpment, these plants grow in association with ponderosa pine, Rocky Mountain juniper, western snowberry, skunkbush sumac, common chokecherry, and rose. Wyoming big sagebrush occurs in minor amounts in the drier far western portion of the MLRA; however, small remnant stands can be found in the eastern portion of the Oglala National Grassland in Nebraska.

Sixty percent of the MLRA is grassland, 11 percent of which is under Federal management. Twenty-two percent of the area is used as cropland, and four percent is forested. Major resource concerns include the hazards of wind and water erosion, and surface water quality (USDA, NRCS. 2006. Ag Handbook 296).

For development of ecological sites, MLRA 64 is divided into two precipitation zones (PZ): 14 to 17 inches and 17 to 20 inches per year. The wetter 17 to 20 inches zone extends from the western end of the Pine Ridge Escarpment near Lusk, Wyoming, eastward along the escarpment through Nebraska and into the Big Badlands area of South Dakota. The drier zone, 14 to 17 inches, extends from Wyoming eastward to Alliance and Oshkosh, Nebraska, south of the Pine Ridge Escarpment. MLRA 64 stops at the western edge of the Nebraska Sand Hills (MLRA 65).

In the far southwest corner of the 14 to 17-inch PZ, there is a unique geologic area known as the Hartville Uplift. The Hartville Uplift is an elongated, north-northwest oriented, broad domal arch, of Laramide age (70-50 Ma). It extends approximately 45 miles between Guernsey and Lusk, Wyoming and is 15 miles wide at its widest point. Erosion has exposed a core of granite and Precambrian metasedimentary and metavolcanic rocks (Steele et al., 2018). In addition to the ecological sites that occur in the 14-17-inch PZ of MLRA 64, three unique ecological sites were added to help describe the soils and plant community dynamics that occur in the Hartville Uplift.

Classification relationships

USDA - Land Resource Region G – Western Great Plains Range and Irrigated Region, Major Land Resource Area (MLRA) 64 – Mixed Sandy and Silty Tableland and Badlands

US Environmental Protection Agency (EPA) Level IV Ecoregions of the Conterminous United States:
High Plains—25; Pine Ridge Escarpment—25a, Flat to Rolling Plains—25d, Pine Bluffs and Hills—25f, and Sandy and Silty Tablelands—25g
Northwestern Great Plains—43; White River Badlands—43h, and Keya Paha Tablelands—43i

USDA Forest Service, Ecological Subregions: Sections and Subsections of Conterminous United States:
Great Plains and Palouse Dry Steppe Province – 331, Western Great Plains Section – 331F, Subsections: Shale Scablands – 331Fb, White River Badlands – 311Fh, Pine Ridge Escarpment – 311Fj, High Plains – 311Fk, Hartville Uplift – 311Fm, Western Nebraska Sandy and Silty Tablelands – 311Fn, Keye Paha Tablelands – 331Ft
Powder River Basin Section – 311G, Subsection: Powder River Basin – 311Ge

Ecological site concept

The Shallow ecological site occurs throughout MLRA 64. It is located on hills and ridges and does not receive additional moisture from run off or overflow. Typical slopes range from 0 to 60 percent. The soils are formed in soft siltstone or sandstone. They are shallow, between 10 and 20 inches deep, with very fine sandy loam to silt loam surface textures, 2 to 10 inches thick. Soils are typically calcareous to the surface. The vegetation in the Reference State (1.0) consists of a mix of warm- and cool-season grasses. Little bluestem, sideoats grama, and blue grama are dominant. Cool-season grasses and grass-like species including needle and thread, rhizomatous wheatgrass, and threadleaf sedge make up a significant portion of the composition. Forbs are common and diverse, and shrubs are common. Ponderosa pine and Rocky Mountain juniper can occur on this site but in minor amounts. Conifers will typically occur on steep slopes and ridgetops that are adjacent to rock outcrops.

Associated sites

R064XY011NE	**Sandy 14-17" PZ** The Sandy 14-17” PZ ecological site can be found on less sloping landscapes adjacent to or down slope of the Shallow site.
GX064X01X015	**Loamy 14-17" PZ** The Loamy 14-17” PZ ecological site can be found on less sloping landscapes adjacent to or down slope of the Shallow site.
R064XY032NE	**Sandy 17-20" PZ** The Sandy 14-17” PZ ecological site can be found on less sloping landscapes adjacent to or down slope of the Shallow site.
GX064X01X036	**Loamy 17-20" PZ** The Sandy 17-20” PZ ecological site can be found on less sloping landscapes adjacent to or down slope of the Shallow site.
R064XY037NE	**Thin Upland** The Thin Upland ecological site can be found adjacent to or intermixed with the Shallow site.

Similar sites

R064XY047NE	**Very Shallow** The Very Shallow ecological site will occur on similar landscape positions, but the soils are less than 10 inches deep. The plant community will have less little bluestem and considerably less forage production than the Shallow site.
R064XY037NE	**Thin Upland** The Thin Upland ecological site will occur on similar landscape positions, but the soils are greater than 20 inches deep. The plant community will have more little bluestem and higher forage production than the Shallow site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium var. scoparium* (2) *Hesperostipa comata ssp. comata*

Physiographic features

The Shallow ecological site occurs on side slopes, and on ridgetops of hills, plains, and uplands.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Ridge (3) Plain
Runoff class	Very low to high
Flooding frequency	None
Elevation	884–1,524 m
Slope	0–60%
Aspect	Aspect is not a significant factor

Climatic features

MLRA 64 is considered to have a continental climate consisting of cold winters and hot summers, low humidity, light rainfall, and ample sunshine. Extremes in temperature may also abound. The climate is the result of the location of MLRA 64 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 ranges from 14 to 20 inches per year. The normal average annual temperature is about 47°F. January is the coldest month with average temperatures ranging from about 21°F (Wood, SD) to about 25°F (Hemingford, NE). July is the warmest month with temperatures averaging from about 70°F (Keeline 3 W, WY – 1953-1986) to about 76°F (Wood, SD). The range of normal average monthly temperatures between the coldest and warmest months is about 55°F. This large annual range attests to the continental nature of the climate of this area. Hourly winds 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 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 (characteristic range)	92-120 days
Freeze-free period (characteristic range)	119-139 days
Precipitation total (characteristic range)	406-483 mm
Frost-free period (actual range)	87-122 days
Freeze-free period (actual range)	110-149 days
Precipitation total (actual range)	381-508 mm
Frost-free period (average)	107 days
Freeze-free period (average)	130 days
Precipitation total (average)	432 mm

Climate stations used

- (1) INTERIOR 3 NE [USC00394184], Interior, SD
- (2) MARTIN [USC00395281], Martin, SD
- (3) WOOD [USC00399442], Wood, SD
- (4) LUSK 2 SW [USC00485830], Lusk, WY
- (5) TORRINGTON 29N [USC00488997], Jay Em, WY
- (6) CHADRON 3NE [USC00251578], Chadron, NE
- (7) HARRISON 20 SSE [USW00094077], Harrison, NE
- (8) ALLIANCE 1WNW [USC00250130], Alliance, NE
- (9) HARRISON [USC00253615], Harrison, NE
- (10) HEMINGFORD [USC00253755], Hemingford, NE

Influencing water features

No riparian or wetland features are directly associated with the Shallow ecological site.

Soil features

The common features of soils in this site are the very fine sandy loam to silt loam surface layer with slopes of 0 to 60 percent. The soils in this site are shallow (10-20 inches in depth), well to somewhat excessively drained, and formed in soft siltstone or sandstone. The surface layer is 2 to 10 inches thick and has moderate infiltration rates. These soils are typically calcareous at or near the surface; however, carbonates are not always distinguishable in the surface layer. The textures of the subsoil range from very fine sandy loam to silt loam.

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. Sub-surface soil layers are restrictive to water movement and root penetration.

Major soils correlated to the Shallow ecological site are Canyon, Enning, Epping, Fairburn, Imlay, Tassel, Trelona, and an unnamed Torriorthentic Haplustolls soil in eastern Wyoming.

Soils that have the potential for conifer (forest-like) plant communities, especially when adjacent to rock outcrop, include Canyon, Epping, Enning, Tassel, and an unnamed, Torriorthentic Haplustolls.

These soils are susceptible to water erosion. The hazard of water erosion increases on slopes greater than about 15 percent. Low available water capacity caused by the shallow rooting depth strongly influences the soil-water-plant relationship.

More information can be found in the various soil survey reports. Contact the local USDA Service Center for soil survey reports that include more detail specific to your area of interest, or use the internet to access USDA's Web Soil Survey.

Table 4. Representative soil features

Parent material	(1) Residuum–sandstone and siltstone
Surface texture	(1) Loam (2) Silt loam (3) Very fine sandy loam
Family particle size	(1) Loamy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderate to moderately rapid
Soil depth	25–51 cm
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–20%
Available water capacity (0-101.6cm)	5.08–7.62 cm
Calcium carbonate equivalent (0-101.6cm)	0–15%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–15%

Ecological dynamics

This site developed under Northern Great Plains climatic conditions, light to severe grazing by bison and other large herbivores, sporadic natural or human-caused wildfire (often of light intensities), and other biotic and abiotic factors that typically influence soil and site development. Changes will occur in the plant communities due to short-term weather variations, impacts of native and exotic plant and animal species, and management actions. While the following plant community descriptions specify more typical transitions between communities that will occur, severe disturbances, such as periods of well below-average precipitation and the introduction of non-native cool-season grasses, can cause significant shifts in plant communities and species composition.

The Shallow ecological site can have minor amounts of ponderosa pine and/or Rocky Mountain juniper in the plant community. Conifers typically occur on cool, steep slopes and ridgetops adjacent to rock outcrops. On the Pine Ridge Escarpment, the Shallow ecological site with north- or east-facing slopes with periodic fire can look like an open ponderosa pine woodland or savanna. Prior to 1900, fire frequency was 5-15 years (CWPP. 2013). In the absence of periodic fire, these trees have the potential to expand or encroach onto adjacent sites, and over time

have the potential to produce marketable timber. Currently, ponderosa pine density can be high in the Pine Ridge Area, with excessive ladder fuels in the understory and an increased potential for large crown fires (CWPP. 2013). Once hot fires remove ponderosa pine from the plant communities they may not regenerate for many decades, if ever. Post-fire regeneration in open areas can only be found in favorable microsites, such as next to logs or under the cover of litter, and near available seed sources (Haffey et al 2018). Pockets of ponderosa pine will endure after fire, and the species won't disappear from the Pine Ridge landscape, but regeneration will be slow, and a return of a pine woodland will take a very long time (Gaarder, 2013). Soils adjacent to rock outcrops provide a refugia for pine and juniper during fire and surviving mature trees as a seed source for future regeneration.

In the far western portion of the MLRA 64, alderleaf mountain mahogany can also occur on this site. It will typically be seen on ridges and steeper north- and east-facing slopes that tend to have cooler and wetter micro climates.

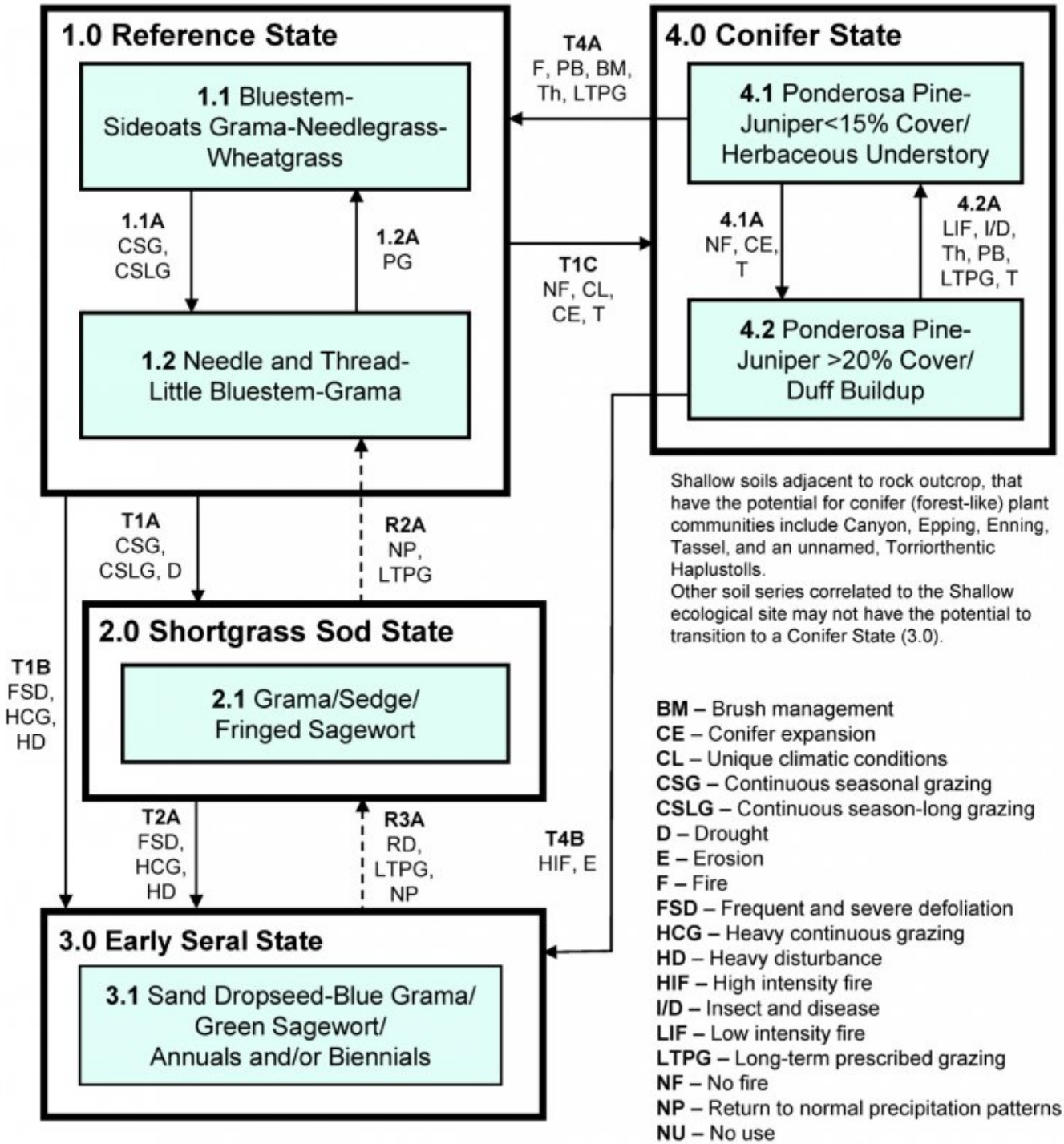
Continuous season-long grazing (during the typical growing season of May through October) or repeated seasonal grazing (e.g., every spring, every summer) without adequate recovery periods following each grazing occurrence causes this site to depart from the Bluestem-Sideoats Grama-Needlegrass-Wheatgrass Plant Community (1.1).

Interpretations are primarily based on the Bluestem-Sideoats Grama-Needlegrass-Wheatgrass Plant Community. It 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 used. Plant communities, states, transitional pathways, and thresholds have been determined through similar studies and experience.

The following is a diagram that illustrates the common plant communities that can occur on the site and the transition pathways between communities. The ecological processes will be discussed in more detail in the plant community descriptions following the diagram.

State and transition model

Shallow – R064XY040NE 2/4/19



Shallow soils adjacent to rock outcrop, that have the potential for conifer (forest-like) plant communities include Canyon, Epping, Enning, Tassel, and an unnamed, Torriorthentic Haplustolls.
Other soil series correlated to the Shallow ecological site may not have the potential to transition to a Conifer State (3.0).

BM – Brush management
CE – Conifer expansion
CL – Unique climatic conditions
CSG – Continuous seasonal grazing
CSLG – Continuous season-long grazing
D – Drought
E – Erosion
F – Fire
FSD – Frequent and severe defoliation
HCG – Heavy continuous grazing
HD – Heavy disturbance
HIF – High intensity fire
I/D – Insect and disease
LIF – Low intensity fire
LTPG – Long-term prescribed grazing
NF – No fire
NP – Return to normal precipitation patterns
NU – No use
PB – Prescribed burning
PG – Prescribed grazing
RD – Remove management induced disturbance
S – Seeding for erosion control
T – Time
Th – Conifer thinning
- - → Recovery may not be fast or feasible

Diagram Legend - Shallow - R064XY040NE

T1A	Continuous seasonal grazing, or continuous season-long grazing, or heavy grazing in combination with drought.
T1B	Frequent and severe defoliation, and/or heavy disturbance, or heavy grazing in combination with drought.
T1C	Long-term no fire, favorable climatic conditions, expansion of conifers, and time.
T2A	Frequent and severe defoliation, and/or heavy disturbance, or heavy grazing in combination with drought.
T4A	Fire, prescribed burning, mechanical brush management, timber thinning or harvest, followed by long-term prescribed grazing with proper stocking, change in season of use, and adequate time for recovery.
T4B	High-intensity fire and possibly soil erosion.

R2A	A return to normal precipitation patterns, and long-term prescribed grazing. This transition may take an extended period of time and in the end not meet management objectives.
R3A	Removal of disturbance coupled with long-term prescribed grazing with proper stocking, change in season of use, adequate time for recovery, and a return to normal precipitation patterns. Transition may not be fast or feasible.

CP 1.1A	1.1 - 1.2	Continuous seasonal grazing or continuous season-long grazing.
CP 1.2A	1.2 - 1.1	Prescribed grazing with proper stocking, change in season of use, and adequate time for recovery.
CP 4.1A	4.1 - 4.2	Long-term no fire, expansion of conifers, and time.
CP 4.2A	4.2 - 4.1	Low-intensity fire, insect and/or disease damage, timber thinning or harvest, prescribed burning, followed by long-term prescribed grazing with proper stocking, change in season of use, and adequate time for recovery.

State 1
Reference State

The Reference State represents what is believed to show the natural range of variability that dominated the dynamics of the Shallow ecological site prior to European settlement. This site, in the Reference State, is dominated by warm-season grasses and subdominant cool-season grass. Forbs will be common and diverse, shrubs species will vary depending on precipitation, and slope aspect. Ponderosa pine and Rocky Mountain juniper can occur naturally on steep slopes and ridges adjacent to rock outcrops. Grazing or the lack of grazing, fire, and drought are the major drivers between plant communities.

Community 1.1
Bluestem-Sidoats Grama-Needlegrass-Wheatgrass

Figure 8. PCP 1.1 - Pine Ridge Escarpment

Interpretations are based primarily on the Bluestem-Sideoats Grama-Needlegrass-Wheatgrass Plant Community. This is also considered to be the Reference Plant Community (1.1). This plant community 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. The potential vegetation is about 85 percent grasses or grass-like plants, 10 percent forbs, and 5 percent shrubs and trees. A mixture of cool- and warm-season grasses dominates the site. The major grasses include sideoats grama, needle and thread, little bluestem, big bluestem, western wheatgrass, and blue grama. Other grasses and grass-likes that occur in this community include hairy grama, plains muhly and sedge. Significant forbs include purple coneflower and purple prairie clover. Shrubs that occuring in this plant community are fringed sagewort and yucca. Refer to the Plant Community Composition and Group Annual Production table for species composition and production. This plant community is extremely resilient and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high tolerance to drought. Community dynamics, nutrient and water cycles, and energy flow are functioning properly. Plant litter is properly distributed with very little movement off-site and natural plant mortality is very low. The diversity in plant species allows for high tolerance to drought.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	678	1480	1827
Forb	78	127	174
Shrub/Vine	28	58	90
Tree	–	17	39
Total	**784**	**1682**	**2130**

Figure 10. Plant community growth curve (percent production by month). NE6404, Pine Ridge/Badlands, warm-season dominant, cool-season sub-dominant. Warm-season dominant, cool-season sub-dominant.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	8	15	24	23	15	5	5		

Community 1.2
Needle and thread-Little Bluestem-Grama

This plant community evolved under continuous seasonal grazing or in some cases with low stock densities under continuous season-long grazing. The potential vegetation is about 85 percent grasses or grass-like plants, 10 percent forbs, and 5 percent shrubs and trees. A mixture of cool- and warm-season grasses dominates the site. Needle and thread, little bluestem, and blue grama are significant species in this plant community. Big bluestem and sideoats grama will decrease, while the short grasses and grass-likes, such as blue grama, hairy grama, and sedge will increase. Forbs commonly found in this plant community include purple coneflower and purple prairie clover. Significant shrubs include yucca, cactus, rose, and fringed sagewort. Refer to the Plant Community Composition and Group Annual Production table for species composition and production. 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.

Table 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	577	1246	1681
Forb	67	109	151
Shrub/Vine	28	87	151
Tree	–	15	34
Total	**672**	**1457**	**2017**

Figure 12. Plant community growth curve (percent production by month). NE6404, Pine Ridge/Badlands, warm-season dominant, cool-season sub-dominant. Warm-season dominant, cool-season sub-dominant.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	8	15	24	23	15	5	5		

Pathway 1.1A
Community 1.1 to 1.2

Continuous seasonal grazing or low stock densities under continuous season-long grazing will convert this plant community to the Needle and Thread-Little Bluestem-Grama Plant Community (1.2).

Pathway 1.2A
Community 1.2 to 1.1

Prescribed grazing that included proper stocking rates, change in season of use, and adequate time for plant recovery following grazing will convert this plant community to the Bluestem-Sideoats Grama-Needlegrass Plant Community (1.1).

State 2
Shortgrass Sod State

The Shortgrass State is dominated by warm-season shortgrass species and upland sedges. This State is the result of grazing management that does not provide adequate recovery time for tall- and mid-statured warm- and cool-season grasses. The hydrologic function of this state may be altered. Runoff is high, and infiltration is low. The Shortgrass State is very resistant to change through grazing management alone.

Community 2.1
Grama/Sedge/Fringed Sagewort

This plant community evolves from continuous seasonal grazing, or continuous season-long grazing over several years. Diversity is lost, as the shortgrasses become dominant in the plant community. The grazing-tolerant blue or hairy grama and sedges replace big bluestem, little bluestem, western wheatgrass, and the needlegrasses. Sideoats grama remains in the plant community but is less productive because of the mid-summer grazing pressure. Because of the grazing pressure, fringed sagewort, broom snakeweed, yucca, woolly Indianwheat, pussytoes, Cuman ragweed, and cactus become more prevalent in the plant community. Non-native species such as cheatgrass will tend to invade this plant community. This plant community is typically resistant to change. Runoff will increase, and infiltration will decrease. Continued overuse results in considerable bare ground and high potential for erosion.

Table 7. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	370	699	1026
Shrub/Vine	39	90	140
Forb	39	90	140
Tree	–	18	39
Total	**448**	**897**	**1345**

Figure 14. Plant community growth curve (percent production by month). NE6404, Pine Ridge/Badlands, warm-season dominant, cool-season sub-dominant. Warm-season dominant, cool-season sub-dominant.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	8	15	24	23	15	5	5		

State 3
Early Seral State

The Early Seral State is dominated by weedy annuals and biennials, sand dropseed, threeawn, and tarragon (green sagewort). This State is the result of heavy disturbance such as frequent and severe defoliation or heavy livestock concentrations coupled with grazing management that does not provide adequate time for recovery in the Reference State (1.0). It can also be the result of a high-intensity fire and subsequent soil erosion in the Conifer State (3.0). The hydrologic function is also likely to be dramatically altered. Runoff is high, and infiltration is low. The Early Seral State is very resistant to change through grazing management alone.

Community 3.1
Sand Dropseed-Threeawn/Field Sagewort/Annuals and Biennials

Figure 15. PCP 3.1 - Pine Ridge Escarpment

This plant community develops where the rangeland is grazed year-round at high stock densities or upon occupation by prairie dogs. The plant composition is made up of annuals with a few species of perennial forbs and grasses that are tolerant to frequent and severe defoliation. Dominant species are sand dropseed, threeawn, and blue grama. Most of the mid-statured grasses have been eliminated or severely reduced. Cheatgrass has invaded the site. Perennial forbs are Cuman ragweed, rush skeleton plant, curlycup gumweed, and hairy false goldenaster. Tarragon (green sagewort), broom snakeweed, and cactus can be abundant here. This plant community can also transition from a conifer-dominated plant community following a high-intensity fire resulting in the removal of most, if not all, conifers from the plant community. Initially, weedy species such as common mullein, thistle, and annual grasses and forbs will occupy the site, but in time, upland sedges, shortgrass species, and dropseed will become dominant. This transition is most likely to come from the Ponderosa Pine-Juniper > 20 Percent Cover/Duff Build Up Plant Community (4.2). This plant community is resistant to change due to the lack of perennial species present and the amount of annuals and invaders occupying the site. Soil erosion is high due to the increased bare ground.

Infiltration is low, and runoff is high from the lack of litter and viable plant population.

Figure 16. Plant community growth curve (percent production by month). NE6404, Pine Ridge/Badlands, warm-season dominant, cool-season sub-dominant. Warm-season dominant, cool-season sub-dominant.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		5	8	15	24	23	15	5	5		

State 4
Conifer State

The Conifer State occurs when ponderosa pine, Rocky Mountain juniper, or eastern red cedar become established or expand on this site. As conifer canopy cover increases, the herbaceous component will decrease, bare ground increases and pine needles build up and create a thick duff layer. As competition from herbaceous species decrease, conifers can establish more readily under the canopy. Heavy grazing can contribute to this transition, but it may also occur independently without human influence other than through fire suppression. The Pine Ridge area of Nebraska is drier than the Black Hills (MLRA 62) where expansive stands of ponderosa pine occur, and pine regenerates readily following fire. Nebraska is not an area where ponderosa pines thrive as the state is at the southern and eastern edge of ponderosa pine range (Gaarder, 2013). Replanting is difficult because of the limited growing conditions for the species in Nebraska. Previous efforts to replant ponderosa pine in burned areas of northwest Nebraska, notably near Fort Robinson State Park (Gaarder, 2013), Chadron State Park, and East Ask Creek watershed have been largely unsuccessful (CWPP 2013). It would not appear that MLRA 64 has consistent climatic conditions necessary for ponderosa pine germination and regeneration. Those conditions may be episodic as they are in the drier American southwest. Regeneration of ponderosa pine in New Mexico and Arizona are strongly episodic and the basis of these pulses are at least partly controlled by climate. Ponderosa pine in the Southwest require a warm wet spring and an above-average water supply throughout the year for germination to occur and seedlings to establish. One study from northern Arizona showed a large cohort of ponderosa pine that established within a two-year period between 1919 and 1920 when optimal combination of temperature and precipitation factors occurred. This episodic event was not repeated for 73 years (Savage, M., et al, 1996). The Conifer State on the Shallow ecological sites may be limited in extent, especially those plant communities having large ponderosa pine components. As high intensity, medium to large sized wildfires occur, these plant communities may become less common as grassland communities replace these woodlands.

Community 4.1
Ponderosa Pine-Juniper < 15 Percent Cover/Herbaceous Understory

Figure 17. PCP 4.1 - Fort Robinson State Park

Historically, ponderosa pine and juniper were confined to ridges and steep, north- or east-facing slopes that were located adjacent to rock outcrops. This plant community is produced due to fire suppression and the expansion of ponderosa pine and juniper on the ecological site. Ponderosa pine/juniper canopy make up approximately 15 percent mature trees in this plant community. The understory is made up of about 80 percent grasses and grass-like species, 10 percent forbs, and 10 percent shrubs. Dominant grasses and grass-likes include needle and thread, little bluestem, sideoats grama, blue grama and sedge. Grasses of secondary importance include Canada wildrye,

green needlegrass and western wheatgrass. Forbs commonly found in this community include white sagebrush (cudweed sagewort), western yarrow, and pussytoes. Shrubs can include fringed sagewort, western snowberry, chokecherry, and poison ivy. When compared to the Bluestem-Sideoats Grama-Needlegrass-Western Wheatgrass Plant Community (1.1), ponderosa pine or juniper increases. The grass component has decreases as the buildup of pine and juniper needles increases. Annual herbaceous production has also decreased. While the conifer canopy provides excellent protection from the weather for both livestock and wildlife, it is not capable of supporting large numbers of wildlife and livestock due to decreased production. This plant community is resistant to change. A significant reduction of conifers can only be accomplished through fire, or mechanical removal. The vegetation in the understory is capable of enduring fire without a detrimental effect to the site and the associated plant community.

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	185	841	1721
Tree	50	112	174
Shrub/Vine	50	84	118
Forb	50	84	118
Total	**335**	**1121**	**2131**

Figure 19. Plant community growth curve (percent production by month). NE6411, Pine Ridge/Badlands, heavy conifer canopy. Mature ponderosa pine/juniper overstory.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3	7	10	20	28	15	5	4	4	2	1

Community 4.2
Ponderosa Pine-Juniper > 20 Percent Cover/Duff Buildup

This plant community develops with long-term fire suppression resulting in the expansion of ponderosa pine and juniper on the ecological site. Before European settlement, an acre that once had 30 to 50 ponderosa pines might now have 2,000 to 3,000 trees (Gaarder, 2013). Ponderosa pine/juniper canopy in this plant community is greater than 20 percent mature trees. A thick duff layer, composed of pine needles, branches, and cones, can develop under the pine canopy, which will limit the growth of the herbaceous understory. The understory will be made up of about 75 percent grasses and grass-like species, 10 percent forbs, and 15 percent shrubs and immature trees. Dominant grasses and grass-likes include upland sedges, and needle and thread. Grasses of secondary importance include Canada wildrye, and green needlegrass. Forbs commonly found in this community include white sagebrush (cudweed sagewort), and pussytoes. Shrubs can include western snowberry, chokecherry, yucca, and poison ivy. Kentucky bluegrass can become the dominate grass species in this plant community and dominate the plant community dynamics and adversely affect ecological recovery. When compared to the Bluestem-Sideoats Grama-Needlegrass-Western Wheatgrass Plant Community (1.1), ponderosa pine and/or juniper increases significantly. The grass component decreases dramatically as the buildup of pine and juniper needles increases. Annual production also decreases significantly. This plant community is resistant to change. A significant reduction of conifers can only be accomplished through fire, mechanical brush management, or thinning. The vegetation in the understory is capable of enduring fire; however, very hot crown fires will have a detrimental effect to the site and the associated plant community that can last for many years.

Pathway 4.1A
Community 4.1 to 4.2

Long-term fire suppression, the expansion of conifers, and time will likely move this plant community to the Ponderosa Pine-Juniper > 20 Percent Canopy Cover/Duff Buildup Plant Community (4.2). Conifers will expand, and the herbaceous understory will decline.

Pathway 4.2A

Community 4.2 to 4.1

Insect or disease epidemics, low-intensity fires, thinning and/or timber harvest, periodic prescribed burning, followed by long-term prescribed grazing, and time, may move this plant community back to the Ponderosa Pine-Juniper < 15 Percent Canopy Cover/Herbaceous Understory Plant Community (4.1).

Transition T1A
State 1 to 2

Continuous seasonal grazing, or continuous season-long grazing without change in season of use, or heavy grazing in combination with drought, will convert the plant community to Shortgrass Sod State (2.0).

Transition T1B
State 1 to 3

Frequent and severe defoliation or heavy disturbance including livestock feeding areas, prairie dog towns, and calving pastures will transition this the Reference State (1.0) to the Early Seral State (3.0).

Transition T1C
State 1 to 4

Long-term fire suppression, favorable climatic conditions that allow for pine regeneration and establishment, expansion of conifers, and time will lead to the Conifer State (3.0).

Restoration pathway R2A
State 2 to 1

Long-term prescribed grazing, including proper stocking rates, change in season of use, and adequate time for plant recovery after grazing, may convert this plant community to the Reference State (1.0). A return to normal precipitation patterns following drought will help with recovery. This transition may not be rapid or meet management objectives.

Transition T2A
State 2 to 3

Frequent and severe defoliation or heavy disturbance including livestock feeding areas, prairie dog towns, and calving pastures will transition this the Shortgrass Sod State (2.0) to the Early Seral State (3.0).

Restoration pathway R3A
State 3 to 2

Removal of any management-induced disturbance coupled with long-term prescribed grazing, including proper stocking rates, change in season of use, and adequate time for plant recovery after grazing, may convert this plant community to the Shortgrass Sod State (2.0). A return to normal precipitation patterns following drought will help with recovery. This transition may not be rapid or meet management objectives.

Transition T4A
State 4 to 1

Prescribed burning or wildfire followed by long-term prescribed grazing will move this plant community towards the herbaceous dominated Reference State (1.0). Mechanical removal of pine/juniper, either through bush management, timber harvest, or thinning, followed by long-term prescribed grazing may also allow the understory to develop and transition to the Reference State (1.0). Trees located on the steeper escarpments and deeper canyons may escape most fires and provide a seed source for ponderosa pine expansion in the future. This transition is most likely to occur from the Ponderosa Pine-Juniper < 15 Percent Cover/Herbaceous Understory Plant Community (4.1).

Transition T4B
State 4 to 3

High-intensity fire, followed by excessive soil erosion will cause a transition to the Early Seral State (3.0). Initially weedy species including annual grasses and forbs, common mullein, and thistles will become established, eventually, upland sedges, shortgrasses, and dropseeds will dominate the plant community. Trees located on the steeper escarpments and deeper canyons may escape most fires and provide a seed source for ponderosa pine to expansion in the future. This transition can occur from any plant community within the Conifer State (4.0) but is more likely to occur from the Ponderosa Pine-Juniper > 20 Percent Cover/Duff Buildup Plant Community (4.2).

Additional community tables

Table 9. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall and Mid- Warm-Season Grasses**			252–841	
	little bluestem	SCSCS	*Schizachyrium scoparium var. scoparium*	84–336	–
	sideoats grama	BOCUC2	*Bouteloua curtipendula var. curtipendula*	84–252	–
	big bluestem	ANGE	*Andropogon gerardii*	34–168	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–168	–
2	**Mid- Cool-Season Grasses**			84–588	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	84–252	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–252	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–84	–
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–84	–
	green needlegrass	NAVI4	*Nassella viridula*	0–84	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–84	–
3	**Short- Warm Season Grasses**			84–336	
	blue grama	BOGR2	*Bouteloua gracilis*	135–252	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	0–168	–
	buffalograss	BODA2	*Bouteloua dactyloides*	0–84	–
4	**Other Native Grasses and Grass-Likes**			34–168	
	threadleaf sedge	CAFI	*Carex filifolia*	84–252	–
	plains muhly	MUCU3	*Muhlenbergia cuspidata*	0–84	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–50	–
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–34	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	0–17	–
	Canada wildrye	ELCA4	*Elymus canadensis*	–	–
5	**Non-Native Cool-Season Grasses**			–	
Forb					
6	**Forbs**			84–168	
	purple prairie clover	DAPU5	*Dalea purpurea*	50–84	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	50–84	–
	large Indian breadroot	PEES	*Pediomelum esculentum*	0–84	–

	pussytoes	ANTEN	*Antennaria*	0–84	–
	spiny phlox	PHHO	*Phlox hoodii*	0–84	–
	Indian breadroot	PEDIO2	*Pediomelum*	0–84	–
	dotted blazing star	LIPU	*Liatris punctata*	17–84	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–50	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	17–50	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	17–50	–
	tarragon	ARDR4	*Artemisia dracunculus*	0–34	–
	scarlet beeblossom	OESU3	*Oenothera suffrutescens*	17–34	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	17–34	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–34	–
	scurfpea	PSORA2	*Psoralidium*	17–34	–
	groundplum milkvetch	ASCR2	*Astragalus crassicarpus*	17–34	–
	prairie milkvetch	ASLAR	*Astragalus laxmannii var. robustior*	0–34	–
	prairie clover	DALEA	*Dalea*	17–34	–
	American bird's-foot trefoil	LOUNU	*Lotus unifoliolatus var. unifoliolatus*	0–34	–
	western yarrow	ACMIO	*Achillea millefolium var. occidentalis*	0–34	–
	Forb, perennial	2FP	*Forb, perennial*	0–34	–
	hoary verbena	VEST	*Verbena stricta*	0–17	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–17	–
	white penstemon	PEAL2	*Penstemon albidus*	0–17	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–17	–
	large beardtongue	PEGR7	*Penstemon grandiflorus*	0–17	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–17	–
	stemless four-nerve daisy	TEACA2	*Tetraneuris acaulis var. acaulis*	0–17	–
	milkvetch	ASTRA	*Astragalus*	0–17	–
	prairie thermopsis	THRH	*Thermopsis rhombifolia*	0–17	–
	creeping barberry	MARE11	*Mahonia repens*	–	–
Shrub/Vine					
7	**Shrubs**			34–84	
	leadplant	AMCA6	*Amorpha canescens*	0–84	–
	prairie sagewort	ARFR4	*Artemisia frigida*	17–84	–
	pricklypear	OPUNT	*Opuntia*	0–84	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–84	–
	rose	ROSA5	*Rosa*	0–84	–
	soapweed yucca	YUGL	*Yucca glauca*	0–84	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–50	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–50	–
	chokecherry	PRVI	*Prunus virginiana*	0–17	–
Tree					
8	**Trees**			0–34	
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–34	–
	ponderosa pine	PIPO	*Pinus ponderosa*	0–34	–

Table 10. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall and Mid- Warm-Season Grasses**			146–583	
	little bluestem	SCSCS	*Schizachyrium scoparium var. scoparium*	146–364	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	73–219	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–117	–
	big bluestem	ANGE	*Andropogon gerardii*	0–73	–
2	**Mid- Cool-Season Grasses**			73–364	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	73–291	–
	western wheatgrass	PASM	*Pascopyrum smithii*	29–146	–
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–146	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–73	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–73	–
	green needlegrass	NAVI4	*Nassella viridula*	0–44	–
3	**Short Warm-Season Grasses**			219–437	
	blue grama	BOGR2	*Bouteloua gracilis*	146–291	–
	buffalograss	BODA2	*Bouteloua dactyloides*	0–73	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	29–73	–
4	**Other Native Grasses and Grass-Likes**			146–291	
	threadleaf sedge	CAFI	*Carex filifolia*	146–291	–
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	15–73	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	0–44	–
	plains muhly	MUCU3	*Muhlenbergia cuspidata*	0–44	–
	plains muhly	MUCU3	*Muhlenbergia cuspidata*	0–44	–
5	**Non-Native Cool-Season Grasses**			0–29	
	cheatgrass	BRTE	*Bromus tectorum*	0–29	–
Forb					
6	**Forbs**			73–146	
	white sagebrush	ARLU	*Artemisia ludoviciana*	44–87	–
	dotted blazing star	LIPUP	*Liatris punctata var. punctata*	15–73	–
	Indian breadroot	PEDIO2	*Pediomelum*	0–73	–
	scurfpea	PSORA2	*Psoralidium*	29–73	–
	Forb, perennial	2FP	*Forb, perennial*	29–73	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	15–44	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	15–44	–
	western yarrow	ACMIO	*Achillea millefolium var. occidentalis*	15–44	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–44	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	15–44	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–44	–

	milkvetch	ASTRA	*Astragalus*	15–44	–
	groundplum milkvetch	ASCR2	*Astragalus crassicarpus*	15–44	–
	prairie milkvetch	ASLAR	*Astragalus laxmannii var. robustior*	15–44	–
	field sagewort	ARCA12	*Artemisia campestris*	15–44	–
	white prairie clover	DACA7	*Dalea candida*	15–44	–
	American bird's-foot trefoil	LOUNU	*Lotus unifoliolatus var. unifoliolatus*	0–29	–
	pussytoes	ANTEN	*Antennaria*	0–29	–
	scarlet beeblossom	OESU3	*Oenothera suffrutescens*	15–29	–
	stemless four-nerve daisy	TEACA2	*Tetraneuris acaulis var. acaulis*	0–29	–
	prairie thermopsis	THRH	*Thermopsis rhombifolia*	0–29	–
	woolly plantain	PLPA2	*Plantago patagonica*	15–29	–
	white heath aster	SYER	*Symphyotrichum ericoides*	15–29	–
	hoary verbena	VEST	*Verbena stricta*	0–15	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–15	–
	spiny phlox	PHHO	*Phlox hoodii*	0–15	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–15	–
	white penstemon	PEAL2	*Penstemon albidus*	0–15	–
	large beardtongue	PEGR7	*Penstemon grandiflorus*	0–15	–
Shrub/Vine					
7	**Shrubs**			29–146	
	prairie sagewort	ARFR4	*Artemisia frigida*	29–117	–
	rose	ROSA5	*Rosa*	15–73	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–73	–
	soapweed yucca	YUGL	*Yucca glauca*	15–73	–
	pricklypear	OPUNT	*Opuntia*	15–73	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–44	–
	leadplant	AMCA6	*Amorpha canescens*	0–44	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–44	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–29	–
	chokecherry	PRVI	*Prunus virginiana*	0–15	–
Tree					
8	**Trees**			0–29	
	ponderosa pine	PIPO	*Pinus ponderosa*	0–29	–
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–29	–

Table 11. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall and Mid- Warm-Season Grasses**			0–135	
	little bluestem	SCSCS	*Schizachyrium scoparium var. scoparium*	0–90	–
	sideoats grama	BOCUC2	*Bouteloua curtipendula var. curtipendula*	0–90	–
2	**Mid- Cool-Season Grasses**			18–90	

2	**Mid- Cool-Season Grasses**			18–90	
	western wheatgrass	PASM	*Pascopyrum smithii*	4–90	–
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–45	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–18	–
3	**Short- Warm-Season Grasses**			179–359	
	hairy grama	BOHI2	*Bouteloua hirsuta*	90–314	–
	blue grama	BOGR2	*Bouteloua gracilis*	90–314	–
	buffalograss	BODA2	*Bouteloua dactyloides*	0–45	–
4	**Other Native Grasses and Grass-Likes**			90–269	
	threadleaf sedge	CAFI	*Carex filifolia*	90–269	–
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	18–90	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	18–90	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–27	–
	plains muhly	MUCU3	*Muhlenbergia cuspidata*	0–18	–
5	**Non-Native Cool-Season Grasses**			18–135	
	cheatgrass	BRTE	*Bromus tectorum*	18–135	–
	field brome	BRAR5	*Bromus arvensis*	0–18	–
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–18	–
Forb					
6	**Forbs**			45–135	
	white sagebrush	ARLU	*Artemisia ludoviciana*	45–72	–
	field sagewort	ARCA12	*Artemisia campestris*	27–45	–
	scurfpea	PSORA2	*Psoralidium*	18–45	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	9–45	–
	western yarrow	ACMIO	*Achillea millefolium var. occidentalis*	18–45	–
	Forb, perennial	2FP	*Forb, perennial*	18–45	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	9–36	–
	stemless four-nerve daisy	TEACA2	*Tetraneuris acaulis var. acaulis*	0–27	–
	prairie thermopsis	THRH	*Thermopsis rhombifolia*	0–27	–
	woolly plantain	PLPA2	*Plantago patagonica*	18–27	–
	pussytoes	ANTEN	*Antennaria*	9–27	–
	scarlet beeblossom	OESU3	*Oenothera suffrutescens*	9–27	–
	American bird's-foot trefoil	LOUNU	*Lotus unifoliolatus var. unifoliolatus*	0–27	–
	dotted blazing star	LIPUP	*Liatris punctata var. punctata*	0–27	–
	Indian breadroot	PEDIO2	*Pediomelum*	0–27	–
	milkvetch	ASTRA	*Astragalus*	9–27	–
	groundplum milkvetch	ASCR2	*Astragalus crassicarpus*	9–27	–
	prairie milkvetch	ASLAR	*Astragalus laxmannii var. robustior*	9–27	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–18	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	9–18	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–18	–
	white prairie clover	DACA7	*Dalea candida*	9–18	–
	hoary verbena	VEST	*Verbena stricta*	0–18	–

	white heath aster	SYER	*Symphyotrichum ericoides*	9–18	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–9	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–9	–
	spiny phlox	PHHO	*Phlox hoodii*	0–9	–
	white penstemon	PEAL2	*Penstemon albidus*	0–9	–
	large beardtongue	PEGR7	*Penstemon grandiflorus*	0–9	–
Shrub/Vine					
9	**Shrubs**			45–135	
	prairie sagewort	ARFR4	*Artemisia frigida*	45–135	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	9–45	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–45	–
	soapweed yucca	YUGL	*Yucca glauca*	18–45	–
	pricklypear	OPUNT	*Opuntia*	9–45	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–27	–
	rose	ROSA5	*Rosa*	0–27	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–18	–
	chokecherry	PRVI	*Prunus virginiana*	0–9	–
Tree					
8	**Trees**			0–36	
	ponderosa pine	PIPO	*Pinus ponderosa*	0–36	–
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	0–36	–

Table 12. Community 3.1 plant community composition

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

Table 13. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall and Mid- Warm-Season Grasses**			0–336	
	sideoats grama	BOCU	*Bouteloua curtipendula*	0–224	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–112	–
	little bluestem	SCSCS	*Schizachyrium scoparium var. scoparium*	0–112	–
	big bluestem	ANGE	*Andropogon gerardii*	0–56	–
2	**Mid- Cool-Season Grasses**			22–336	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	22–224	–
	porcupinegrass	HESP11	*Hesperostipa spartea*	0–112	–
	green needlegrass	NAVI4	*Nassella viridula*	0–90	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–56	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–56	–
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–56	–
3	**Short Warm-Season Grasses**			0–224	
	blue grama	BOGR2	*Bouteloua gracilis*	0–168	–

	hairy grama	BOHI2	*Bouteloua hirsuta*	0–112	–
	buffalograss	BODA2	*Bouteloua dactyloides*	0–22	–
4	**Other Native Grasses and Grass-Likes**			56–224	
	threadleaf sedge	CAFI	*Carex filifolia*	22–168	–
	Canada wildrye	ELCA4	*Elymus canadensis*	11–56	–
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–45	–
	plains muhly	MUCU3	*Muhlenbergia cuspidata*	11–45	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	11–34	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	0–22	–
5	**Non-Native Cool-Season Grasses**			22–168	
	cheatgrass	BRTE	*Bromus tectorum*	22–112	–
	field brome	BRAR5	*Bromus arvensis*	0–90	–
	Kentucky bluegrass	POPR	*Poa pratensis*	0–90	–
Forb					
6	**Forbs**			56–112	
	white sagebrush	ARLU	*Artemisia ludoviciana*	22–56	–
	field sagewort	ARCA12	*Artemisia campestris*	34–56	–
	scurfpea	PSORA2	*Psoralidium*	22–56	–
	western yarrow	ACMIO	*Achillea millefolium var. occidentalis*	22–56	–
	Forb, perennial	2FP	*Forb, perennial*	22–56	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	11–34	–
	woolly plantain	PLPA2	*Plantago patagonica*	22–34	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–34	–
	pussytoes	ANTEN	*Antennaria*	0–34	–
	dotted blazing star	LIPU	*Liatris punctata*	0–34	–
	Indian breadroot	PEDIO2	*Pediomelum*	0–34	–
	milkvetch	ASTRA	*Astragalus*	11–34	–
	groundplum milkvetch	ASCR2	*Astragalus crassicarpus*	11–34	–
	prairie milkvetch	ASLAR	*Astragalus laxmannii var. robustior*	11–34	–
	white prairie clover	DACA7	*Dalea candida*	11–34	–
	American bird's-foot trefoil	LOUNU	*Lotus unifoliolatus var. unifoliolatus*	0–34	–
	scarlet beeblossom	OESU3	*Oenothera suffrutescens*	0–22	–
	creeping barberry	MARE11	*Mahonia repens*	0–22	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–22	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	11–22	–
	purple prairie clover	DAPU5	*Dalea purpurea*	0–22	–
	stemless four-nerve daisy	TEACA2	*Tetraneuris acaulis var. acaulis*	0–22	–
	prairie thermopsis	THRH	*Thermopsis rhombifolia*	0–22	–
	stiff sunflower	HEPA19	*Helianthus pauciflorus*	0–11	–
	spiny phlox	PHHO	*Phlox hoodii*	0–11	–
	hoary verbena	VEST	*Verbena stricta*	0–11	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–11	–
	white penstemon	PEAL2	*Penstemon albidus*	0–11	–

	large beardtongue	PEGR7	*Penstemon grandiflorus*	0–11	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–11	–
Shrub/Vine					
7	**Shrubs**			56–112	
	skunkbush sumac	RHTR	*Rhus trilobata*	0–90	–
	prairie sagewort	ARFR4	*Artemisia frigida*	11–78	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	11–56	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–56	–
	soapweed yucca	YUGL	*Yucca glauca*	34–56	–
	chokecherry	PRVI	*Prunus virginiana*	11–56	–
	leadplant	AMCA6	*Amorpha canescens*	0–34	–
	rose	ROSA5	*Rosa*	11–34	–
	pricklypear	OPUNT	*Opuntia*	0–22	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–22	–
	western poison ivy	TORY	*Toxicodendron rydbergii*	11–22	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–11	–
Tree					
8	**Trees**			56–168	
	ponderosa pine	PIPO	*Pinus ponderosa*	56–168	5–15
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	56–112	5–15
	eastern redcedar	JUVI	*Juniperus virginiana*	0–56	0–5

Animal community

Wildlife Interpretations:
MLRA 64 lies within the drier portion of northern mixed-grass prairie ecosystem where sagebrush steppes to the west yield to grassland steppes to the east. Prior to European settlement, this area consisted of diverse grass/shrub land habitats interspersed with varying densities of depressional, instream wetlands, and woody riparian corridors. These habitats provided critical life cycle components for many of its users. Many species of grassland birds, small mammals, reptiles, amphibians, and herds of roaming bison, elk, and pronghorn were among the inhabitants adapted to this semi-arid region. Roaming herbivores, as well as, several small mammal and insect species, were the primary consumers linking the grassland resources to predators such as the wolf, mountain lion, and grizzly bear, as well as, smaller carnivores such as the coyote, bobcat, fox, and raptors. The prairie dog was once abundant; however, the species remains a keystone species within its range. The black-footed ferret, burrowing owl, ferruginous hawk, mountain plover, and swift fox were associated with prairie dog complexes.

Historically, the northern mixed-grass prairie was a disturbance-driven ecosystem with fire, herbivory, and climate functioning as the primary disturbance factors either singly or in combination. Following European settlement, livestock grazing, cropland conversion, elimination of fire, energy development, and other anthropogenic factors influenced species composition and abundance. Introduced and invasive species further impacted plant and animal communities. The bison was a historical keystone species but have been extirpated as a free-ranging herbivore. The loss of the bison and reduction of prairie dog populations and fire as ecological drivers greatly influenced the character of the remaining native plant communities and altered wildlife habitats. Human development has reduced habitat quality for area-sensitive species.

Within MLRA 64, the Shallow ES provides upland grassland cover with an associated forb, shrub, and tree component. It was typically part of an expansive grassland landscape that included combinations of Badlands, Thin Breaks, Clayey, Claypan, Dense Clay, Loamy, Saline, Sandy, Overflow, Subirrigated, and Terrace ecological sites. This site provided habitat for species requiring unfragmented grassland. Important habitat features, and components found commonly or exclusively on this site may include sharp-tailed grouse leks; upland nesting habitat for

grassland birds, forbs and insects for brood habitat; and a forage source for small and large herbivores. Many grassland and shrub steppe nesting bird populations are declining. Extirpated species include free-ranging American bison, grizzly bear, gray wolf, black-footed ferret, mountain plover, Rocky Mountain locust, and swift fox. The majority of the Shallow ecological site remains intact and provides increasingly important habitat for grassland and shrub steppe nesting birds, small rodents, coyote, and a variety of reptiles, amphibians, and insects. Invasive species such as annual bromegrasses and cheatgrass have impacted the biological integrity of the site for some grassland birds. Changes in historic fire regime and domestic grazing have impacted the forb/shrub/grass percentages.

Bluestem-Sideoats Grama-Needlegrass-Wheatgrass (1.1) and Needle and Thread-Little Bluestem-Grama (1.2): The predominance of grasses plus high diversity of forbs and shrubs in this community favors grazers and mixed-feeders, such as deer and pronghorn. Insects, such as pollinators, play a large role in maintaining the forb community and provide a forage base for grassland birds and other species. The complex plant structural diversity provides habitat for a wide array of migratory and resident birds. Grasshopper sparrow, chestnut-collared longspur, Sprague's pipit, horned lark, lark bunting, and sharp-tailed grouse are common and benefit from the structure and composition this plant community provides. Diverse prey populations are available for grassland raptors such as ferruginous hawk, Swainson's hawk, golden eagle, and prairie falcon.
The diversity of grasses, forbs, and shrubs provide high nutrition levels for small and large herbivores including voles, mice, spotted ground squirrel, desert cottontail, white-tailed and black-tailed jackrabbit, and deer. The higher stature of this plant community provides thermal, protective, and escape cover for herbivores and grassland birds. Predators utilizing this plant community include coyote, American badger, red fox, and long-tailed weasel. This plant community provides limited habitat for amphibians, mostly toads (i.e., Great Plains, Woodhousi's, and Plains spade-foot). Prey abundance and shade opportunities may attract multiple reptile species such as gopher snake, milk snake, prairie rattlesnake, and western ornate box turtle to this site. Several species of sand loving lizards such as the lesser earless lizard, prairie lizard, many-lined skink, and six-lined racerunner utilize this site. Resulting from continuous seasonal grazing the grass component a shift to a medium to short height plant community occurs. Forb and shrub abundance increases; however, the plant community changes do not significantly change the wildlife community form the Reference Plant Community (1.1).

Grama/Sedge/Fringed Sagewort (2.1): Resulting from continuous heavy grazing grama species (e.g., blue grama) and sedges will dominate. Forb and shrub abundance increases and provides valuable wildlife cover in the absence of adequate grass cover. However, the decrease in diversity of grasses will result in less seed production or lower quality nutrition for small herbivores including voles, mice, and spotted ground squirrel. Species such as desert cottontail may frequently use this site.
The short stature of this plant community limits suitable thermal, protective, and escape cover. Prey populations are reduced and are more vulnerable to raptor and mammalian predation. Predators utilizing this plant community include the coyote, American badger, red fox, and long-tailed weasel.
Extreme impairment of the ecological processes impacts offsite aquatic habitats through excessive runoff, nutrient, and sediment loads. Elevated surface temperatures resulting from reduced cover and litter will greatly reduce habitat for most amphibian species, grassland birds, and mammals.

Conifer State (3.0): Resulting from no fire, and the expansion or encroachment of ponderosa pine and juniper. Forb diversity has decreased while shrub abundance has increased. Juniper and ponderosa pine increase significantly. Grass species decline dramatically while the grass species composition shifts and can become dominated by invasive species. Juniper and ponderosa pine stands provide nesting cover, escape cover, and den sites for a variety of species. Species such as mule deer, white-footed mice, bushy-tailed woodrat, black-billed magpie, Townsend's solitaire, western meadowlark, Bohemian waxwing, dark-eyed junco, brown thrasher, lark sparrow, and white-crowned sparrow will increase. Species such as meadow voles, spotted ground squirrel, thirteen-lined ground squirrel, northern grasshopper mice, and western harvest mice will not utilize this site. Grassland nesting songbirds will be significantly reduced. Raptors, such as the long-eared owl, will increase.
If the tree canopy is high enough then bare ground will likely increase and excessive runoff, nutrient and sediment loads may impact offsite aquatic habitat.

Grazing Interpretations:
The following list provides annual, suggested initial stocking rates with average growing conditions. These are conservative estimates that should be used only as guidelines in the initial stages of conservation planning. Often, the current plant composition does not entirely match any particular plant community (as described in this Ecological Site Description). Therefore, a resource inventory is necessary to document plant composition and production. More

accurate carrying capacity estimates should eventually be calculated using the following stocking rate information along with animal preference data and actual stocking records, particularly when grazers other than cattle are involved. With consultation of the land manager, more intensive grazing management may result in improved harvest efficiencies and increased carrying capacity.

The following initial suggested stocking rates are based on 912 lbs./acre (air-dry weight) per Animal-Unit-Month (AUM), with a 25 percent harvest efficiency of preferred and desirable forage species (refer to USDA NRCS, National Range and Pasture Handbook). An AUM is defined as the equivalent amount of forage required by a 1,000-pound cow with or without calf, for one month.

Plant Community: Bluestem-Sideoats Grama-Wheatgrass (1.1)
Average Production (lbs./acre, air-dry): 1,500
Stocking Rate (AUM/acre): 0.41

Plant Community: Needle and Thread-Little Bluestem-Grama (1.2)
Average Production (lbs./acre, air-dry): 1,300
Stocking Rate (AUM/acre): 0.36

Plant Community: Grama/Sedge/Fringed Sagewort (2.1)
Average Production (lbs./acre, air-dry): 800
Stocking Rate (AUM/acre): 0.22

*Plant Community: Ponderosa Pine-Juniper < 15% Cover/Herbaceous Understory (3.1)
Average Production (lbs./acre, air-dry): 1,000
**Stocking Rate (AUM/acre): 0.22

Plant Community: All other plant communities identified in this document will have variable annual production values and will require on-site sampling to determine suggested initial stocking rates.

* Total annual production and stocking rates are highly variable and will require on-site sampling.

**Total annual production on-site may contain vegetation deemed undesirable or untargeted by the grazing animal. Therefore, AUM values may have been reduced to reflect only preferred or desirable forage species.

Grazing by domestic livestock is one of the major income-producing industries in the area. Rangeland in this area may provide yearlong forage for livestock. During the dormant period, the forage for livestock will likely be lacking protein to meet livestock requirements and added protein will allow ruminants to better utilize the energy stored in grazed plant materials. A forage quality test (either directly or through fecal sampling) should be used to determine the level of supplementation needed.

Hydrological functions

Water is the principal factor limiting herbage production on this site. The site is dominated by soils in hydrologic group D. Infiltration varies from moderately slow to moderate and runoff varies from low to high depending upon slope and ground cover. In many cases, areas with greater than 75 percent 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 percent have the greatest potential to have reduced infiltration and higher runoff (Refer to the USDA-NRCS National Engineering Handbook for hydrologic soil groups, runoff quantities, and hydrologic curves, Part 630.).

Recreational uses

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

Wood products

The Pine Ridge Escarpment is the primary source of wood products in MLRA 64. Some soils in this area may

produce marketable ponderosa pine, however, steep slopes may make this resource inaccessible to modern timber harvesting equipment. Management of this forest resource for watershed protection, grazing, wildlife, recreation, and timber harvest may be the most critical issues land managers and owners currently face.

Before the 1950s, ponderosa pines covered approximately 250,000 acres of the Pine Ridge Escarpment. Wildfires have reduced that to less than 120,000. Much of the remaining acres are also at risk of catastrophic fire because dense stands of pine and cedar have creating dense stands of fuel (Gaarder, 2013). Forest and grazing land specialist stress the need to create and manage fire-tolerant forests on a landscape basis. They recommend fuels mitigation treatments through grazing management, forest thinning, prescribed burning, and managed timber harvest. They also recommend additional access roads for fire protection, the expansion of defensible space around homes and building, and education on Fire Wise practices (CWPP, 2014).

Other products

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

Other information

Revision Notes: “Previously Approved” Provisional
This Provisional ecological site concept has passed Quality Control (QC) and Quality Assurance (QA) to ensure that the site meets the 2014 NESH standards for a Provisional ecological site description. This is an updated “Previously Approved” ESD that represents a first-generation tier of documentation that, prior to the release of the 2014 National Ecological Site Handbook (NESH), met all requirements as an “Approved” ESD as laid out in the 1997 (rev.1, 2003) National Range and Pasture Handbook (NRPH). The document fully described the Reference State and Community Phase in the State-and-Transition model. All other alternative states are at least described in narrative form. The “Previously Approved” ESD has been field-tested for a minimum of five years and is a proven functional document for conservation planning. The “Previously Approved” ESD does not contain all tabular and narrative entries as required in the current “Approved” level of documentation, but it is expected that the “Previously Approved” ESD will continue refinement toward an “Approved” status.

Site Development and Testing Plan:
Future work, as described in a Project Plan, will include field activities to collect low-, medium-, and high-intensity sampling, soil correlations, and analysis of that data. Annual field reviews should be done by soil scientists and vegetation specialists. The final field review, peer review, quality control, and quality assurance reviews of the ESD will be required to produce the final document.

Inventory data references

Information presented here has been derived from NRCS clipping data and other inventory data. Field observations from range-trained personnel were also used. Those involved in developing this site include: Stan Boltz, Range Management Specialist (RMS), NRCS; Jill Epley, RMS, NRCS; Rick Peterson, RMS, NRCS; David Steffen, RMS, NRCS; Jeff Vander Wilt; RMS, NRCS; Phil Young, Soil Scientist, NRCS, Kent Cooley, Resource Soils Scientist, NRCS; George Gamblin, RMS, NRCS; and Wade Anderson, Range Professional/Rancher.

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Approval

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George Gamblin
Editorial Review by Carla Green Adams.

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.

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Date	06/18/2008
Approved by	Stan Boltz
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Slight to none, typically on steeper slopes and discontinuous.

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2. **Presence of water flow patterns:** None, or barely visible and discontinuous with numerous debris dams when present.

3. **Number and height of erosional pedestals or terracettes:** Few pedastalled plants typically on steeper slopes.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 0 to 15 percent is typical.

5. **Number of gullies and erosion associated with gullies:** None should 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):** Small size litter classes will generally move short distances, some medium size class litter will move very short distances. Litter debris dams are occasionally present.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil aggregate stability ratings should typically be 5 to 6, normally 6. Surface organic matter adheres to the soil surface. Soil surface fragments will typically retain structure indefinitely when dipped in distilled water.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** A-horizon should be 2 to 5 inches thick with light to dark brownish gray colors. Structure should typically be fine granular at least in the upper A-horizon.

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):** None – when dry, B horizons can be hard and appear to be compacted, but no platy structure will 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: Mid/tall warm-season grasses >

    Sub-dominant: Mid/tall cool-season bunchgrasses = short warm-season grasses > rhizomatous cool-season grasses >

    Other: Short cool-season grass-likes > forbs > shrubs

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Very little evidence of decadence or mortality. Bunch grasses have strong, healthy centers and shrubs are vigorous.

14. **Average percent litter cover (%) and depth (in):** Litter cover typically 40 to 60 percent, with depth about 0.25 inches.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Total annual production ranges from 700 to 1,900 pounds/acre, with the reference value being 1,400 pounds/acre (air-dry basis).

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

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.