Evaluation of Ecological Site Classes and Community Classes for Regional Scale Modeling of Conservation Effects on Grazing Lands: MLRA 60A

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INTRODUCTION

The Grazing Lands Component of the Conservation Effects Assessment Project (CEAP-GL) is evaluating the development and use of Ecological Site Classes and Community Classes within Major Land Resource Areas for regional and national scale modeling of conservation effects. National Resources Inventory (NRI) data is correlated to proposed Ecological Site Classes to provide data for the Agricultural Policy/Environmental eXtender (APEX) model and other models. The Rangeland Hydrology and Erosion Model (RHEM) is used to assess runoff and erosion differences between Community Classes.

CLASSIFICATION HIERARCHY AND DEFINITIONS

Ecological Site Class

Ecological Site Classes are proposed subdivisions of a Major Land Resource Area (MLRA) or Land Resource Unit (LRU). They are similar in concept to a general soil survey map unit – a general grouping of ecological sites by major landforms and vegetation types. An Ecological Site Class differs from other kinds of land in the kinds and amounts of vegetation produced, in the responses to disturbances, in recovery mechanisms, and management responses.

Plant Functional Groups

The Plant Functional/Structural Group indicator is defined in Interpreting Indicators of Rangeland Health (version 4) as, *"A suite or group of species that because of similar shoot or root structure, photosynthetic pathways, nitrogen fixing ability, life cycle, etc., are grouped together on an ecological site basis."*
The presence, dominance and relative proportions of plant functional groups affect soil, hydrologic and biotic variables including:

- the kinds and amounts of canopy and foliar cover
- amount and arrangement of bare ground and litter cover
- plant spacing and amount of basal cover
- runoff and erosion rates
- structure and arrangement of vegetation which then influences the potential to carry fire and regulate fire intensity
- grazing preferences and distribution
- wildlife habitat values

The change in presence, dominance and/or proportion of plant functional groups is the primary attribute used to characterize States and Community Phases within an Ecological Site Description. Standardized plant functional groups were developed based on growth forms and flowering period. All plant species found in the MLRA were assigned to a plant functional groups. Non-native species were assigned to functional groups designated with (I) -

for introduced. Production by functional group was then calculated for each NRI Primary Sampling Unit (PSU) community in the MLRA. Refer to Appendix E for a list of common species and their assigned functional groups used for this project.

Community Class

A Community Class is a proposed plant community classification for an Ecological Site Class. The name of the Community Class is derived using the seven (7) dominant plant functional groups, listed in descending order by annual aboveground production on a dry weight basis. A Community Class is differentiated from other Community Classes by the presence and relative dominance of plant functional groups, and/or by significant differences in annual production.

Plant Community

An actual plant community found at a given location, at a point in time.

MAJOR LAND RESOURCE AREA 60A – PIERRE SHALE PLAINS

Major Land Resource Area 60A occurs in the west-central and southwestern corner of South Dakota, extending into northeast Wyoming and northwest Nebraska around the base of the Black Hills and Dakota Hogback. This area is part of the Western Great Plains Range and Irrigated Region - Land Resource Region (LRR G). MLRA 60A is just under 6.5 million acres in size (26,295 square kilometers). Elevations range from 2620 feet (800 meters) above mean sea level to 4260 feet (1,300 meters). The area is an unglaciated portion of the Missouri Plateau. The MLRA is characterized by eroded plateaus and terraces of cretaceous Pierre shale with layers of smectitic clay formed from volcanic ash. The Cheyenne and Belle Fourche Rivers are the major drainages in the MLRA.

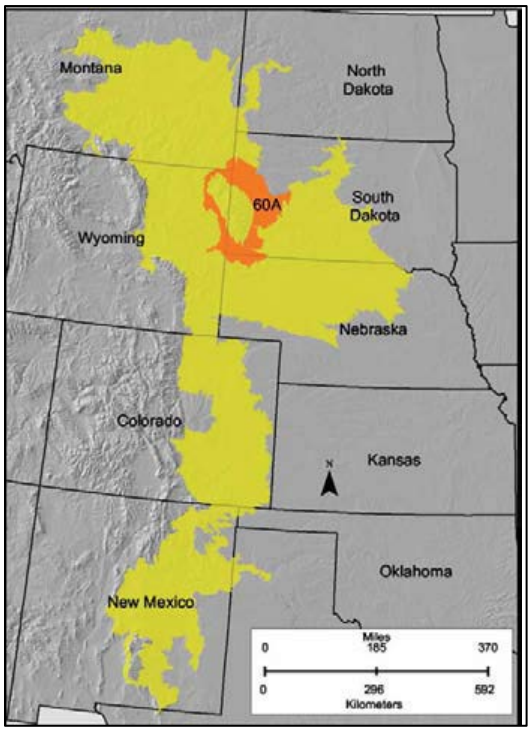

Figure 1. LRR G and MLRA 60A map. Source: Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296 (2006).

This Major Land Resource Area is dominated by grassland vegetation with trees and shrubs along the drainages. Important perennial grasses include western wheatgrass, blue grama, needleandthread, buffalograss, green needlegrass and little bluestem. Common native shrubs include sand sagebrush leadplant, and western snowberry. Trees include boxelder, plains cottonwood and green ash with some ponderosa pine and eastern redcedar. Refer to Appendix E for scientific plant names and additional plant classification data used throughout the report.

Important wildlife includes pronghorn antelope, white-tailed deer, mule deer, ring-necked pheasant, sharp-tailed grouse, ducks, coyotes, badgers and beaver. The black-footed ferret and sage grouse are important species of concern in the MLRA.

CLIMATE

The following climate information is excerpted from the Loamy 16-18" P.Z. Ecological Site Description and characterizes the climate in MLRA 60A.

"The climate in this MLRA is typical of the drier portions of the Northern Great Plains where sagebrush steppes to the west yield to grassland steppes to the east. Annual precipitation ranges from 16 to 18 inches per year, with most occurring during the growing season. Temperatures show a wide range between summer and winter and between daily maximums and minimums, due to the high elevation and dry air, which permits rapid incoming and outgoing radiation. Cold air masses from Canada in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Chinook winds may occur in winter and bring rapid rises in temperature. Extreme storms may occur during the winter, but most severely affect ranch operations during late winter and spring. The normal average annual temperature is about 47°F. January is the coldest month with average temperatures ranging from about 18°F (Newell, SD), to about 23°F (Oelrichs, SD). July is the warmest month with average temperatures ranging from about 72°F (Newell, SD), to about 74°F (Oelrichs, SD). The range of normal average monthly temperatures between the coldest and warmest months is about 53°F. 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 cool season plants begins in early to mid-March, slowing or ceasing in late June. Warm season plants begin growth about mid-May and can continue to early or mid-September. Green up of cool season plants may occur in September and October when adequate soil moisture is present."

Averages

Frost-free period (days):	130
Freeze-free period (days):	148
Mean annual precipitation (inches):	19.0

Table 1. Monthly Precipitation (Inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	0.43	0.57	0.94	1.78	3.19	3.38	2.78	1.76	1.50	1.32	0.61	0.49
Medium	0.40	0.51	0.89	1.72	2.97	3.21	2.33	1.56	1.38	1.20	0.59	0.48
Low	0.37	0.45	0.85	1.66	2.74	3.05	1.87	1.37	1.26	1.07	0.57	0.48

Table 2. Monthly Temperature (°F)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	34.6	40.9	48.8	60.9	71.1	81.5	90.3	89.7	79.2	65.5	47.9	37.5
Low	6.00	11.4	19.5	31.4	42.6	52.2	57.8	55.9	44.8	32.9	20.3	10.0

The soil temperature regime is mesic and the soil moisture regime is ustic.

Representative Climate Stations

(1) SD0236, Ardmore 2 N. Period of record 1948-1999
(2) SD8911, Wasta. Period of record 1949 – 1999*
(3) SD6054 Newell. Period of Record 1948-1999
*This climate station was used for the Rangeland Hydrology and Erosion Model (RHEM) evaluations.

AGRICULTURAL OPERATIONS

Cropland covers about 11 percent of the acres in this MLRA, while rangeland covers about 82 percent. Twenty three percent (23%) of the MLRA is federal land. The kind and size of livestock operations are variable, but a typical livestock operation is cow-calf, about 8000 acres in size, with about 200 mother cows. Stocking rates average 0.2-0.3 AUMs/Ac. Most calves are born from January through early April in barns or lots where livestock are fed during the winter. Cattle graze on rangelands starting from mid-April through May and typically come off the rangeland from late October to early November. Calves are kept about a month after weaning, and then shipped in mid to late October. If the operation includes crop or hay land, livestock may graze those areas through November. During the winter, cattle are typically fed grass-alfalfa hay with protein cake or distillers grain.

Crops grown in this MLRA include small grains (wheat, barley) that are planted in mid to late May and harvested from then the end of July through August. Most of the small grain cropland is highly erodible land, so it is not grazed. Corn, sunflower, and alfalfa are other common crops. Canola is grown in the northern portion of the MLRA. Potatoes and specialty crops are grown in a few areas. Intermediate wheatgrass is grown for grass hay. There is very little irrigation used in the MLRA.

RESOURCE MANAGEMENT SYSTEMS

Conservation Practices Applied

Table 3 shows the kinds and amounts of conservation practices that the landowners in MLRA 60A are investing in on grazing lands. The table shows the most common conservation practices applied with NRCS assistance on grazed rangeland during fiscal years 2006-2011.

Table 3. Common conservation practices applied on grazed rangeland in MLRA 60A from 2006-2011 (NRCS).

Practice Code	Practice Name (Units)	Practice Count	Amount Applied	Acres Benefitted
516	Pipeline (ft)	1,092	4,063,840	765,390
614	Watering Facility (no)	1,016	3,103	708,865
528	Prescribed Grazing (ac)	475	201,687	241,441
595	Integrated Pest Management (IPM) (ac)	349	111,139	114,388
382	Fence (ft)	260	895,245	110,519
533	Pumping Plant (no)	122	2,556	69,917
645	Upland Wildlife Habitat Management (ac)	99	100,577	106,738
642	Water Well (no)	98	98	54,263
472	Access Control (ft)	54	24,190	36,818
314	Brush Management (ac)	46	325	10,835
380	Windbreak/Shelterbelt Establishment (ac)	40	34,131	11,673
378	Pond (no)	26	26	22,234
561	Heavy Use Area Protection (ac)	24	3,960	7,297
484	Mulching (ac)	24	40	4,270
548	Grazing Land Mechanical Treatment (ac)	14	723	8,197
574	Spring Development (no)	8	8	9,075
327	Conservation Cover (ac)	7	32	20
512	Forage and Biomass Planting (ac)	7	312	1,829
550	Range Planting (ac)	6	721	736

Prescribed Grazing

Prescribed grazing is a common conservation practice applied to address resource concerns on rangelands in this MLRA. A typical livestock operation has 2-3 pastures used primarily for herd management. Season long grazing is common. Prescribed grazing focuses on maintaining proper stocking rates and encouraging producers to change the period of use in the rangeland pastures each year to help maintain desirable species composition.

Watering Facilities

On the eastern side of the MLRA, livestock water is mostly provided through rural water supply systems. There are some artesian wells (1500 ft. deep) but water quality is typically poor. On the western side of the MLRA, water is mostly provided by ponds and wells (150 – 200 ft. deep), livestock pipeline, and watering facilities. Water quality in dams is poor (sulfates).

Brush Management

This practice is rarely applied in this MLRA primarily because of sage grouse concerns. There is some brush management applied on rocky mountain juniper, eastern red cedar and ponderosa pine using mechanical methods (nippers and chain saws). Russian olive and salt cedar in riparian areas are also being controlled using chemical and mechanical methods.

Range Planting

Range planting is not common in this MLRA. There is typically a sufficient seed source for the desirable species to become re-established with good grazing management.

Prescribed Burning

Prescribed Burning is not commonly used in this MLRA, but it plays an important role the ecology of many of the plant communities. The natural fire frequency in this MLRA is 75-100 years on the west side with Wyoming big sagebrush. The shallow clay soils with big sagebrush will not carry a fire. The rest of the MLRA has a 10-15 year natural fire frequency.

Fencing

Standard barbed wire fencing using 3-4 wires is the typical fencing used for livestock control. More 2-wire electric fence is being installed in the last 10 years.

Herbaceous Weed Control

Herbaceous weed control is being used to control noxious weeds such as leafy spurge, and Canada thistle. Biological control of leafy spurge with flea beetles or moths is successful. Leafy spurge is also controlled using 2,4-D, picloram and imazapic. Aminopyralid is used on Canada thistle as well. Ground spraying using trucks is the most common application method. On the western side of the MLRA, cheatgrass is more of a problem than the non-native perennial species such as Kentucky bluegrass and smooth brome.

Upland Wildlife Habitat Management

Most conservation plans manage grazing to benefit wildlife. Some operations diversify income with fee hunting for whitetail deer and waterfowl. Sage grouse occur in the northern portion of the MLRA.

ECOLOGICAL SITE CLASSES AND COMMUNITY CLASSES

As of January 2017, there were 27 ecological sites correlated to soil map unit components in MLRA 60A. Those were grouped into eight (8) ecological site classes by working with the state and local NRCS soil and rangeland management scientists in MLRA 60A. The ecological site classes are based on landscape position, soil characteristics, plant community composition, plant production and the response to climate, disturbance, use, and management.

ECOLOGICAL SITE CLASSES FOR MAJOR LAND RESOURCE AREA 60A

Loamy Terrace Ecological Site Class

- Clayey Overflow R060AY021SD
- Loamy Overflow R060AY020SD
- Loamy Terrace R060AY022SD
- Lowland R060AY042SD

Loamy Upland Ecological Site Class

- Clayey 13-16" PZ R060AY011SD
- Clayey 16-18" PZ R060AY040SD
- Loamy 13-16" PZ R060AY010SD
- Loamy 16-18" PZ R060AY041SD

Saline Bottomland Ecological Site Class

- Closed Depression R060AY019SD
- Saline Lowland R060AY007SD
- Saline Subirrigated R060AY036SD

Sandy Upland Ecological Site Class

- Sands R060AY008SD
- Sandy R060AY009SD

Shallow Porous Clay Upland Ecological Site Class

- Porous Clay R060AY030SD
- Shallow Clay R060AY017SD
- Shallow Porous Clay R060AY043SD

Shallow Upland Ecological Site Class

- Claypan R060AY013SD
- Dense Clay R060AY018SD
- Saline Upland R060AY026SD
- Shallow Dense Clay R060AY025SD
- Shallow Loamy R060AY024SD
- Thin Claypan R060AY015SD
- Thin Upland R060AY012SD

Very Shallow Upland Ecological Site Class

- Very Shallow R060XY016SD
- Shallow Sandy R060AY044SD

Wet Bottomland Ecological Site Class

- Subirrigated R060AY003SD
- Wetland R060AY002SD

Each NRI Primary Sampling Unit (PSU) in the MLRA was correlated to a Community Class where possible. PSU data were not used when the species present or vegetation production was questionable. Additional Community Classes that are not currently represented in the ecological site descriptions were added when present in the NRI data. Community Class names are derived using the top seven (7) plant functional groups, listed in descending order of annual aboveground air-dry production.

All species and plant community production values shown as pounds per acre (lbs/ac) in the following ecological site class descriptions, refers to annual aboveground production air-dried production. The dominant functional groups and average production for the plant functional groups are calculated from the NRI PSUs that are correlated to each Community Class. Refer to Appendix E for plant taxonomy.

The following sections describe the eight ecological site classes in MLRA 60A.

LOAMY TERRACE ECOLOGICAL SITE CLASS

General Description

The Loamy Terrace ecological site class occurs on nearly level to gently sloping low-lying areas of the landscape that benefit from run-on moisture from adjacent sites and/or rare to occasional flooding. The soils are formed from mixed alluvium.

Geomorphic Features

Landscape Positions:	Alluvial Fan, Flood Plain, Plain, Stream Terrace
Slope (percent):	0 - 9

Representative Soil Features

Soil Depth:	Moderately Deep to Deep
Parent Material Kind:	Alluvium
Parent Material Origin:	Mixed
Surface Texture:	Loam, Silt Loam, Silty Clay Loam, Fine Sandy Loam, Sandy Clay Loam, Clay, Sandy Clay, Sandy Loam, Clay Loam,
Surface Texture Modifier:	Gravelly, Cobbly
Subsurface Texture Group:	Loamy to Clayey
Drainage Class:	Moderately Well to Well
Permeability Class:	Very Slow to Rapid
Chemistry:	None to Slightly Saline
Available Water Capacity:	3 – 8 inches

Vegetation Dynamics

Community Class 1.1 in the State and Transition Model (Figure 2) was derived from functional group production for the reference communities in the ecological sites correlated to this ecological site class. This community class produces about 2700 lbs/ac/yr dominated by western wheatgrass, green needlegrass, big bluestem, slender wheatgrass, thickspike wheatgrass, switchgrass, sedges, and blue grama. With continuous season long heavy grazing, the plant community is likely to transition to a shortgrass dominated community class with increases in buffalograss and blue grama. Long term prescribed grazing and a return of the natural fire frequency may return the site to the Community Class 1.1.

With heavy continuous grazing and the introduction of non-native species, the site will transition to a Native – Non-Native Herbaceous - Native Woody State with Japanese brome, cheatgrass, field brome and crested wheatgrass becoming part of the plant community. The site will not transition from this state back to the Native Herbaceous state.

Plowing and tillage convert the site to a “Planted Herbaceous State”. Cropping and harvesting of annual and perennial crops maintain a cropland community class (Community Class 3.1). When seeded to native perennial grasses, the site transitions to a native planted community class (Community Class 3.2). Native planting species shown are some of the species recommended in the NRCS South Dakota Technical Note Number 4 for the sites correlated to this Site Class. Once the site is tilled and planted, it does not return to States 1 or 2.

State and Transition Model

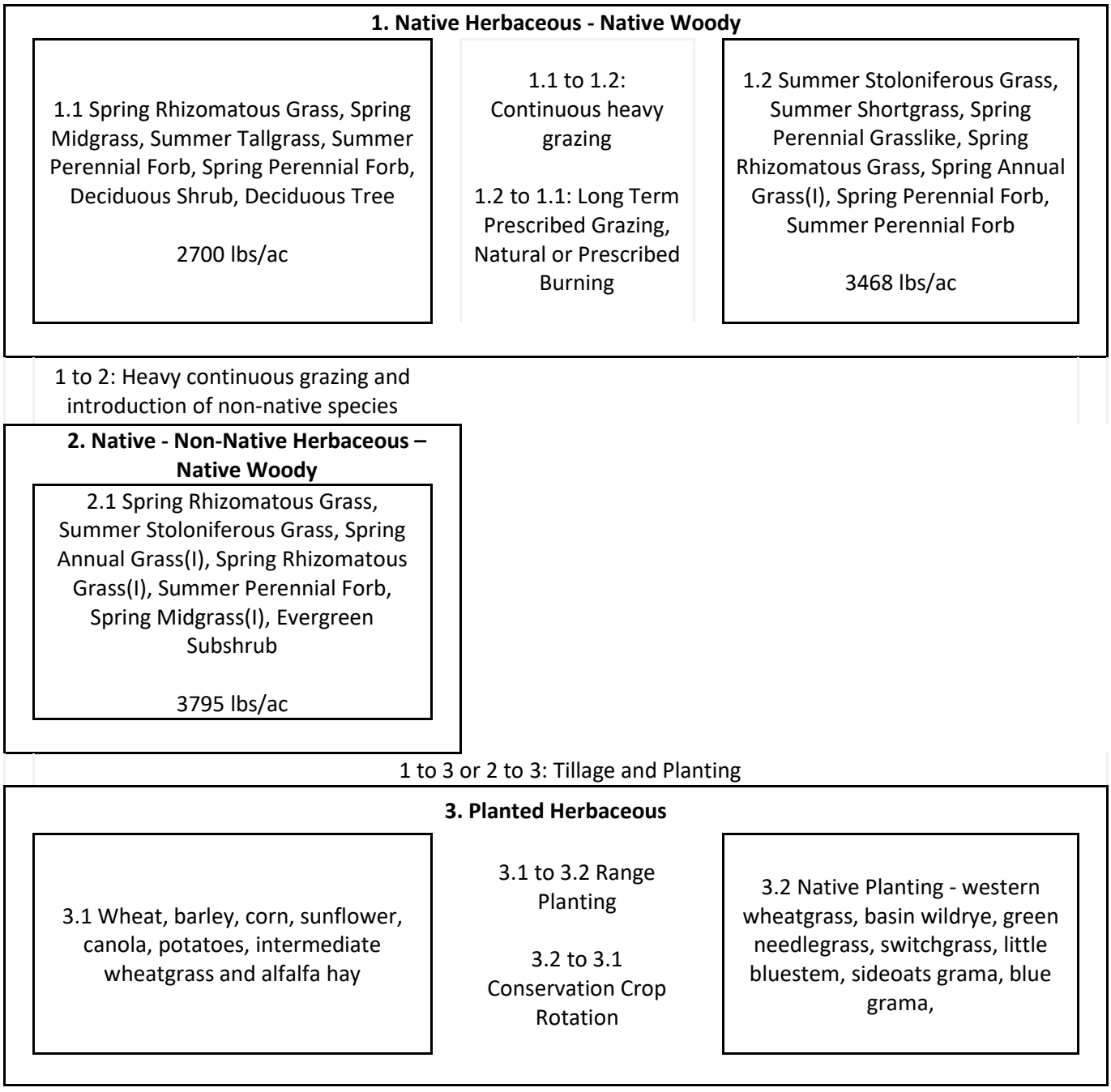

Figure 2. State and Transition Model, MLRA 60A Loamy Terrace ecological site class.

NRI Primary Sampling Units (PSUs) were correlated to these community classes where possible. Community class production, functional group dominance, and dominant species based on available NRI data are shown in Table 4. Ground and canopy cover from the NRI PSUs was used to estimate average annual erosion and percent runoff using the Rangeland Hydrology and Erosion Model (RHEM). No data is shown if the NRI data indicated that the ecological site description did not match the soil characteristics at the PSU.

Table 4. NRI Community Class Data and RHEM Results - MLRA 60A Loamy Terrace ecological site class.

Comm Class ID	Community Class Name	Dominant Species (Symbol)(Lbs/Ac)	Production Lbs/Ac	Soil Loss T/Ac/Yr	% Runoff	# PSUs
060A.3.1.1	Spring Rhizomatous Grass(1166), Spring Midgrass(717), Spring Perennial Forb(194), Evergreen Subshrub(150), Herbaceous Vine(126), Summer Stoloniferous Grass(76), Summer Perennial Forb(50)	western wheatgrass(PASM)(1166), slender wheatgrass(ELTR7)(552), green needlegrass(NAVI4)(165), Gardner's saltbush(ATGA)(150), American vetch(VIAM)(126), common dandelion(TAOF)(114), Buffalograss(BODA2)(76), desert biscuitroot(LOFO)(68)	2545			1
060A.3.1.2	Summer Stoloniferous Grass(1316), Summer Shortgrass(630), Spring Perennial Grasslike(555), Spring Rhizomatous Grass(287), Spring Annual Grass(I)(245), Spring Perennial Forb(138), Summer Perennial Forb(116)	Buffalograss(BODA2)(1316), blue grama(BOGR2)(630), sedge(CAREX)(313), western wheatgrass(PASM)(287), threadleaf sedge(CAFI)(242), cheatgrass(BRTE)(214), aster(ASTER)(126), goldenrod(SOLID)(108)	3468	0.28	8.11%	2
060A.3.2.1	Spring Rhizomatous Grass(1174), Summer Stoloniferous Grass(1124), Spring Annual Grass(I)(538), Spring Rhizomatous Grass(I)(279), Summer Perennial Forb(166), Spring Midgrass(I)(158), Evergreen Subshrub(96)	western wheatgrass(PASM)(1174), Buffalograss(BODA2)(1124), cheatgrass(BRTE)(476), smooth brome(BRIN2)(249), crested wheatgrass(AGCR)(158), white prairie aster(SYFA)(135), broom snakeweed(GUSA2)(96), Japanese brome(BRAR5)(62)	3795	0.10	6.40%	5

Supporting Information

The following publications support the STM. The first publication reiterates the statement of the STM, that varieties of wheatgrass will thrive in environments of no-till land management. The second publication describes

fire effects in an overflow site. This publication examines vegetation within reference state, as described in the STM.

Engle, D.M. and P.M. Bultsma. 1984. Burning of Northern Mixed Prairie During Drought. Journal of Range Management 37(5): 398-401.

This study took place in north-central South Dakota and examined burn effects on Northern mixed prairie during drought. Burning was timed at the latter part of the active growth season of Kentucky bluegrass. Comparisons were made between two burning dates and two different sites with below average precipitation. The first site was a silty range site and the second was an overflow range site. The first site was in excellent range condition and dominated by western wheatgrass, needleandthread and green needlegrass. The overflow site was also in excellent condition with big bluestem exhibiting dominance. Both sites were progressively exhibiting Kentucky bluegrass as a major component.

A randomized block design was utilized with three replications. The treatments were two burning dates, one early during the emergence of warm-season grasses, and the other later once the warm-season grasses were approximately 5-10 cm tall. Ten quadrats were established on each treatment plot and herbage was clipped. Standing litter and mulch were also evaluated. Additionally, two plants of each species (Kentucky bluegrass, green needlegrass, western wheatgrass, and big bluestem) were randomly selected to evaluate fire effects. Leaf length and basal area were also measured.

The results found that the leaf length, number of inflorescences, and basal area of cool-season grasses were reduced with burning and more pronounced with the later burn. Leaf length of big bluestem was reduced by burning on the overflow sites, but inflorescence was increased. Standing crop of big bluestem on overflow sites increased on plots burned earlier, but not on those burned later. However, green needlegrass decreased on burned, compared to unburned. Kentucky bluegrass standing crop decreased with burning on both sites. Burning did not reduce standing crop on any other species. On the second year, the growth on overflow sites was higher on burned plots than on control plots. Silty sites did not have a higher standing crop with burning.

Perryman, B.L., W.A. Laycock and D.W. Kock. 2000. Investigation of herbaceous species adapted to snowfence areas. Journal of Range Management 53(4): 371-375.

This study took place in Albany county, Wyoming, with the objective of determining which cultural practices and herbaceous species could be best suited for revegetating snowdrift areas. The species evaluated at the site included mountain brome, altai wildrye, basin wildrye, Russian wildrye, tall fescue, pubescent wheatgrass, western wheatgrass, thickspike wheatgrass, crested wheatgrass, slender wheatgrass, big bluegrass and tufted hairgrass. There were two sites, one shallow upland, and one deep lowland. Snow drift depth was measured for all fences at the time of maximum drift accumulation each year of the study.

The study on the two sites was a randomized complete block factory design, with three replicate blocks. Species performance was based on foliar cover at the end of the first growing season, and aboveground biomass at the end of the second growing season. Seeding operations were conducted as were herbicide treatments.

On the shallow soil site, the results found that foliar cover and aboveground biomass indicated benefits to tillage and moisture supply. The tilled plot cover was three times that of the no-till. Drift area produced more cover than the non-drift area. Unexpectedly, the non-drift area-till produced 20% more aboveground biomass than the drift area-till. Pubescent wheatgrass, thickspike wheatgrass, and slender wheatgrass produced the most cover and aboveground biomass. The deep soil site showed improved foliar coverage on tilled sites. Non-drift areas produced twice as much foliar cover. Slender wheatgrass was the best performer for both cover and biomass production. These results indicate that seedbed preparation is superior to no-till. Additionally, slender wheatgrass varieties, pubescent wheatgrass, and thickspike wheatgrass do well in no-till situations.

LOAMY UPLAND ECOLOGICAL SITE CLASS

General Description

The Loamy Upland ecological site class occurs on nearly level to moderately steep uplands. The soils are well drained and formed in alluvium, residuum derived from silty or clayey material or from shale.

Geomorphic Features

Landscape Positions:	Fan, Hill, Plain
Slope (percent):	0 – 30

Representative Soil Features

Soil Depth:	Moderately Deep to Deep
Parent Material Kind:	Alluvium, Residuum
Parent Material Origin:	Mixed
Surface Texture:	Loam, Silt Loam, Silty Clay Loam, Silty Clay
Surface Texture Modifier:	None
Subsurface Texture Group:	Clayey to Loamy
Drainage Class:	Well
Permeability Class:	Very Slow to Moderate
Chemistry:	None
Available Water Capacity:	3 – 8 inches

Vegetation Dynamics

Community Class 1.1 in the State and Transition Model (Figure 3) was derived from functional group production for the reference communities in the ecological sites correlated to this ecological site class. The reference communities have an average annual production of 1975 lbs/ac/yr dominated by western wheatgrass, green needlegrass, thickspike wheatgrass, sideoats grama, needleandthread, blue grama, sedges, and big bluestem.

With heavy continuous grazing, no fire, and the introduction of non-native species, the site will transition to a Native Woody, Native -- Non-Native Herbaceous State (State 2) dominated by crested wheatgrass and big sagebrush. In the southeast portion of this MLRA, in the highest and wettest portion of the MLRA, this site class includes a juniper – ponderosa pine forest community (30% canopy cover). There is no NRI data for the juniper – pine community class.

Plowing and tillage convert the site to a “Planted Herbaceous State”. Cropping and harvesting of annual and perennial crops maintain a cropland community class (Community Class 3.1). When seeded to native perennial grasses, the site transitions to a native planted community class (Community Class 3.2). Native planting species shown are some of the species recommended in the NRCS South Dakota Technical Note Number 4 for the sites correlated to this Site Class. Once the site is tilled and planted, it does not return to States 1 or 2.

State and Transition Model

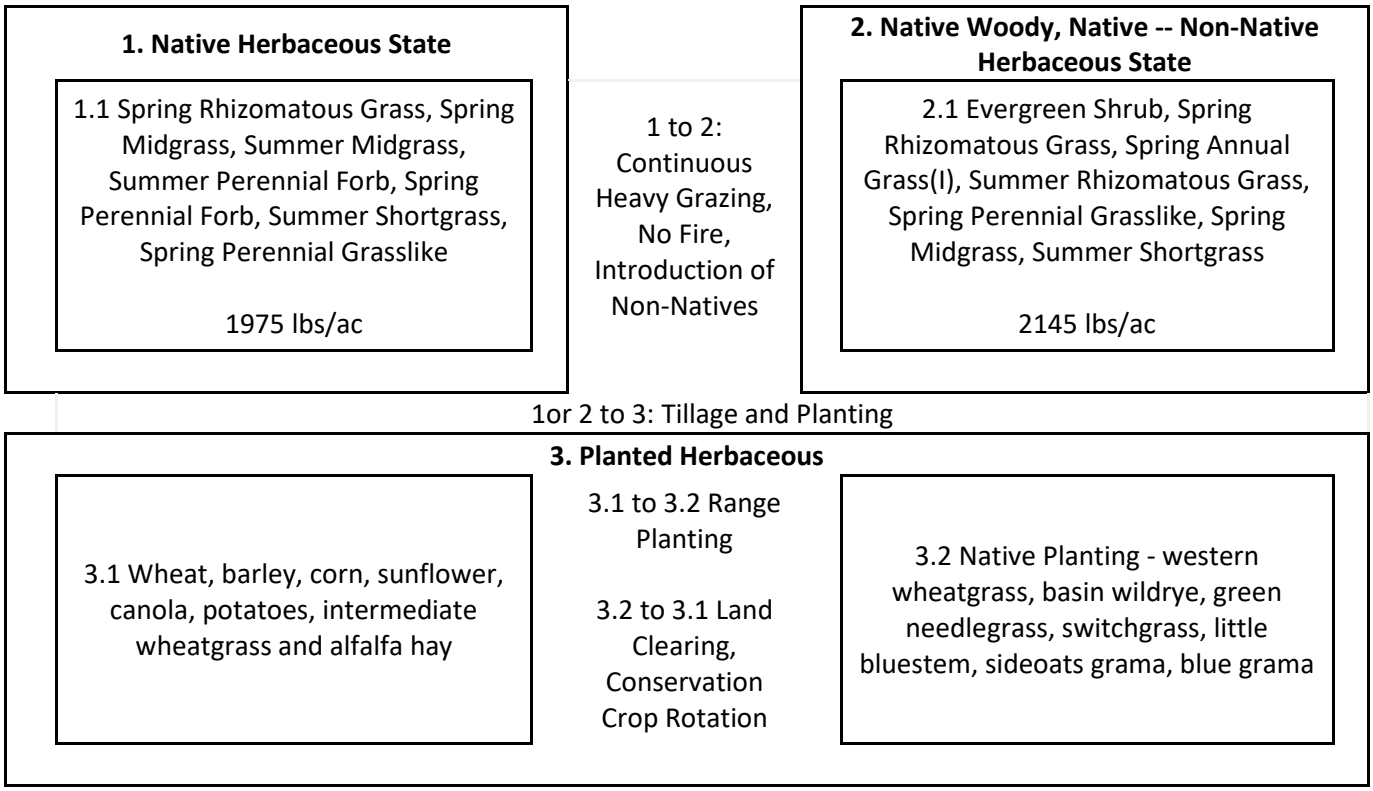

Figure 3. State and Transition Model, MLRA 60A Loamy Upland ecological site class.

NRI Primary Sampling Units (PSUs) were correlated to these community classes where possible. Community class production, functional group dominance, and dominant species based on available NRI data are shown in Table 5. Ground and canopy cover from the NRI PSUs was used to estimate average annual erosion and percent runoff using the Rangeland Hydrology and Erosion Model (RHEM).

Table 5. NRI Community Class Data and RHEM Results - MLRA 60A Loamy Upland ecological site class.

Comm Class ID	Community Class Name	Dominant Species (Symbol)(Lbs/Ac)	Production Lbs/Ac	Soil Loss T/Ac/Yr	% Runoff	# PSUs
060A.6.1.1	Spring Rhizomatous Grass(969), Summer Stoloniferous Grass(672), Spring Midgrass(104), Summer Shortgrass(97), Spring Perennial Forb(67), Summer Perennial Forb(40), Herbaceous Vine(38)	western wheatgrass(PASM)(957), Buffalograss(BODA2)(672), blue grama(BOGR2)(97), green needlegrass(NAVI4)(59), American vetch(VIAM)(38), sedge(CAREX)(27), prairie Junegrass(KOMA)(26), scarlet globemallow(SPCO)(22)	2125	0.56	7.21%	20
060A.6.2.1	Evergreen Shrub(810), Spring Midgrass(I)(748), Summer Stoloniferous Grass(300), Spring Rhizomatous Grass(216), Spring Annual Grass(I)(133), Summer Shortgrass(68)	crested wheatgrass(AGCR)(748), big sagebrush(ARTR2)(660), Buffalograss(BODA2)(300), western wheatgrass(PASM)(216), rubber rabbitbrush(ERNA10)(150), Japanese brome(BRAR5)(133), blue grama(BOGR2)(68), woolly plantain(PLPA2)(30), field brome(BRAR5)(24)	2401	0.12	3.18%	3

Supporting Information

The following publications support the STM. The first publication illustrates the vegetation changes that will occur with varying grazing management systems after fire. The study found the same conclusions to that of the STM, in terms of increases and decreases in herbage production. Although the second publication did not see a significant decrease of western wheatgrass with continuous grazing, the study did find that once utilization exceeded 80% there would be a decrease. This corresponds with the STM, as season-long heavy continuous grazing would likely produce this amount of utilization.

Stroud, D.O., R.H. Hart, M.J. Samuel, and J.D. Rodgers. 1985. Western Wheatgrass Responses to Simulated Grazing. Journal of Range Management 38(2): 103-108.

The objective of this study, which took place in Cheyenne, Wyoming, was to develop improved guides for grazing management than those from conventional clipping. The major grass species that were present included blue grama, western wheatgrass and needleandthread.

Twenty-four plots were established on native range. Four replications of six treatments were implemented in a randomized block design. The six treatments included unclipped control, clipping western wheatgrass to 2.5 to 4 times, and 4 clipping treatments simulating 4 levels of continuous grazing. All western wheatgrass tillers were individually labeled with bird leg bands. Aboveground and belowground production was analyzed with covariance procedures.

The results found that second heaviest simulated grazing treatment increased the production of western wheatgrass the most. No significant differences in forage production were witnessed with the ungrazed and three lighter simulated continuous grazing treatments. There was a significant negative correlation between western wheatgrass herbage production and the herbage production of other species. In the two years of the study, simulated continuous grazing resulted in no significant decrease of production of western wheatgrass, until utilization exceeded 80%.

Watts, C.R., L.C. Eichhorn, and R.J. Mackie. 1987. Vegetation Trends within Rest-Rotation and Season-long Grazing Systems in the Missouri River Breaks, Montana. Journal of Range Management 40 (5): 393-396.

This study took place northwest of Petroleum County, Montana, with the objective of reporting the results of two 10-year studies of vegetation trends on rough "breaks-type" rangeland. One study was designed to help evaluate the potential application of rest-rotation grazing in diverse vegetation and topography. The other study was designed to evaluate season-long grazing under proper stocking rates. The sites were highly dissected uplands, with coulees and creek bottoms interspersed. Soils in the breaks are moderately saline and alkaline clays and heavy clay loams were predominant throughout. On ridgetops, big sagebrush and wheatgrasses dominate, with ponderosa pine, Douglas fir, and Rocky Mountain juniper common on side slopes and drainages. Common grasses included bluebunch wheatgrass, western wheatgrass, green needlegrass, Sandberg's bluegrass and prairie junegrass. Other dominant vegetation included a variety of sedges, American vetch, snowberry, fragrant sumac, rabbitbrush and chokecherry.

Vegetation trends associated with rest-rotation grazing were measured in 1 of 3 pastures of fair to good range condition with 3,482 AUMs (utilizing an average of 2,700 annually), using the formula: early use (May to August), late use (August to November), total rest. The season-long system was 4,963 ha of poor to fair range condition with 1,876 AUMs and was grazed annually from May to October. The studies were conducted on recent wildfire burns in both pastures. Vegetation trends were assessed using exclosures, paired with line-transects.

The results found that grass coverage trends were similar between the exclosures and transects. However, the trends on a temporal scale varied greatly among the 3 types, mostly as a result of site characteristics. The greatest variation was seen on the ponderosa pine-bluebunch wheatgrass (Pipo-Agsp) and rough cocklebur (Xast) types, on which grass coverage increased sharply for 2-4 years post-burn, then declined variably to year 10, when it differed little from year one. Conversely, grass coverage on the ponderosa pine-Rocky Mountain (Pipo-Jusc) juniper type, on which grass was very sparse until burning eliminated competing woody vegetation, remained low for 3-4 years, then increased through year 10. Grass coverage invariably decreased the year following late season grazing. Bare ground decreased within exclosures and increased outside through year 5. The vegetation trends under season-long grazing varied somewhat for the 3 types over the 10 years, however, grass coverage generally increased on transects inside the exclosure. Trends on grazed transects were more varied. For the big sagebrush-western wheatgrass type (Artr-Agsm), grass coverage changed little outside the exclosure. For Pipo-Jusc, grass coverage sharply increased 2-4 years into the study, but changed little thereafter. In Douglas fir- Rocky Mountain juniper (Psme-Jusc) type, which was on a steeper slope and deeper soil, grass increased through year 6, then decreased to year 10. By the sixth year, grass coverage was significantly greater on Artr-Agsm and Pipo-Jusc types and was significantly greater on all types by year 10. Forbs were relatively similar both inside and outside the exclosures. Prior burning eliminated big sagebrush, which did not return during the study. Trends in shrub coverage were generally similar both inside and outside the exclosure. Ultimately, the results found that rest-rotation grazing may maintain vegetation cover.

SALINE BOTTOMLAND ECOLOGICAL SITE CLASS

General Description

The Saline Bottomland ecological site class occurs on nearly level to gently floodplains, terraces, and alluvial fans. This group is very deep poorly drained soils formed in alluvium overlying clay shale, soft sandstone or stratified alluvium. High soluble salt concentrations occur in the subsoils.

Geomorphic Features

Landscape Positions:	Alluvial Fan, Basin Floor, Depression, Flood Plain, Stream Terrace
Slope (percent)	0 – 6

Representative Soil Features

Soil Depth:	Deep
Parent Material Kind:	Alluvium
Parent Material Origin:	Mixed
Surface Texture:	Silty Clay Loam, Silty Clay, Clay, Slay Loam, Loam, Very Fine Sandy Loam
Surface Texture Modifier:	None
Subsurface Texture Group:	Clayey
Drainage Class:	Poorly to Somewhat Poorly
Permeability Class:	Very Slow to Moderately Rapid
Chemistry:	Saline
Available Water Capacity:	1 – 7 inches

Vegetation Dynamics

Community Class 1.1 in the State and Transition Model (Figure 4) was derived from functional group production for the reference communities in the ecological sites correlated to this ecological site group. The Reference Community produces about 2333 lbs/ac/yr dominated by western wheatgrass, alkali sacaton, thickspike wheatgrass, inland saltgrass, alkali cordgrass, Nuttall's alkaligrass, sedges, and prairie cordgrass. There is no NRI data for this ecological site class.

State and Transition Model

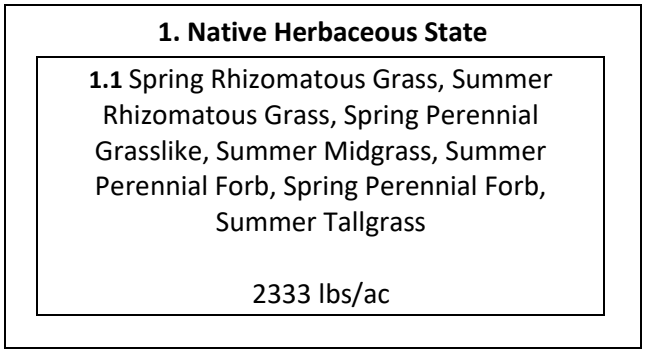

Figure 4. State and Transition Model, MLRA 60A Saline Bottomland ecological site class.

Supporting Information

No literature was found that dealt with this ecological site class.

SANDY UPLAND ECOLOGICAL SITE CLASS

General Description

The Sandy Upland ecological site class occurs mainly on nearly level to undulating slopes on uplands, dune fields and river valleys. Sites in this class formed in eolian sand or sandy alluvium.

Geomorphic Features

Landscape Positions:	Dune, Interdune, Flood Plain, Stream Terrace, Valley
Slope (percent):	0 - 24

Representative Soil Features

Soil Depth:	Moderately Deep to Deep
Parent Material Kind:	Alluvium or Eolian
Parent Material Origin:	Mixed
Surface Texture:	Fine Sand, Loamy Fine sand, Sandy Loam, Fine Sandy Loam
Surface Texture Modifier:	None
Subsurface Texture Group:	Sandy
Drainage Class:	Well to Excessively Drained
Permeability Class:	Moderate to Moderately Rapid
Chemistry:	None
Available Water Capacity:	2 – 5 inches

Vegetation Dynamics

Community Class 1.1 in the State and Transition Model (Figure 5) was derived from functional group production for the reference communities in the ecological site descriptions for sites correlated to this ecological site class. This community class has an average annual production of about 1850 lbs/ac, dominated by prairie sandreed, sand bluestem, little bluestem, needleandthread, blue grama, western wheatgrass, sedges, and wild rose.

With the introduction of non-native species, the site will transition to a Native -- Non-Native Herbaceous state (State 2) with lower production from native grasses and a portion of the production coming from of Japanese brome, cheatgrass and crested wheatgrass.

Plowing and tillage converts the site to a Planted Herbaceous State (State 3). Cropping and harvesting of annual and perennial crops maintain a cropland community class (Community Class 3.1). When seeded to native perennial grasses, the site transitions to a native planted community class (Community Class 3.2). Native planting species shown are some of the species recommended in the NRCS South Dakota Technical Note Number 4 for the sites correlated to this Site Class. Once the site is plowed and planted, it does not return to State 1 or 2.

State and Transition Model

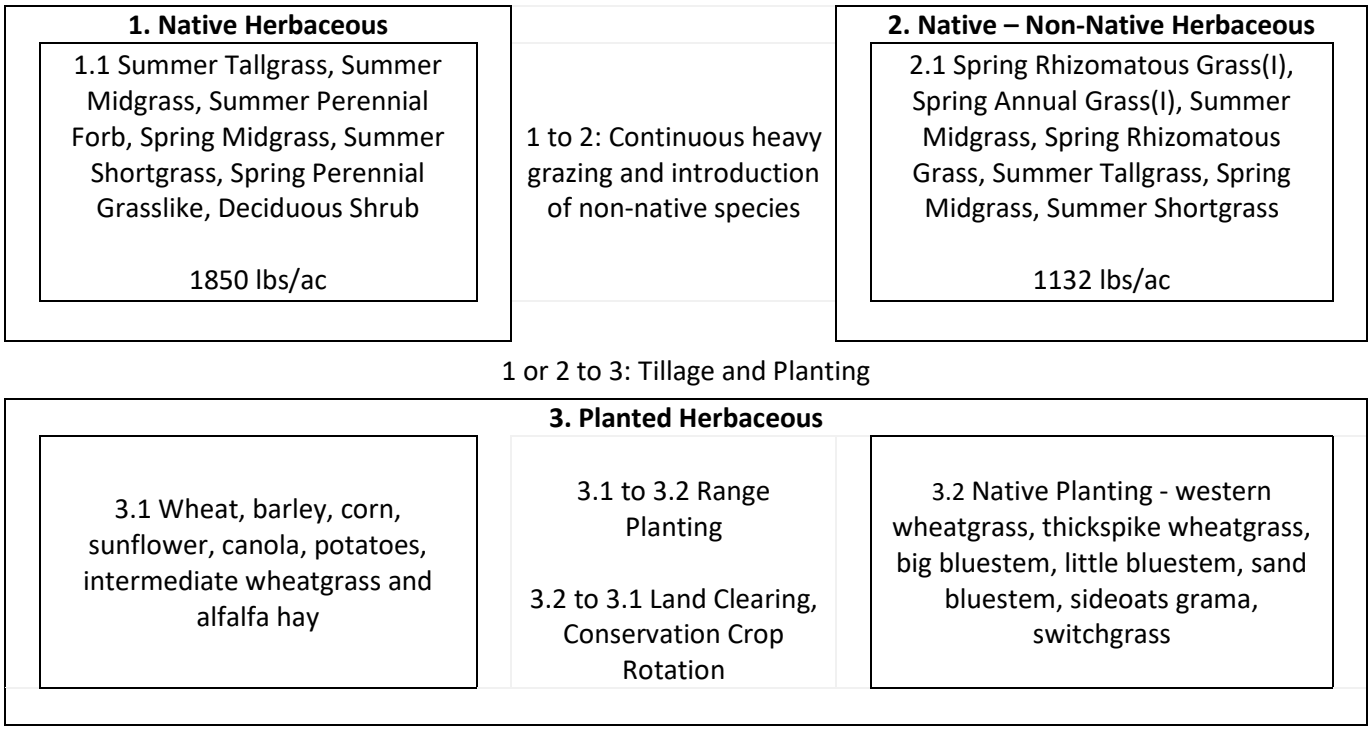

Figure 5. State and Transition Model, MLRA 60A Sandy Upland ecological site class.

NRI Primary Sampling Units (PSUs) were correlated to these community classes where possible. Community class production, functional group dominance, and dominant species based on available NRI data are shown in Table 6. Ground and canopy cover from the NRI PSUs was used to estimate average annual erosion and percent runoff using the Rangeland Hydrology and Erosion Model (RHEM).

Table 6. NRI Community Class Data and RHEM Results - MLRA 60A Sandy Upland ecological site class.

Comm Class ID	Community Class Name	Dominant Species (Symbol)(Lbs/Ac)	Production Lbs/Ac	Soil Loss T/Ac/Yr	% Runoff	# PSUs
060A.29.2.1	Spring Rhizomatous Grass(I)(191), Spring Annual Grass(I)(146), Summer Midgrass(137), Spring Rhizomatous Grass(111), Summer Tallgrass(110), Spring Midgrass(105), Summer Shortgrass(57)	intermediate wheatgrass(THIN6)(187), western wheatgrass(PASM)(111), prairie sandreed(CALO)(110), needleandthread(HECO26)(105), alkali sacaton(SPAI)(88), cheatgrass(BRTE)(87), Japanese brome(BRAR5)(58), crested wheatgrass(AGCR)(57)	1132	0.02	1.55%	4

Supporting Information

The following publication supports the STM. The study results are in accordance with many of the vegetation species the STM suggests would be present in this ecological site group.

Strong, D.J., L.T. Vermeire, A.C. Ganguli. 2013. Fire and Nitrogen Effects on Purple Threeawn (*Aristida purpurea*) Abundance in Northern Mixed-Prairie Old Fields. Rangeland Ecology & Management 66(5): 553-560.
This study in Terry, Montana, maintained three objectives: 1) determine the efficacy of nitrogen and fire during different seasons to reduce purple threeawn, 2) assess nontarget plant responses after nitrogen and fire. The study sites were on abandoned cropland seeded to crested wheatgrass. Two similar sites were selected and treated on variable years. Both sites were sandy ecological sites with purple threeawn, crested wheatgrass, sand dropseed, blue grama, buffalograss, tumblegrass, needleandthread, Sandberg bluegrass, intermediate wheatgrass, sixweeks fescue, field brome, cheatgrass and some shrubs and forbs.

The experimental design included randomly assigning three replications of the three fire treatments (no fire, summer fire, fall fire) and three different levels of nitrogen application. Standing crop, current-year biomass, basal cover, bare ground, litter and relative biomass were measured to assess vegetation response. Measurements were done with line-point intercept and clipping of quadrats with statistical analysis being performed following.

The results found summer and fall fires reduced standing crop relative to non-burned sites. The addition of nitrogen increased current-year biomass. Summer and fall fires reduced biomass, except for no effect being measured with a dry spring. Purple threeawn biomass was reduced by fire, but nitrogen had no effect. Forb biomass more than doubled on non-burned plots at which nitrogen was applied. In terms of ground cover, basal cover was greater in all plots following a dry spring, then a wet spring. Fall fire reduced purple threeawn regardless of the weather. Needleandthread was reduced by fire also. Crested wheatgrass showed a significant increase with fire. Litter cover was increased with nitrogen application on non-burned plots, had no effect on summer burned plots and little effect on fall burned. Summer fire decreased purple threeawn relative composition, but caused a doubling of crested wheatgrass.

SHALLOW POROUS CLAY UPLAND ECOLOGICAL SITE CLASS

General Description

The Shallow Porous Clay Upland ecological site class occurs on gently to moderately rolling to steeply sloping uplands. Soils are generally shallow and are formed from acid material weathered from shale and contain many small shale fragments.

Geomorphic Features

Landscape Positions:	Hill, Plain, Ridge
Slope (percent):	2 - 60

Representative Soil Features

Soil Depth:	Shallow to Deep
Parent Material Kind:	Residuum
Parent Material Origin:	Shale
Surface Texture:	Clay, Silty Clay Loam, Silty Clay
Surface Texture Modifier:	Channery
Subsurface Texture Group:	Clayey
Drainage Class:	Well
Permeability Class:	Very Slow to Moderately Rapid
Chemistry:	None
Available Water Capacity:	2 – 5 inches

Vegetation Dynamics

Community Class 1.1 in the State and Transition Model (Figure 6) was derived from functional group production for the reference communities in the ecological sites correlated to this ecological site group. This community class produces about 1285 lbs/ac/yr. dominated by little bluestem, western wheatgrass, sideoats grama, prairie sandreed, thickspike wheatgrass, big bluestem, sun sedge, and green needlegrass. With continuous heavy grazing, the site may transition to a shortgrass dominated community class dominated by buffalograss and blue grama. With long term prescribed grazing the site may transition back to Community 1.1.

With lack of fire, woody species such as juniper and ponderosa pine will increase on the site and transition the site to State 2. Timber harvest, brush management, and stand replacing crown fires can return the site to the reference state. There are no NRI points representing this state.

With the introduction of non-natives such as cheatgrass, crested wheatgrass, and sweetclover, the site will transition to a Native – Non-Native Herbaceous state (State 3). Once non-natives have become established, the site will not transition back to State 1 or 2.

Plowing and tillage converts the site to a Planted Herbaceous State (State 4). Cropping and harvesting of annual and perennial crops maintain a cropland community class (Community Class 4.1). When seeded to native perennial grasses, the site transitions to a native planted community class (Community Class 4.2). Native planting species shown are some of the species recommended in the NRCS South Dakota Technical Note Number 4 for the sites correlated to this Site Class. Once the site is plowed and planted, it does not return to State 1, 2 or 3.

State and Transition Model

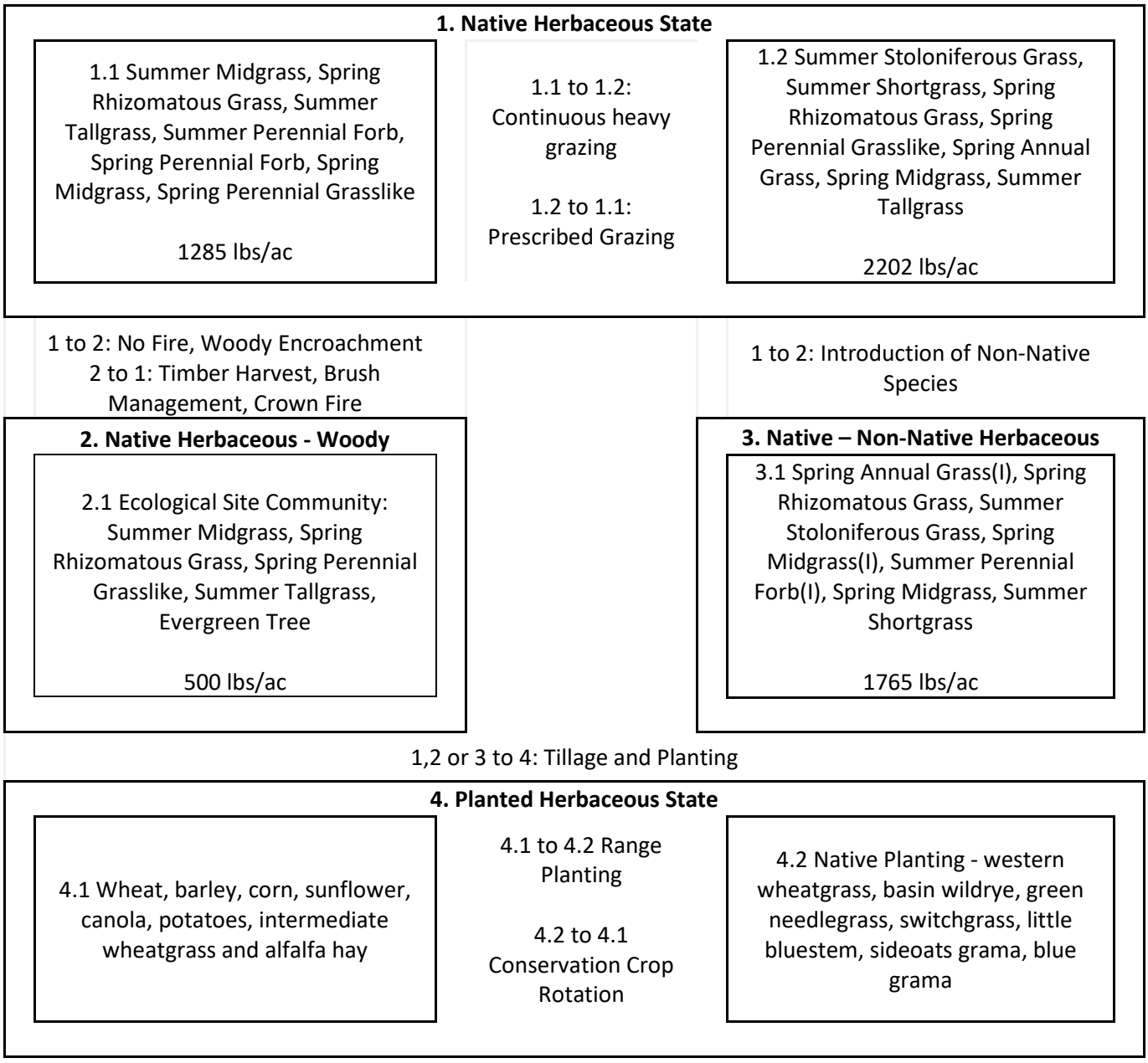

Figure 6. State and Transition Model, MLRA 60A Shallow Porous Clay Upland ecological site class.

NRI Primary Sampling Units (PSUs) were correlated to these community classes where possible. Community class production, functional group dominance, and dominant species based on available NRI data are shown in Table 7. Ground and canopy cover from the NRI PSUs was used to estimate average annual erosion and percent runoff using the Rangeland Hydrology and Erosion Model (RHEM).

Table 7. NRI Community Class Data and RHEM Results - MLRA 60A Shallow Porous Clay Upland ecological site class.

Comm Class ID	Community Class Name	Dominant Species (Symbol)(Lbs/Ac)	Production Lbs/Ac	Soil Loss T/Ac/Yr	% Runoff	# PSUs
060A.33.1.1	Spring Rhizomatous Grass(708), Summer Midgrass(259), Spring Midgrass(113), Summer Perennial Forb(91), Coniferous Tree(65), Spring Perennial Forb(19), Summer Shortgrass(11)	western wheatgrass(PASM)(708), green needlegrass(NAVI4)(106), sideoats grama(BOCU)(105), little bluestem(SCSC)(95), Rocky Mountain juniper(JUSC2)(65), prairie dropseed(SPHE)(58), white sagebrush(ARLU)(47), silverleaf Indian breadroot(PEAR6)(28)	1288			3
060A.33.1.2	Summer Stoloniferous Grass(1128), Summer Shortgrass(432), Spring Rhizomatous Grass(296), Spring Perennial Grasslike(169), Spring Annual Grass(I)(91), Spring Midgrass(45), Summer Tallgrass(17)	Buffalograss(BODA2)(1128), blue grama(BOGR2)(432), western wheatgrass(PASM)(296), threadleaf sedge(CAFI)(169), Japanese brome(BRAR5)(91), green needlegrass(NAVI4)(45), big bluestem(ANGE)(17), crested wheatgrass(AGCR)(9)	2202			2
060A.33.2.1	Spring Annual Grass(I)(375), Spring Rhizomatous Grass(338), Summer Stoloniferous Grass(280), Spring Midgrass(I)(176), Summer Perennial Forb(I)(141), Spring Midgrass(101), Summer Shortgrass(54)	cheatgrass(BRTE)(352), western wheatgrass(PASM)(338), buffalograss(BODA2)(280), crested wheatgrass(AGCR)(176), sweetclover(MEOF)(141), needleandthread(HECO26)(66), blue grama(BOGR2)(50), sedge(CAREX)(37)	1765	0.90	19.71%	9

Supporting Information

The following publications supports the STM. This study takes place in an adjacent MLRA, but demonstrates many of the same vegetation dynamics that would be present in this ecological site class. The second study examines herbage production under a ponderosa pine stand. As the STM suggests, with a lack of disturbance, the ponderosa pine crown cover will increase, causing the herbage production to decrease. The publication suggests thinning to increase forage supply.

Karn, J.F., R.E. Ries and L. Hofmann. 1999. Season-long grazing of seeded cool-season pastures in the Northern Great Plains. Journal of Range Management 52(3): 235-240.

Grazing studies were implemented for 140 days each summer for two years near Mandan, North Dakota. The species that were seeded included western wheatgrass, crested wheatgrass and smooth bromegrass. Native pastures were located adjacent on loam, silt loam and silty clay soils. Both seeded and native pastures underwent 2 replications of moderate and heavy stocking rates. Flat native pastures were fine-silty soils and consisted of blue grama, green needlegrass, needleandthread, western wheatgrass, sedges, threeawn and Kentucky bluegrass. Rolling native pastures consisted of the same, with the addition of little bluestem and some patches of western snowberry and buffaloberry.

Standing crop was measured by hand clipping forage at a 5mm stubble height from 36 plots randomly located in cages. These cages were randomly placed in each seeded pasture and each of the flat and rolling native pastures. Steers were weighed and observed during the study.

Results found that western wheatgrass had the highest average end of season standing crop and the greatest amount of grazed residue. Smooth bromegrass has the lowest end of season standing crop and grazed residue. End of season standing crop averaged over all cool-season and native pastures was greater at the moderate versus the heavy stocking rate.

Pase, Charles P. 1958. Herbage Production and Composition under Immature Ponderosa Pine Stands in the Black Hills. Journal of Range Management 11(5): 238-243.

This study in southwestern South Dakota, took place on soils that range from sandy loams to clay loams. The study purpose was to determine the herbage production and composition under immature ponderosa pine stands of the Black Hills. Vegetation in the area consists of ponderosa pine, juniper, bearberry, chokecherry, snowberry, eastern hornbeam, hazelnut, Pennsylvania sedge, Kentucky bluegrass, roughleaf ricegrass, poverty oatgrass, pussytoes and goldenrod. The study design included thirty-one sample areas on timber sites of even-aged, second-growth ponderosa pine. Herbage production was determined by the weight estimate method. Twenty circular plots were established at each sample area and transects were spaced 10 feet apart. Crown density was gathered by the “moosehorn” estimator and basal area by Bitterlich stick.

The results found that herbage production decreased as crown cover increased. All groups of vegetation (grasses, forbs, shrubs) increased as crown cover decreased. Herbage production decreased as pine litter increased. Various species related differently to crown canopy. For instance, Pennsylvania sedge and roughleaf ricegrass persisted under a dense canopy. However, Kentucky bluegrass and fuzzyspike wildrye virtually disappeared under dense stands. Little bluestem was generally most abundant under open stands of southerly exposure. Few of the 63 forbs persisted under even moderately dense canopies. Bearberry, common juniper, and snowberry were the abundant of the 19 species of shrubs, but each decreased with an increase in canopy.

SHALLOW UPLAND ECOLOGICAL SITE CLASS

General Description

The Shallow Upland ecological site class occurs on nearly level to steeply sloping uplands. These sites have formed in residuum weathered from clay shale, siltstone or silty and clayey alluvium.

Geomorphic Features

Landscape Positions:	Fan, Flat, Hill, Plain, Ridge, Terrace
Slope (percent):	0 – 50

Representative Soil Features

Soil Depth:	Very Shallow to Deep
Parent Material Kind:	Alluvium, Residuum
Parent Material Origin:	Mixed
Surface Texture:	Loam, Silty Loam, Fine Sandy Loam, Clay
Surface Texture Modifier:	None
Subsurface Texture Group:	Clayey
Drainage Class:	Moderately Well to Well
Permeability Class:	Slow to Very Slow
Chemistry:	Sodic
Available Water Capacity:	1 – 5 inches

Vegetation Dynamics

Community Class 1.1 in the State and Transition Model (Figure 7) was derived from functional group production in the reference communities for the ecological sites correlated to this ecological site class. This site class produces about 1083 lbs/ac/yr dominated by western wheatgrass, thickspike wheatgrass, Montana wheatgrass, blue grama, green needlegrass, needleandthread, sideoats grama, and little bluestem. With continuous heavy grazing the site will likely transition to a shortgrass community (1.2) dominated by buffalograss and blue grama.

With continuous heavy grazing and a lack of fire, the site will transition to a Native Woody – Native Herbaceous state with a decrease of grasses and the invasion of woody species including big sagebrush, and ponderosa pine and juniper in the higher rainfall areas. With timber harvest, brush management, regular natural or Prescribed Burning and long term Prescribed Grazing, the site may return to the Native Herbaceous State.

With the introduction of non-natives such as cheatgrass, Japanese brome, crested wheatgrass, and sweetclover, the site will transition to a Native – Non-Native Herbaceous state. Once non-natives have become established, the site will not transition back to State 1 or 2.

Plowing and tillage converts the site to a Planted Herbaceous State (State 4). Cropping and harvesting of annual and perennial crops maintain a cropland community class (Community Class 4.1). When seeded to native perennial grasses, the site transitions to a native planted community class (Community Class 4.2). Native planting species shown are some of the species recommended in the NRCS South Dakota Technical Note Number 4 for the sites correlated to this Site Class. Once the site is plowed and planted, it does not return to State 1, 2 or 3.

State and Transition Model

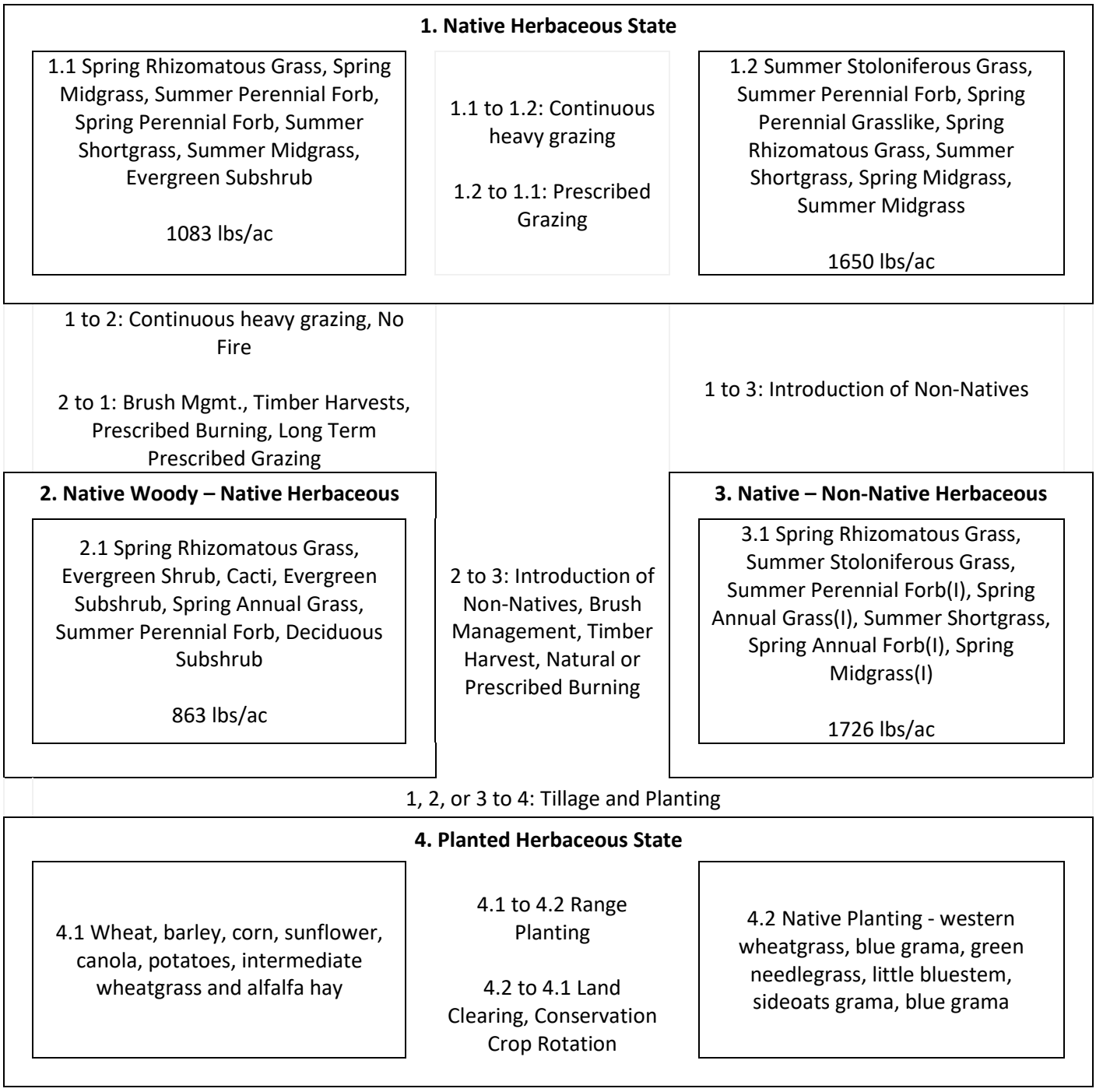

Figure 7. State and Transition Model, MLRA 60A Shallow Upland ecological site class.

NRI Primary Sampling Units (PSUs) were correlated to these community classes where possible. Community class production, functional group dominance, and dominant species based on available NRI data are shown in Table 8. Ground and canopy cover from the NRI PSUs was used to estimate average annual erosion and percent runoff using the Rangeland Hydrology and Erosion Model (RHEM).

Table 8. NRI Community Class Data and RHEM Results - MLRA 60A Shallow Upland ecological site class.

Comm Class ID	Community Class Name	Dominant Species (Symbol)(Lbs/Ac)	Production Lbs/Ac	Soil Loss T/Ac/Yr	% Runoff	# PSUs
060A.18.1.1	Spring Rhizomatous Grass(537), Summer Stoloniferous Grass(228), Summer Midgrass(97), Spring Midgrass(88), Spring Perennial Forb(67), Summer Perennial Forb(57), Spring Perennial Grasslike(37)	western wheatgrass(PASM)(505), buffalograss(BODA2)(228), sideoats grama(BOCU)(61), needleandthread(HECO26)(32), sedge(CAREX)(32), little bluestem(SCSC)(32), Montana wheatgrass(ELAL7)(31), green needlegrass(NAVI4)(27)	1278	2.19	24.60%	20
060A.18.1.2	Summer Stoloniferous Grass(341), Summer Perennial Forb(291), Spring Perennial Grasslike(221), Spring Rhizomatous Grass(184), Summer Shortgrass(156), Spring Midgrass(109), Summer Midgrass(97)	Buffalograss(BODA2)(341), sedge(CAREX)(162), western wheatgrass(PASM)(157), blue grama(BOGR2)(155), slimflower scurfpea(PSTE5)(150), dotted blazing star(LIPU)(99), sideoats grama(BOCU)(69), threadleaf sedge(CAFI)(58)	1650	2.30	19.21%	8
060A.18.2.1	Spring Rhizomatous Grass(340), Evergreen Shrub(326), Cacti(75), Evergreen Subshrub(52), Spring Annual Grass(I)(25), Summer Perennial Forb(14), Deciduous Subshrub(13)	big sagebrush(ARTR2)(308), western wheatgrass(PASM)(251), Montana wheatgrass(ELAL7)(88), Opuntia spp.(OPUNT)(75), Nuttall's saltbush(ATNU2)(46), Japanese brome(BRAR5)(25), branched false goldenweed(OOMU)(13), knotweed(POLYG4)(8)	863	0.67	27.15%	3
060A.18.3.1	Spring Rhizomatous Grass(686), Summer Stoloniferous Grass(206), Summer Perennial Forb(I)(132), Spring Annual Grass(I)(108), Summer Shortgrass(93), Spring Annual Forb(I)(80), Spring Midgrass(I)(62)	western wheatgrass(PASM)(685), Buffalograss(BODA2)(206), sweetclover(MEOF)(132), blue grama(BOGR2)(93), crested wheatgrass(AGCR)(62), Japanese brome(BRAR5)(58), sweetclover(MELIL)(53), cheatgrass(BRTE)(50), field brome(BRAR5)(11)	1726	1.18	13.53%	23

Supporting Information

The following publication supports the STM. The first publication delves into herbage production in response to canopy cover. The publication supports the STM in the finding that as canopy cover increases, herbage production decreases. The second publication, though it is farther west than the STM, demonstrates similar dynamics to MLRA 60A. As described in the STM, this study shows similar responses to disturbance in terms of how fire alters vegetation states.

Bennett, D.L., G.D. Lemme and P.D. Evenson. 1987. Understory Herbage Production of Major Soils within the Black Hills of South Dakota. Journal of Range Management 40(2): 166-170.

The objective of this study was to develop models to predict understory herbage production potential of predominant forest soils of the Black Hills. The study was conducted on a variety of soil temperature regimes and varying soil classifications; however, all classifications were of loamy or fine.

A total of twelve sites were selected within each of the 7 soil types, each were large homogeneous areas on slopes that had been utilized by cattle following thinning. Transects were placed across each study area. Canopy cover was measured with a spherical densiometer and basal area with a cruising prism. Percent slope and aspect were also calculated. Understory vegetation was oven-dried and determined with the double-sampling method from quadrats.

The results found that canopy cover was the most important independent variable in the prediction of yield components. Basal area was not as predictive in determining understory herbage yield. It was found that higher yielding soils had a more negative interaction with cover, resulting in a faster yield reduction as canopy cover increased. However, the general trend indicated, with an increase in canopy cover, herbage production and forage potential decreased.

MacNeil, M.D., M.R. Haferkamp, L.T. Vermeire and J.M. Muscha. 2008. Prescribed fire and grazing effects on carbon dynamics in a northern mixed-grass prairie. Agriculture, Ecosystems and Environment 127: 66-72.

The objective of this study was to determine the effects of fire and grazing on CO_2 fluxes and other measures of biotic and abiotic states. The study took place in at Fort Keogh Livestock and Range Research Laboratory near Miles City, MT on fine loam soils.

The experimental design included four replicate plots, which were randomly assigned undisturbed, burned, or grazed treatments. Burned plots were treated during the dormant season and grazed were stocked with yearling ewes with the intent of harvesting 50%. For measurement of CO_2 flux, an open-chamber gas exchange system was utilized. Above-ground biomass was clipped to the soil surface and sorted into vegetation components. Soil cores were also taken to determine soil C, and soil respiration measurements were also done. Statistical analyses of all measurements were completed to determine biotic and abiotic variables.

In terms of abiotic variables, temperatures and photosynthetically active radiation were unaffected by treatments. Treatments did temporally alter soil water content in seasonal changes. Burned plots had less soil water content than grazed or undisturbed. Seasonal dynamics of primary production were noted and temporal changes in green biomass were affected by treatment. In May-June, green biomass was greater on burned plots than on either grazed or undisturbed and decreased greatly in July on grazed plots. CO_2 fluxes in the study were relatively small, but were mainly altered by soil water availability. CO_2 flux over burned and unburned plots was very similar, but green biomass was increased on the burned plots. Grazing removed green biomass and reduced the amount of currently senesced biomass.

Dix, R.L. 1958. Some Slope-Plant Relationships in the Grasslands of the Little Missouri Badlands of North Dakota. Journal of Range Management 11(2): 88-92.

This study, located in Billings County, North Dakota focused on describing the vegetational characteristics of four grassland sites that differed in slope and exposure to determine the similarities and differences.
The soils of the sites were well-drained clay loam series. The native vegetation on moderate slopes included blue grama, western wheatgrass, thread-leaf sedge, and needleandthread. On steeper slopes vegetation included little bluestem, plains muhly, sideoats grama, and little club-moss. Sandy soils were dominated by prairie sandgrass. Grazing by livestock had been limited only to stray cattle for the past 20 years.

The vegetation was sampled with 40 quadrats per stand at 20 pace intervals, measuring the frequency index for each species. Results found that blue grama and western wheatgrass decrease, while little bluestem and plains muhly will increase. Stands highest in sedges and blue grama were found on steep slopes of which erosion was evident, as well as stands of plains muhly, little bluestem and sedges, which are topped with sandstone concretions. Stands high in blue grama and western wheatgrass were found on gentler slopes areas of deposition and erosion. Successional relationships were not evident between the stands, but disturbances by erodibility caused a lack of vegetal stability. Overall, the study found that the most critical factor in determining kinds and numbers of plants on sites is the soil moisture, and in conjunction, the exposure, slope and topography.

VERY SHALLOW UPLAND ECOLOGICAL SITE CLASS

General Description

The Very Shallow Upland ecological site class occurs on gently sloping to very steep uplands. It was derived from soft siltstone, sandstone, porcellanite, alluvium or loess deposits.

Geomorphic Features

Landscape Positions:	Escarpment, Hill, Knoll, Ridge, Terrace
Slope (percent)	0 – 45

Representative Soil Features

Soil Depth:	Very Shallow to Shallow
Parent Material Kind:	Alluvium, Eolian, Residuum
Parent Material Origin:	Mixed
Surface Texture:	Fine Sandy Loam, Sandy Loam, Loamy Fine Sand, Silty Loam, Silty Clay Loam, Clay Loam,
Surface Texture Modifier:	Gravelly
Subsurface Texture Group:	Loamy to Sandy
Drainage Class:	Well to Excessively Well
Permeability Class:	Slow to Very Rapid
Chemistry:	None
Available Water Capacity:	1 – 6 inches

Vegetation Dynamics

Community Class 1.1 in the State and Transition Model (Figure 8) was derived from functional group production for the reference communities in the ecological sites correlated to this ecological site group. The reference state of this ecological site group has an annual production of 1050 lbs/ac/yr dominated by needleandthread, sideoats grama, little bluestem, prairie sandreed, western wheatgrass, blue grama, bluebunch wheatgrass, and thickspike wheatgrass. There are no NRI PSUs representing this site class.

State and Transition Model

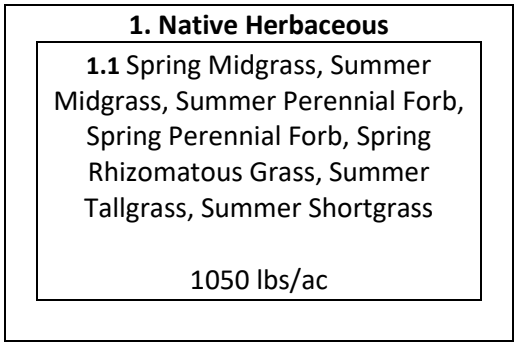

Figure 8. State and Transition Model, MLRA 60A Very Shallow Upland ecological site class.

Supporting Information

The following publication supports the STM. Although this study takes place in a nearby MLRA, the vegetation dynamics are similar to that of this MLRA. This study reiterates the STM findings in regard to vegetation that would be found in similar ecological site groups.

Dix, R.L. 1958. Some Slope-Plant Relationships in the Grasslands of the Little Missouri Badlands of North Dakota. Journal of Range Management 11(2): 88-92.

This study, located in Billings County, North Dakota focused on describing the vegetational characteristics of four grassland sites that differed in slope and exposure to determine the similarities and differences.

The soils of the sites were well-drained clay loam series. The native vegetation on moderate slopes included blue grama, western wheatgrass, thread-leaf sedge, and needleandthread. On steeper slopes vegetation included little bluestem, plains muhly, sideoats grama, and little club-moss. Sandy soils were dominated by prairie sandgrass. Grazing by livestock had been limited only to stray cattle for the past 20 years.

The vegetation was sampled with 40 quadrats per stand at 20 pace intervals, measuring the frequency index for each species. Results found that blue grama and western wheatgrass decrease, while little bluestem and plains muhly will increase. Stands highest in sedges and blue grama were found on steep slopes of which erosion was evident, as well as stands of plains muhly, little bluestem and sedges, which are topped with sandstone concretions. Stands high in blue grama and western wheatgrass were found on gentler slopes areas of deposition and erosion. Successional relationships were not evident between the stands, but disturbances by erodibility caused a lack of vegetal stability. Overall, the study found that the most critical factor in determining kinds and numbers of plants on sites is the soil moisture, and in conjunction, the exposure, slope and topography.

WET BOTTOMLAND ECOLOGICAL SITE CLASS

General Description

The Wet Bottomland ecological site class occurs on level to nearly level river valleys and uplands and are formed in loamy, silty or clayey alluvium. Water tables on this site class range from 1 foot above to 2 feet below the surface several weeks during the growing season. The site also receives additional water from surface runoff and/or underground seepage.

Geomorphic Features

Landscape Positions:	Depression, Flood Plain, Oxbow, Slough, Stream Terrace
Slope (percent):	0 - 3

Representative Soil Features

Soil Depth:	Deep
Parent Material Kind:	Alluvium
Parent Material Origin:	Mixed
Surface Texture:	Silt Loam, Silty Clay Loam, Silty Clay, Loamy Fine Sand
Surface Texture Modifier:	None
Subsurface Texture Group:	Clayey to Loamy
Drainage Class:	Poorly to Moderately Well Drained
Permeability Class:	Very Slow to Rapid
Chemistry:	None
Available Water Capacity:	4 – 8 inches

Vegetation Dynamics

Community Class 1.1 in the State and Transition Model (Figure 9) was derived from functional group production for the reference communities in the ecological site descriptions that were correlated to this ecological site class. This community class has an average annual production of 4900lbs/ac/yr dominated by prairie cordgrass, big bluestem, bluejoint, sedges, switchgrass, rough barnyardgrass, Nebraska sedge), and wheat sedge.

State and Transition Model

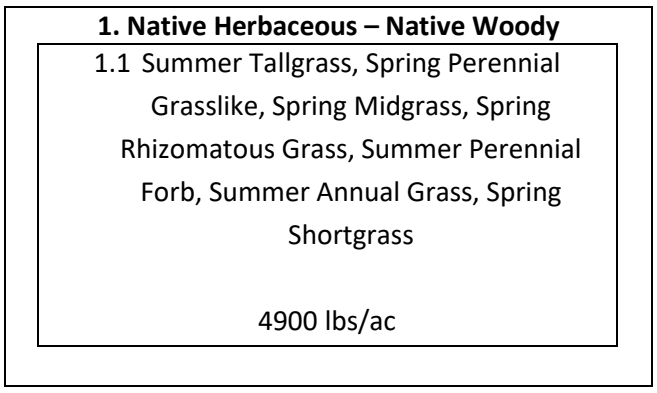

Figure 9. State and Transition Model, MLRA 60A Wet Bottomland ecological site class.

Only one NRI Primary Sampling Units (PSUs) occurs in this community class. REHM was not used to estimate erosion or runoff, because the model was not designed for use on saturated soils, and flooding has the most significant impact on runoff and erosion for this site class.

Table 9. NRI Community Class Data and RHEM Results - MLRA 60A Wet Bottomland ecological site class.

Comm Class ID	Community Class Name	Dominant Species (Symbol)(Lbs/Ac)	Production Lbs/Ac	Soil Loss T/Ac/Yr	% Runoff	# PSUs
060A.22.1.1	Summer Tallgrass(1782), Deciduous Shrub(1440), Summer Perennial Forb(507), Spring Rhizomatous Grass(I)(300), Lichen()	prairie cordgrass(SPPE)(1782), western snowberry(SYOC)(1386), Canada goldenrod(SOCA6)(507), smooth brome(BRIN2)(300), smooth sumac(RHGL)(47), Woods' rose(ROWO)(7), biological crust(SDH_BIO)()	4029			1

Supporting Information

The following publication supports the STM. Although the first study is focused on cattle performance and is slightly further east than this MLRA, the vegetation that is stated as predominant in the STM is agreed upon in this study. The second study took place slightly further east of MLRA 60A, the similarities of vegetation are consistent with the STM. Additionally, the study is in accordance with the estimated vegetation that would be present in a wetland ecological site group.

Lamb, J.B., D.C. Adams, T.J. Klopfenstein, W.W. Stroup, and G.P. Lardy. 1997. Range or meadow regrowth and weaning effects on 2-year old cows. Journal of Range Management 50 (1): 16-19.

This study took place near Whitman, NE and determine time of grazing to improve body condition score and to evaluate nutrient intake on range and subirrigated meadow. The range site was classified as sands in excellent condition. Dominant vegetation included little bluestem, prairie sandreed, sand bluestem, switchgrass, sand lovegrass, blue grama, and leadplant. The subirrigated meadow common vegetation was smooth brome, redtop, timothy, slender wheatgrass, quackgrass, Kentucky bluegrass, prairie cordgrass and several sedges and rushes. Less common vegetation included big bluestem, indiangrass, and switchgrass.

Individual cows and calves were weighed and evaluated for body condition score (BCS) after 16 hours without food and water. Fecal output of 40 cows and 12 steers was assessed and 12 esophageally-fistulated cows were obtained for diet samples. Treatments included: 1) range vs. subirrigated meadow, 2) September vs. November weaning, 3) September vs. November weaning on subirrigated meadow, 4) September vs. November weaning on range.

The results found that forage organic matter intake was similar for all grazing and weaning treatments. Cow body weights and BCS differed between range and meadow, as well as September vs. November weaning. Cows grazing subirrigated pasture regained more growth than the range grazed cows. Additionally, weaning in September increased body weight and BCS.

Reece, P.E., J.T. Nichols, J.E. Brummer, R.K. Engel, and K.M. Eskridge. 1994. Harvest date and fertilizer effects on native and interseeded wetland meadows. Journal of Range Management 47(3): 178-183.

This study evaluates dry matter yield and forage quality on a prairie wetland meadow near Whitman, Nebraska. The study was split-split plot experimental design with the whole plots randomly set in three complete blocks. All plots were hayed and fertilizer applied later in the study. Basal area of plant species was measured on all native

and interseeded plots with a 10-point frame at 10 main locations within each plot. The vegetation in the plots included Garrison creeping foxtail, Bebb sedge, Crawe sedge, Hayden sedge, Nebraska sedge, slender sedge, common rush, compressed spikerush, bluejoint reedgrass, prairie cordgrass, Kentucky bluegrass, etc. Sampling was obtained and oven-dried for dry-matter yield, protein concentration and digestibility estimates.

The results found that forage quality, dry-matter yield and response to spring-applied were similar for native wetland meadow vegetation and interseeded areas over harvest dates; the primary difference being abundance of sedges. Sedge-dominated tended to be more productive than wetland meadows. Harvest date decisions have the greatest potential to affect dry-matter yield and protein concentrations of herbage.

APPENDIX A. MLRA 60A, ECOLOGICAL SITE CLASSES SHOWING THE ECOLOGICAL SITES, ECOLOGICAL SITE IDS, AND PLANT COMMUNITY CLASSES THAT WERE CORRELATED TO EACH SITE CLASS.

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
60A	**Loamy Terrace**	Clayey Overflow	R060AY021SD
		Loamy Overflow	R060AY020SD
		Loamy Terrace	R060AY022SD
		Lowland	R060AY042SD
		Plant Community Class Names	**Plant Community Class ID**
		Spring Rhizomatous Grass, Spring Midgrass, Summer Tallgrass, Summer Perennial Forb, Spring Perennial Forb, Deciduous Shrub, Deciduous Tree	060A.3.1.1
		Summer Stoloniferous Grass, Summer Shortgrass, Spring Perennial Grasslike, Spring Rhizomatous Grass, Spring Annual Grass, Spring Perennial Forb, Summer Perennial Forb	060A.3.1.2
		Spring Rhizomatous Grass, Summer Stoloniferous Grass, Spring Annual Grass(I), Spring Rhizomatous Grass(I), Summer Perennial Forb, Spring Midgrass(I), Evergreen Subshrub	060A.3.2.1
MLRA	**Ecological Site Class Name**	**Ecological Site Names**	**Ecological Site ID**
60A	**Loamy Upland**	Clayey 13-16” PZ	R060AY011SD
		Clayey 16-18” PZ	R060AY040SD
		Loamy 13-16” PZ	R060AY010SD
		Loamy 16-18” PZ	R060AY041SD
		Plant Community Class Names	**Plant Community Class ID**
		Spring Rhizomatous Grass, Spring Midgrass, Summer Midgrass, Summer Perennial Forb, Spring Perennial Forb, Summer Shortgrass, Spring Perennial Grasslike	060A.6.1.1
		Evergreen Shrub, Spring Midgrass(I), Summer Stoloniferous Grass, Spring Rhizomatous Grass, Spring Annual Grass(I), Summer Shortgrass	060A.6.2.1

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
60A	**Saline Bottomland**	Closed Depression	R060AY019SD
		Saline Lowland	R060AY007SD
		Saline Subirrigated	R060AY036SD
		Plant Community Class Names	**Plant Community Class ID**
		Spring Rhizomatous Grass, Summer Rhizomatous Grass, Spring Perennial Grasslike, Summer Midgrass, Summer Perennial Forb, Spring Perennial Forb, Summer Tallgrass	060A.35.1.1

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
60A	**Sandy Upland**	Sands	R060AY008SD
		Sandy	R060AY009SD
		Plant Community Class Names	**Plant Community Class ID**
		Summer Tallgrass, Summer Midgrass, Summer Perennial Forb, Spring Midgrass, Summer Shortgrass, Spring Perennial Grasslike, Deciduous Shrub	060A.29.1.1
		Spring Rhizomatous Grass(I), Spring Annual Grass(I), Summer Midgrass, Spring Rhizomatous Grass, Summer Tallgrass, Spring Midgrass, Summer Shortgrass	060A.29.2.1

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
60A	**Shallow Porous Clay Upland**	Porous Clay	R060AY030SD
		Shallow Clay	R060AY017SD
		Shallow Porous Clay	R060AY043SD
		Plant Community Class Names	**Plant Community Class ID**
		Summer Midgrass, Spring Rhizomatous Grass, Summer Tallgrass, Summer Perennial Forb, Spring Perennial Forb, Spring Midgrass, Spring Perennial Grasslike	060A.33.1.1
		Summer Stoloniferous Grass, Summer Shortgrass, Spring Rhizomatous Grass, Spring Perennial Grasslike, Spring Annual Grass, Spring Midgrass, Summer Tallgrass	060A.33.1.2
		Ecological Site Community: Summer Midgrass, Spring Rhizomatous Grass, Spring Perennial Grasslike, Summer Tallgrass, Evergreen Tree	060A.33.2.1

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
60A	**Shallow Porous Clay Upland** (Continued)	Spring Annual Grass(I), Spring Rhizomatous Grass, Summer Stoloniferous Grass, Spring Midgrass(I), Summer Perennial Forb(I), Spring Midgrass, Summer Shortgrass	060A.33.3.1

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
60A	**Shallow Upland**	Claypan	R060AY013SD
		Dense Clay	R060AY018SD
		Saline Upland	R060AY026SD
		Shallow Dense Clay	R060AY025SD
		Shallow Loamy	R060AY024SD
		Thin Claypan	R060AY015SD
		Thin Upland	R060AY012SD
		Plant Community Class Names	**Plant Community Class ID**
		Spring Rhizomatous Grass, Spring Midgrass, Summer Perennial Forb, Spring Perennial Forb, Summer Shortgrass, Summer Midgrass, Evergreen Subshrub	060A.18.1.1
		Summer Stoloniferous Grass, Summer Perennial Forb, Spring Perennial Grasslike, Spring Rhizomatous Grass, Summer Shortgrass, Spring Midgrass, Summer Midgrass	060A.18.1.2
		Spring Rhizomatous Grass, Evergreen Shrub, Cacti, Evergreen Subshrub, Spring Annual Grass(I), Summer Perennial Forb, Deciduous Subshrub	060A.18.2.1
		Spring Rhizomatous Grass, Summer Stoloniferous Grass, Summer Perennial Forb(I), Spring Annual Grass(I), Summer Shortgrass, Spring Annual Forb(I), Spring Midgrass(I)	060A.18.3.1

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
60A	**Very Shallow Upland**	Very Shallow	R060AY016SD
		Shallow Sandy	R060AY044SD
		Plant Community Class Names	**Plant Community Class ID**
		Spring Midgrass, Summer Midgrass, Summer Perennial Forb, Spring Perennial Forb, Spring Rhizomatous Grass, Summer Tallgrass, Summer Shortgrass	060A.32.1.1

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
60A	**Wet Bottomland**	Subirrigated	R060AY003SD
		Wetland	R060AY002SD
		Plant Community Class Names	**Plant Community Class ID**
		Summer Tallgrass, Spring Perennial Grasslike, Spring Midgrass, Spring Rhizomatous Grass, Summer Perennial Forb, Summer Annual Grass, Spring Shortgrass	060A.22.1.1

APPENDIX B. MLRA 60A, ECOLOGICAL SITE CLASS AND COMMUNITY CLASS SUMMARY

Site Class Name	**State**	**Comm Class ID**	**ESD Comm Class**	**ESD** Lbs/Ac	**NRI Community Class**	**NRI Dominant Species** (Symbol)(Lbs/ac)	**NRI** Lbs/ Ac	**# PSUs**
Loamy Terrace	Native Herbaceous	060A.3.1.1	Spring Rhizomatous Grass, Spring Midgrass, Summer Tallgrass, Summer Perennial Forb, Spring Perennial Forb, Deciduous Shrub, Deciduous Tree	2700	Spring Rhizomatous Grass, Spring Midgrass, Spring Perennial Forb, Evergreen Subshrub, Herbaceous Vine, Summer Stoloniferous Grass, Summer Perennial Forb	western wheatgrass(PASM), slender wheatgrass(ELTR7), green needlegrass(NAVI4), Gardner's saltbush(ATGA), American vetch(VIAM), common dandelion(TAOF), Buffalograss(BODA2), desert biscuitroot(LOFO)	2545	1
Loamy Terrace	Native Herbaceous	060A.3.1.2			Summer Stoloniferous Grass, Summer Shortgrass, Spring Perennial Grasslike, Spring Rhizomatous Grass, Spring Annual Grass(I), Spring Perennial Forb, Summer Perennial Forb	Buffalograss(BODA2), blue grama(BOGR2), sedge(CAREX), western wheatgrass(PASM), threadleaf sedge(CAFI), cheatgrass(BRTE), aster(ASTER), goldenrod(SOLID)	3468	2
Loamy Terrace	Native - Non-Native Herbaceous	060A.3.2.1			Spring Rhizomatous Grass, Summer Stoloniferous Grass, Spring Annual Grass(I), Spring Rhizomatous Grass(I), Summer Perennial Forb, Spring Midgrass(I), Evergreen Subshrub	western wheatgrass(PASM), Buffalograss(BODA2), cheatgrass(BRTE), smooth brome(BRIN2), crested wheatgrass(AGCR), white prairie aster(SYFA), broom snakeweed(GUSA2), Japanese brome(BRAR5)	3795	5
Loamy Upland	Native Herbaceous	060A.6.1.1	Spring Rhizomatous Grass, Spring Midgrass, Summer Midgrass, Summer Perennial Forb, Spring Perennial Forb, Summer Shortgrass,	1975	Spring Rhizomatous Grass, Summer Stoloniferous Grass, Spring Midgrass, Summer Shortgrass, Spring Perennial Forb, Summer Perennial Forb, Herbaceous Vine	western wheatgrass(PASM), Buffalograss(BODA2), blue grama(BOGR2), green needlegrass(NAVI4), American vetch(VIAM), sedge(CAREX), prairie Junegrass(KOMA), scarlet globemallow(SPCO)	2125	20

Site Class Name	State	Comm Class ID	ESD Comm Class	ESD Lbs/Ac	NRI Community Class	NRI Dominant Species (Symbol)(Lbs/ac)	NRI Lbs/ Ac	# PSUs
			Spring Perennial Grasslike					
Loamy Upland	Native Woody - Native Herbaceous	060A.6.2.1			Evergreen Shrub, Spring Midgrass(I), Summer Stoloniferous Grass, Spring Rhizomatous Grass, Spring Annual Grass(I), Summer Shortgrass	crested wheatgrass(AGCR), big sagebrush(ARTR2), Buffalograss(BODA2), western wheatgrass(PASM), rubber rabbitbrush(ERNA10), Japanese brome(BRAR5), blue grama(BOGR2), woolly plantain(PLPA2), field brome(BRAR5)	2401	3
Saline Bottomland	Native Herbaceous	060A.35.1.1	Spring Rhizomatous Grass, Summer Rhizomatous Grass, Spring Perennial Grasslike, Summer Midgrass, Summer Perennial Forb, Spring Perennial Forb, Summer Tallgrass	2333				
Sandy Upland	Native - Non-Native Herbaceous	060A.29.2.1			Spring Rhizomatous Grass(I), Spring Annual Grass(I), Summer Midgrass, Spring Rhizomatous Grass, Summer Tallgrass, Spring Midgrass, Summer Shortgrass	intermediate wheatgrass(THIN6), western wheatgrass(PASM), prairie sandreed(CALO), needleandthread(HECO26), alkali sacaton(SPAI), cheatgrass(BRTE), Japanese brome(BRAR5), crested wheatgrass(AGCR)	1132	4
Shallow Porous Clay Upland	Native Herbaceous	060A.33.1.1	Summer Midgrass, Spring Rhizomatous Grass, Summer Tallgrass, Summer Perennial Forb, Spring Perennial Forb, Spring Midgrass, Spring	1285	Spring Rhizomatous Grass, Summer Midgrass, Spring Midgrass, Summer Perennial Forb, Coniferous Tree, Spring Perennial Forb, Summer Shortgrass	western wheatgrass(PASM), green needlegrass(NAVI4), sideoats grama(BOCU), little bluestem(SCSC), Rocky Mountain juniper(JUSC2), prairie dropseed(SPHE), white sagebrush(ARLU), silverleaf Indian breadroot(PEAR6)	1288	3

Site Class Name	**State**	**Comm Class ID**	**ESD Comm Class**	**ESD** Lbs/Ac	**NRI Community Class**	**NRI Dominant Species** (Symbol)(Lbs/ac)	**NRI** Lbs/ Ac	**# PSUs**
			Perennial Grasslike					
Shallow Porous Clay Upland	Native Herbaceous	060A.33.1.2			Summer Stoloniferous Grass, Summer Shortgrass, Spring Rhizomatous Grass, Spring Perennial Grasslike, Spring Annual Grass(I), Spring Midgrass, Summer Tallgrass	Buffalograss(BODA2), blue grama(BOGR2), western wheatgrass(PASM), threadleaf sedge(CAFI), Japanese brome(BRAR5), green needlegrass(NAVI4), big bluestem(ANGE), crested wheatgrass(AGCR)	2202	2
Shallow Porous Clay Upland	Native Herbaceous - Native Woody	060A.33.2.1	Ecological Site Community: Summer Midgrass, Spring Rhizomatous Grass, Spring Perennial Grasslike, Summer Tallgrass, Evergreen Tree					
Shallow Porous Clay Upland	Native - Non-Native Herbaceous	060A.33.3.1			Spring Annual Grass(I), Spring Rhizomatous Grass, Summer Stoloniferous Grass, Spring Midgrass(I), Summer Perennial Forb(I), Spring Midgrass, Summer Shortgrass	cheatgrass(BRTE), western wheatgrass(PASM), buffalograss(BODA2), crested wheatgrass(AGCR), sweetclover(MEOF), needleandthread(HECO26), blue grama(BOGR2), sedge(CAREX)	1765	9
Shallow Upland	Native Herbaceous	060A.18.1.1	Spring Rhizomatous Grass, Spring Midgrass, Summer Perennial Forb, Spring Perennial Forb, Summer Shortgrass, Summer Midgrass, Evergreen Subshrub	1083	Spring Rhizomatous Grass, Summer Stoloniferous Grass, Summer Midgrass, Spring Midgrass, Spring Perennial Forb, Summer Perennial Forb, Spring Perennial Grasslike	western wheatgrass(PASM), buffalograss(BODA2), sideoats grama(BOCU), needleandthread(HECO26), sedge(CAREX), little bluestem(SCSC), Montana wheatgrass(ELAL7), green needlegrass(NAVI4)	1278	20

Site Class Name	State	Comm Class ID	ESD Comm Class	ESD Lbs/Ac	NRI Community Class	NRI Dominant Species (Symbol)(Lbs/ac)	NRI Lbs/ Ac	# PSUs
Shallow Upland	Native Herbaceous	060A.18.1.2			Summer Stoloniferous Grass, Summer Perennial Forb, Spring Perennial Grasslike, Spring Rhizomatous Grass, Summer Shortgrass, Spring Midgrass, Summer Midgrass	Buffalograss(BODA2), sedge(CAREX), western wheatgrass(PASM), blue grama(BOGR2), slimflower scurfpea(PSTE5), dotted blazing star(LIPU), sideoats grama(BOCU), threadleaf sedge(CAFI)	1650	8
Shallow Upland	Native Woody - Native Herbaceous	060A.18.2.1			Spring Rhizomatous Grass, Evergreen Shrub, Cacti, Evergreen Subshrub, Spring Annual Grass(I), Summer Perennial Forb, Deciduous Subshrub	big sagebrush(ARTR2), western wheatgrass(PASM), Montana wheatgrass(ELAL7), Opuntia spp.(OPUNT), Nuttall's saltbush(ATNU2), Japanese brome(BRAR5), branched false goldenweed(OOMU), knotweed(POLYG4)	863	3
Shallow Upland	Native - Non-Native Herbaceous	060A.18.3.1			Spring Rhizomatous Grass, Summer Stoloniferous Grass, Summer Perennial Forb(I), Spring Annual Grass(I), Summer Shortgrass, Spring Annual Forb(I), Spring Midgrass(I)	western wheatgrass(PASM), Buffalograss(BODA2), sweetclover(MEOF), blue grama(BOGR2), crested wheatgrass(AGCR), Japanese brome(BRAR5), sweetclover(MELIL), cheatgrass(BRTE), field brome(BRAR5)	1726	23
Very Shallow Upland	Native Herbaceous	060A.32.1.1	Spring Midgrass, Summer Midgrass, Summer Perennial Forb, Spring Perennial Forb, Spring Rhizomatous Grass, Summer Tallgrass, Summer Shortgrass	1050				

Site Class Name	**State**	**Comm Class ID**	**ESD Comm Class**	**ESD** Lbs/Ac	**NRI Community Class**	**NRI Dominant Species** (Symbol)(Lbs/ac)	**NRI** Lbs/ Ac	**# PSUs**
Wet Bottomland	Native Herbaceous - Native Woody	060A.22.1.1	Summer Tallgrass, Spring Perennial Grasslike, Spring Midgrass, Spring Rhizomatous Grass, Summer Perennial Forb, Summer Annual Grass, Spring Shortgrass	4900	Summer Tallgrass, Deciduous Shrub, Summer Perennial Forb, Spring Rhizomatous Grass(I), Lichen	prairie cordgrass(SPPE), western snowberry(SYOC), Canada goldenrod(SOCA6), smooth brome(BRIN2), smooth sumac(RHGL), Woods' rose(ROWO), biological crust(SDH_BIO)	4029	1

APPENDIX C. MLRA 60A, NRI PERCENT COVER VALUES BY COMMUNITY CLASS

Site Class Name	Comm Class ID	Bunch-grass	Sodgrass	Shrub	Forb + AnnGrass	Lichen	BareGrnd	Rock	Litter	Basal	Avg Plant Ht (ft)	Avg % Slope
Loamy Terrace	060A.3.1.2	5%	47%	3%	43%	1%	9%	0%	58%	29%	0.66	7
	Summer Stoloniferous Grass, Summer Shortgrass, Spring Perennial Grasslike, Spring Rhizomatous Grass, Spring Annual Grass(I), Spring Perennial Forb, Summer Perennial Forb											
Loamy Terrace	060A.3.2.1	1%	77%	0%	22%	0%	8%	0%	81%	8%	1.48	3
	Spring Rhizomatous Grass, Summer Stoloniferous Grass, Spring Annual Grass(I), Spring Rhizomatous Grass(I), Summer Perennial Forb, Spring Midgrass(I), Evergreen Subshrub											
Loamy Upland	060A.6.1.1	16%	36%	0%	12%	0%	27%	1%	66%	1%	1.05	5
	Spring Rhizomatous Grass, Summer Stoloniferous Grass, Spring Midgrass, Summer Shortgrass, Spring Perennial Forb, Summer Perennial Forb, Herbaceous Vine											
Loamy Upland	060A.6.2.1	9%	13%	5%	57%	0%	7%	4%	86%	2%	0.95	3
	Evergreen Shrub, Spring Midgrass(I), Summer Stoloniferous Grass, Spring Rhizomatous Grass, Spring Annual Grass(I), Summer Shortgrass											
Sandy Upland	060A.29.2.1	4%	28%	9%	42%	0%	31%	0%	40%	0%	1.03	1
	Spring Rhizomatous Grass(I), Spring Annual Grass(I), Summer Midgrass, Spring Rhizomatous Grass, Summer Tallgrass, Spring Midgrass, Summer Shortgrass											
Shallow Porous Clay Upland	060A.33.1.1	28%	17%	26%	4%	0%	61%	4%	11%	1%	1.41	15
	Spring Rhizomatous Grass, Summer Midgrass, Spring Midgrass, Summer Perennial Forb, Coniferous Tree, Spring Perennial Forb, Summer Shortgrass											
Shallow Porous Clay Upland	060A.33.3.1	8%	13%	19%	53%	0%	19%	2%	65%	7%	1.37	16
	Spring Annual Grass(I), Spring Rhizomatous Grass, Summer Stoloniferous Grass, Spring Midgrass(I), Summer Perennial Forb(I), Spring Midgrass, Summer Shortgrass											
Shallow Upland	060A.18.1.1	14%	39%	4%	16%	2%	44%	2%	41%	4%	0.87	6
	Spring Rhizomatous Grass, Summer Stoloniferous Grass, Summer Midgrass, Spring Midgrass, Spring Perennial Forb, Summer Perennial Forb, Spring Perennial Grasslike											
Shallow Upland	060A.18.1.2	27%	37%	4%	6%	2%	51%	4%	15%	8%	0.61	7
	Summer Stoloniferous Grass, Summer Perennial Forb, Spring Perennial Grasslike, Spring Rhizomatous Grass, Summer Shortgrass, Spring Midgrass, Summer Midgrass											
Shallow Upland	060A.18.2.1	4%	23%	13%	10%	1%	67%	1%	27%	2%	0.74	3
	Spring Rhizomatous Grass, Evergreen Shrub, Cacti, Evergreen Subshrub, Spring Annual Grass(I), Summer Perennial Forb, Deciduous Subshrub											
Shallow Upland	060A.18.3.1	18%	37%	3%	31%	0%	11%	1%	71%	6%	0.94	15
	Spring Rhizomatous Grass, Summer Stoloniferous Grass, Summer Perennial Forb(I), Spring Annual Grass(I), Summer Shortgrass, Spring Annual Forb(I), Spring Midgrass(I)											

APPENDIX D. MLRA 60A, REPRESENTATIVE SOIL MAP UNIT COMPONENTS

Loamy Terrace Ecological Site Class

Area Symbol	Soil Survey Area	Map Unit	Component	Component Acres
SD019	Butte County, South Dakota	Sr	Stetter	23865
SD047	Fall River County, South Dakota	Lo	Lohmiller	17934
SD600	Meade County, South Dakota, Southern Part	St	Stetter	14568
SD606	Custer and Pennington Counties Area, Prairie Parts, South Dakota	Lo	Lohmiller	11823
SD019	Butte County, South Dakota	Ss	Stetter	10548

Loamy Upland Ecological Site Class

Area Symbol	Soil Survey Area	Map Unit	Component	Component Acres
SD047	Fall River County, South Dakota	PeB	Pierre	95867
SD600	Meade County, South Dakota, Southern Part	KbB	Kyle	40885
SD600	Meade County, South Dakota, Southern Part	NcA	Nunn	37719
SD019	Butte County, South Dakota	PrB	Pierre	32748
SD019	Butte County, South Dakota	KlB	Kyle	24153.

Saline Bottomland Ecological Site Class

Area Symbol	Soil Survey Area	Map Unit	Component	Component Acres
SD019	Butte County, South Dakota	Sb	Sage	6062
SD019	Butte County, South Dakota	WnB	Sage	3861
SD019	Butte County, South Dakota	Lo	Sage	2046
SD600	Meade County, South Dakota, Southern Part	SkB	Hoven	1474
SD063	Harding County, South Dakota	SbA	Sage	1216

Sandy Upland Ecological Site Class

Area Symbol	Soil Survey Area	Map Unit	Component	Component Acres
SD047	Fall River County, South Dakota	AsB	Ascalon	15099
SD047	Fall River County, South Dakota	VaE	Valent	11612
SD600	Meade County, South Dakota, Southern Part	AsB	Assinniboine	8801
SD600	Meade County, South Dakota, Southern Part	Ba	Bankard	5916
SD047	Fall River County, South Dakota	JaB	Jayem	5845

Shallow Porous Clay Upland Ecological Site Class

Area Symbol	Soil Survey Area	Map Unit	Component	Component Acres
SD606	Custer and Pennington Counties Area, Prairie Parts, South Dakota	SbF	Samsil	91332
SD600	Meade County, South Dakota, Southern Part	SaE	Samsil	56774
SD047	Fall River County, South Dakota	SaE	Samsil	20946
SD601	Meade County, South Dakota, Northern Part	SaD	Samsil	19457
SD047	Fall River County, South Dakota	MpE	Midway	14753

Shallow Upland Ecological Site Class

Area Symbol	Soil Survey Area	Map Unit	Component	Component Acres
SD019	Butte County, South Dakota	ToB	Twotop	27211
SD019	Butte County, South Dakota	EpD	Epsie	12400
SD047	Fall River County, South Dakota	SnE	Shingle	12135
SD606	Custer and Pennington Counties Area, Prairie Parts, South Dakota	BfA	Beckton	10457
SD600	Meade County, South Dakota, Southern Part	SwB	Swanboy	9820

Very Shallow Upland Ecological Site Class

Area Symbol	Soil Survey Area	Map Unit	Component	Component Acres
SD606	Custer and Pennington Counties Area, Prairie Parts, South Dakota	StE	Schamber	4787
SD606	Custer and Pennington Counties Area, Prairie Parts, South Dakota	NeD	Nihill	528
SD606	Custer and Pennington Counties Area, Prairie Parts, South Dakota	EnD	Nihill	281
SD019	Butte County, South Dakota	RdE	Schamber	117

Wet Bottomland Ecological Site Class

Area Symbol	Soil Survey Area	Map Unit	Component	Component Acres
SD047	Fall River County, South Dakota	N658E	Herdcamp	1931
SD613	Shannon County Area, South Dakota	N658E	Herdcamp	474
SD600	Meade County, South Dakota, Southern Part	Le	Herdcamp	174
SD019	Butte County, South Dakota	Gh	Herdcamp	74

APPENDIX E. MLRA 60A, COMMON PLANTS AND FUNCTIONAL GROUPS

Common Name	Accepted Symbol	Scientific Name	Functional Group
alfalfa	MEDIC	Medicago	Spring Perennial Forb(I)
alfalfa	MESA	Medicago sativa	Spring Perennial Forb(I)
alkali sacaton	SPAI	Sporobolus airoides	Summer Midgrass
alpine golden buckwheat	ERFL4	Eriogonum flavum	Summer Perennial Forb
Alyssum	ALYSS	Alyssum	Spring Annual Forb(I)
alyssumleaf phlox	PHAL3	Phlox alyssifolia	Spring Perennial Forb
American bird's-foot trefoil	LOUN	Lotus unifoliolatus	Summer Annual Forb
American licorice	GLLE3	Glycyrrhiza lepidota	Summer Perennial Forb
American milkvetch	ASAM3	Astragalus americanus	Summer Perennial Forb
American sloughgrass	BESY	Beckmannia syzigachne	Summer Annual Grass
American vetch	VIAM	Vicia americana	Herbaceous Vine
annual ragweed	AMAR2	Ambrosia artemisiifolia	Summer Annual Forb
aromatic aster	SYOB	Symphyotrichum oblongifolium	Summer Perennial Forb
wormwood	ARTEM	Artemisia	Evergreen Shrub
aster	ASTER	Aster	Spring Perennial Forb
aster	SYMPH4	Symphyotrichum	Summer Perennial Forb
ballhead ipomopsis	IPCO5	Ipomopsis congesta	Summer Perennial Forb
Baltic rush	JUARL	Juncus balticus	Spring Perennial Grasslike
bastard toadflax	COUM	Comandra umbellata	Spring Perennial Forb
beaked spikerush	ELRO2	Eleocharis rostellata	Summer Perennial Grasslike
bearded wheatgrass	ELTRS	Elymus subsecundus	Summer Perennial Grasslike
bearded wheatgrass	ELCA11	Elymus caninus	Spring Tallgrass(I)
bedstraw	GALIU	Galium	Spring Perennial Forb
big bluestem	ANGE	Andropogon gerardii	Summer Tallgrass
big sagebrush	ARTR2	Artemisia tridentata	Evergreen Shrub
bighead pygmycudweed	EVPR	Evax prolifera	Spring Annual Forb
bindweed	CONVO	Convolvulus	Summer Perennial Forb(I)
bird's-foot trefoil	LOCO6	Lotus corniculatus	Spring Perennial Forb(I)
black medick	MELU	Medicago lupulina	Summer Annual Forb(I)
blacksamson echinacea	ECAN2	Echinacea angustifolia	Summer Perennial Forb
bladderpod	LESQU	Lesquerella	Spring Perennial Forb
blazing star	LIATR	Liatris	Summer Perennial Forb
blue flax	LIPE2	Linum perenne	Summer Perennial Forb(I)
blue grama	BOGR2	Bouteloua gracilis	Summer Shortgrass
blue lettuce	LATA	Lactuca tatarica	Summer Perennial Forb
bluebunch wheatgrass	PSSP6	Pseudoroegneria spicata	Spring Midgrass
borage	BORAG	Borage	Spring Annual Forb
branched false goldenweed	OOMU	Oonopsis multicaulis	Deciduous Subshrub

Common Name	Accepted Symbol	Scientific Name	Functional Group
breadroot	PEDIO2	Pediomelum	Spring Perennial Forb
bristlegrass	SETAR	Setaria	Summer Midgrass
brittle pricklypear	OPFR	Opuntia fragilis	Cacti
broadbeard beardtongue	PEAN4	Penstemon angustifolius	Spring Perennial Forb
broom snakeweed	GUSA2	Gutierrezia sarothrae	Evergreen Subshrub
buckwheat	ERIOG	Eriogonum	Spring Perennial Forb
buffaloberry	SHEPH	Shepherdia	Deciduous Shrub
buffalobur nightshade	SORO	Solanum rostratum	Spring Annual Forb
buffalograss	BODA2	Bouteloua dactyloides	Summer Stoloniferous Grass
Buffalograss	BODA2	Buchloe dactyloides	Summer Stoloniferous Grass
bulrush	SCHOE6	Schoenoplectus	Summer Perennial Grasslike
California seablite	SUCA	Suaeda californica	Evergreen Subshrub
Canada bluegrass	POCO	Poa compressa	Spring Rhizomatous Grass(I)
Canada goldenrod	SOCA6	Solidago canadensis	Summer Perennial Forb
Canada thistle	CIAR4	Cirsium arvense	Summer Perennial Forb(I)
Canada wildrye	ELCA4	Elymus canadensis	Spring Midgrass
Canadian anemone	ANCA8	Anemone canadensis	Spring Perennial Forb
Canadian horseweed	COCA5	Conyza canadensis	Spring Annual Forb
candle anemone	ANCY	Anemone cylindrica	Summer Perennial Forb
Carolina draba	DRRE2	Draba reptans	Spring Annual Forb
catchfly	SILEN	Silene	Spring Annual Forb
cheatgrass	BRTE	Bromus tectorum	Spring Annual Grass(I)
chokecherry	PRVI	Prunus virginiana	Deciduous Shrub
cinquefoil	POTEN	Potentilla	Summer Perennial Forb
climbing false buckwheat	POSC3	Polygonum scandens	Herbaceous Vine
clover	TRIFO	Trifolium	Spring Perennial Forb
clustered field sedge	CAPR5	Carex praegracilis	Spring Perennial Grasslike
common barley	HOVU	Hordeum vulgare	Spring Annual Grass
common chickweed	STME2	Stellaria media	Spring Annual Forb(I)
common dandelion	TAOF	Taraxacum officinale	Spring Perennial Forb
common milkweed	ASSY	Asclepias syriaca	Summer Perennial Forb
common mouse-ear chickweed	CEFO2	Cerastium fontanum	Summer Perennial Forb(I)
common pepperweed	LEDE	Lepidium densiflorum	Spring Annual Forb
common snowberry	SYAL	Symphoricarpos albus	Deciduous Shrub
common spikerush	ELPA3	Eleocharis palustris	Spring Perennial Grasslike
common starlily	LEMO4	Leucocrinum montanum	Spring Perennial Forb
common sunflower	HEAN3	Helianthus annuus	Summer Annual Forb
common wheat	TRAE	Triticum aestivum	Spring Annual Grass(I)

Common Name	Accepted Symbol	Scientific Name	Functional Group
common yarrow	ACMI2	Achillea millefolium	Spring Perennial Forb
common yellow oxalis	OXST	Oxalis stricta	Summer Perennial Forb
coneflower	RATIB	Ratibida	Summer Perennial Forb
coneflower	ECHIN	Echinacea	Summer Perennial Forb
Conyza	CONYZ	Conyza	Spring Annual Forb
creeping jenny	LYNU	Lysimachia nummularia	Summer Perennial Forb(I)
creeping juniper	JUHO2	Juniperus horizontalis	Evergreen Shrub
creeping meadow foxtail	ALAR	Alopecurus arundinaceus	Spring Rhizomatous Grass(I)
crested wheatgrass	AGCR	Agropyron cristatum	Spring Midgrass(I)
curly dock	RUCR	Rumex crispus	Spring Perennial Forb(I)
curlycup gumweed	GRSQ	Grindelia squarrosa	Summer Annual Forb
curlytop knotweed	POLA4	Polygonum lapathifolium	Summer Annual Forb
currant	RIBES	Ribes	Deciduous Shrub
Cusick's bluegrass	POCU3	Poa cusickii	Spring Perennial Grasslike
Dalea spp.	DALEA	Dalea	Deciduous Subshrub
davy mannagrass	GLLE2	Glyceria leptostachya	Spring Midgrass
deathcamas	ZIGAD	Zigadenus	Spring Perennial Forb
desert biscuitroot	LOFO	Lomatium foeniculaceum	Spring Perennial Forb
dotted blazing star	LIPU	Liatris punctata	Summer Perennial Forb
dwarf false indigo	AMNA	Amorpha nana	Deciduous Subshrub
eastern pasqueflower	PUPA5	Pulsatilla patens	Spring Perennial Forb
eastern poison ivy	TORA2	Toxicodendron radicans	Deciduous Subshrub
Evening Primrose	OENOT	Oenothera	Spring Perennial Forb
fall rosette grass	DIWI5	Dichanthelium wilcoxianum	Summer Shortgrass
false boneset	BREU	Brickellia eupatorioides	Summer Perennial Forb
false flax	CAMEL	Camelina	Summer Annual Forb
false pennyroyal	HEDEO	Hedeoma	Summer Annual Grass(I)
fescue	FESTU	Festuca	Spring Midgrass
fetid marigold	DYPA	Dyssodia papposa	Summer Annual Forb
field bindweed	COAR4	Convolvulus arvensis	Summer Perennial Forb(I)
field chickweed	CEAR4	Cerastium arvense	Summer Perennial Forb
field pennycress	THAR5	Thlaspi arvense	Spring Annual Forb(I)
field pepperweed	LECA5	Lepidium campestre	Spring Annual Forb(I)
field pussytoes	ANNE	Antennaria neglecta	Spring Perennial Forb
field sagewort	ARCAB4	Artemisia campestris ssp. borealis var. borealis	Summer Perennial Forb
field sagewort	ARCA12	Artemisia campestris	Summer Perennial Forb
field sowthistle	SOAR2	Sonchus arvensis	Summer Perennial Forb(I)
fireberry hawthorn	CRCH	Crataegus chrysocarpa	Deciduous Shrub
flax	LINUM	Linum	Spring Perennial Forb

Common Name	Accepted Symbol	Scientific Name	Functional Group
fleabane	ERIGE2	Erigeron	Summer Perennial Forb
flexile milkvetch	ASFL2	Astragalus flexuosus	Summer Perennial Forb
Flodman's thistle	CIFL	Cirsium flodmanii	Summer Perennial Forb
foothill arnica	ARFU3	Arnica fulgens	Spring Perennial Forb
fourwing saltbush	ATCA2	Atriplex canescens	Evergreen Shrub
fowl bluegrass	POPA2	Poa palustris	Spring Midgrass
foxtail barley	HOJU	Hordeum jubatum	Spring Shortgrass
Gardner's saltbush	ATGA	Atriplex gardneri	Evergreen Subshrub
goatsbeard	TRAGO	Tragopogon	Summer Perennial Forb
goldenaster	CHRYS7	Chrysopsis	Summer Perennial Forb
goldenrod	SOLID	Solidago	Spring Perennial Forb
goosefoots	CHENO	Chenopodium	Spring Annual Forb
greasewood	SAVE4	Sarcobatus vermiculatus	Evergreen Shrub
green ash	FRPE	Fraxinus pennsylvanica	Deciduous Tree
green carpetweed	MOVE	Mollugo verticillata	Spring Annual Forb
green dragon	ARDR3	Arisaema dracontium	Spring Perennial Forb
green molly	BAAM4	Kochia americana	Evergreen Subshrub
green needlegrass	NAVI4	Nassella viridula	Spring Midgrass
groundplum milkvetch	ASCR2	Astragalus crassicarpus	Spring Perennial Forb
hairy false goldenaster	HEVI4	Heterotheca villosa	Spring Perennial Forb
hairy grama	BOHI2	Bouteloua hirsuta	Summer Shortgrass
hardstem bulrush	SCAC3	Schoenoplectus acutus	Spring Perennial Grasslike
Heller's rosette grass	DIOL	Dichanthelium oligosanthes	Spring Midgrass
herb sophia	DESO2	Descurainia sophia	Spring Annual Forb
hoary fleabane	ERCA4	Erigeron canus	Summer Perennial Forb
hoary puccoon	LICA12	Lithospermum canescens	Spring Perennial Forb
Horsetail	EQUIS	Equisetum	Spring Perennial Grasslike
Indiangrass	SONU2	Sorghastrum nutans	Summer Tallgrass
Indianhemp	APCA	Apocynum cannabinum	Summer Perennial Forb
inland rush	JUIN2	Juncus interior	Spring Perennial Grasslike
inland saltgrass	DISP	Distichlis spicata	Summer Rhizomatous Grass
intermediate wheatgrass	THIN6	Thinopyrum intermedium	Spring Rhizomatous Grass(I)
Japanese brome	BRAR5	Bromus japonicus	Spring Annual Grass(I)
Juniper	JUNIP	Juniperus	Coniferous Tree
Kentucky bluegrass	POPR	Poa pratensis	Spring Rhizomatous Grass(I)
knotweed	POLYG4	Polygonum	Summer Perennial Forb
kochia	BASC5	Kochia scoparia	Spring Annual Forb(I)
lacy tansyaster	MAPI	Machaeranthera pinnatifida	Spring Perennial Forb
lambsquarters	CHAL7	Chenopodium album	Spring Annual Forb
lambstongue ragwort	SEIN2	Senecio integerrimus	Spring Perennial Forb

Common Name	Accepted Symbol	Scientific Name	Functional Group
large Indian breadroot	PEES	Pediomelum esculentum	Summer Perennial Forb
leadplant	AMCA6	Amorpha canescens	Deciduous Subshrub
leafy spurge	EUES	Euphorbia esula	Summer Perennial Forb(I)
lemon scurfpea	PSLA3	Psoralidium lanceolatum	Spring Perennial Forb
lesser spikemoss	SEDE2	Selaginella densa	Fern
lettuce	LACTU	Lactuca	Summer Annual Forb(I)
lilac penstemon	PEGR5	Penstemon gracilis	Spring Perennial Forb
little barley	HOPU	Hordeum pusillum	Spring Annual Grass
little bluestem	SCSC	Schizachyrium scoparium	Summer Midgrass
littleleaf pussytoes	ANMI3	Antennaria microphylla	Spring Perennial Forb
littlepod false flax	CAMI2	Camelina microcarpa	Spring Annual Forb(I)
locoweed	OXYTR	Oxytropis	Spring Annual Forb
longbract spiderwort	TRBR	Tradescantia bracteata	Summer Perennial Forb
longleaf phlox	PHLO2	Phlox longifolia	Spring Perennial Forb
long-stolon sedge	CAIN9	Carex inops	Spring Perennial Grasslike
Louisiana broomrape	ORLU	Orobanche ludoviciana	Summer Perennial Forb
maidenstears	SIVU	Silene vulgaris	Summer Perennial Forb(I)
marsh muhly	MURA	Muhlenbergia racemosa	Spring Rhizomatous Grass
mat muhly	MURI	Muhlenbergia richardsonis	Summer Rhizomatous Grass
matted sandmat	CHSE4	Chamaesyce serpens	Summer Annual Forb
meadow zizia	ZIAP	Zizia aptera	Spring Perennial Forb
milfoil	ACHIL	Achillea	Spring Perennial Forb
milfoil wattle	ACMI	Acacia millefolia	Deciduous Shrub
milkvetch	ASTRA	Astragalus	Spring Perennial Forb
milkweed	ASCLE	Asclepias	Spring Perennial Forb
mint	MENTH	Mentha	Spring Perennial Forb(I)
Missouri goldenrod	SOMI2	Solidago missouriensis	Summer Perennial Forb
Missouri milkvetch	ASMI10	Astragalus missouriensis	Spring Perennial Forb
Montana wheatgrass	ELAL7	Elymus albicans	Summer Rhizomatous Grass
mountain big sagebrush	ARTRV	Artemisia tridentata ssp. vaseyana	Evergreen Shrub
mouse-ear chickweed	CERAS	Cerastium	Summer Annual Forb(I)
mustard	BRASS2	Brassica	Spring Annual Forb(I)
muttongrass	POFE	Poa fendleriana	Spring Shortgrass
Nailwort	PARON	Paronychia	Summer Perennial Forb
narrowleaf goosefoot	CHLE4	Chenopodium leptophyllum	Summer Annual Forb
narrowleaf stoneseed	LIIN2	Lithospermum incisum	Spring Annual Forb
needleandthread	HECO26	Hesperostipa comata	Spring Midgrass
needleandthread	HECOC8	Hesperostipa comata ssp. comata	Spring Midgrass
needlegrass	HESPE11	Hesperostipa	Spring Midgrass

Common Name	Accepted Symbol	Scientific Name	Functional Group
needleleaf sedge	CADU6	Carex duriuscula	Summer Perennial Grasslike
New England aster	SYNO2	Symphyotrichum novae-angliae	Summer Perennial Forb
nightshade	SOLAN	Solanum	Spring Perennial Forb
northern bedstraw	GABO2	Galium boreale	Spring Perennial Forb
Norwegian cinquefoil	PONO3	Potentilla norvegica	Summer Annual Forb
Nuttall's alkaligrass	PUNU2	Puccinellia nuttalliana	Spring Rhizomatous Grass
Nuttall's saltbush	ATNU2	Atriplex nuttallii	Evergreen Shrub
oak	QUERC	Quercus	Evergreen Tree
obtuse sedge	CAOB4	Carex obtusata	Summer Perennial Grasslike
old man's whiskers	GETR	Geum triflorum	Spring Perennial Forb
Onion spp.	ALLIU	Allium	Spring Perennial Forb
Opuntia spp.	OPUNT	Opuntia	Cacti
orchardgrass	DAGL	Dactylis glomerata	Spring Midgrass(I)
other introduced annual forbs	2FA		Spring Annual Forb(I)
other native annual forbs	2FA		Spring Annual Forb
other native perennial forbs	2FP		Spring Perennial Forb
pale agoseris	AGGL	Agoseris glauca	Spring Perennial Forb
pasqueflower	PULSA	Pulsatilla	Spring Perennial Forb
peachleaf willow	SAAM2	Salix amygdaloides	Deciduous Shrub
Pennsylvania cinquefoil	POPE8	Potentilla pensylvanica	Summer Perennial Forb
Pennsylvania sedge	CAPE6	Carex pensylvanica	Spring Perennial Grasslike
pennycress	MICRO18	Microthlaspi	Spring Annual Forb(I)
pennycress	THLAS	Thlaspi	Spring Perennial Forb(I)
Penstemon spp.	PENST	Penstemon	Summer Perennial Forb
pepperweed	LEPID	Lepidium	Spring Annual Forb
Philadelphia fleabane	ERPH	Erigeron philadelphicus	Spring Perennial Forb
phlox	PHLOX	Phlox	Spring Perennial Forb
plains bluegrass	POAR3	Poa arida	Spring Rhizomatous Grass
plains milkvetch	ASGI5	Astragalus gilviflorus	Spring Perennial Forb
plains milkweed	ASPU	Asclepias pumila	Summer Perennial Forb
plains muhly	MUCU3	Muhlenbergia cuspidata	Summer Midgrass
plains pricklypear	OPPO	Opuntia polyacantha	Cacti
plains reedgrass	CAMO	Calamagrostis montanensis	Summer Rhizomatous Grass
Plantago spp.	PLANT	Plantago	Spring Annual Forb
porcupinegrass	HESP11	Hesperostipa spartea	Spring Midgrass
prairie bluebells	MELA3	Mertensia lanceolata	Spring Perennial Forb
prairie cordgrass	SPPE	Spartina pectinata	Summer Tallgrass
prairie dropseed	SPHE	Sporobolus heterolepis	Summer Midgrass

Common Name	Accepted Symbol	Scientific Name	Functional Group
prairie fleabane	ERST3	Erigeron strigosus	Summer Annual Forb
prairie Junegrass	KOMA	Koeleria macrantha	Spring Midgrass
prairie rose	ROAR3	Rosa arkansana	Deciduous Subshrub
prairie sagewort	ARFR4	Artemisia frigida	Evergreen Subshrub
prairie sandreed	CALO	Calamovilfa longifolia	Summer Tallgrass
prairie spiderwort	TROC	Tradescantia occidentalis	Summer Perennial Forb
prairie thermopsis	THRH	Thermopsis rhombifolia	Spring Perennial Forb
prairie threeawn	AROL	Aristida oligantha	Summer Midgrass
prairie wedgescale	SPOB	Sphenopholis obtusata	Spring Annual Grass(I)
prickly lettuce	LASE	Lactuca serriola	Spring Annual Forb(I)
prickly rose	ROAC	Rosa acicularis	Deciduous Subshrub
Prunus spp.	PRUNU	Prunus	Deciduous Shrub
purple dalea	DALA4	Dalea lasiathera	Spring Perennial Forb
purple locoweed	OXLA3	Oxytropis lambertii	Summer Perennial Forb
purple meadow-rue	THDA	Thalictrum dasycarpum	Spring Perennial Forb
purple milkvetch	ASAG2	Astragalus agrestis	Spring Perennial Forb
purple prairie clover	DAPU5	Dalea purpurea	Summer Perennial Forb
purple threeawn	ARPU9	Aristida purpurea	Summer Midgrass
Pursh seepweed	SUCA2	Suaeda calceoliformis	Summer Annual Forb
pussytoes	ANTEN	Antennaria	Spring Perennial Forb
pygmyflower rockjasmine	ANSE4	Androsace septentrionalis	Summer Annual Forb
quackgrass	ELRE4	Elymus repens	Spring Rhizomatous Grass(I)
rabbitbrush	CHRYS9	Chrysothamnus	Evergreen Shrub
rabbit-tobacco	PSOB3	Pseudognaphalium obtusifolium	Summer Annual Forb
ragweed	AMBRO	Ambrosia	Summer Annual Forb
rayless alkali aster	SYCI2	Symphyotrichum ciliatum	Summer Annual Forb
rayless sunflower	HERA	Helianthus radula	Summer Perennial Forb
reed canarygrass	PHAR3	Phalaris arundinacea	Spring Rhizomatous Grass
reedgrass	CALAM	Calamagrostis	Summer Rhizomatous Grass
rockcress	ARABI2	Arabis	Spring Perennial Forb
rockjasmine	ANDRO3	Androsace	Summer Perennial Forb
rose	ROSA5	Rosa	Deciduous Shrub
rosy pussytoes	ANRO2	Antennaria rosea	Summer Perennial Forb
rough bentgrass	AGSC5	Agrostis scabra	Summer Midgrass
rough cocklebur	XAST	Xanthium strumarium	Spring Annual Forb
rough false pennyroyal	HEHI	Hedeoma hispida	Summer Annual Forb
rubber rabbitbrush	ERNA10	Ericameria nauseosa	Evergreen Shrub
rush	JUNCU	Juncus	Spring Perennial Grasslike
rush skeletonplant	LYJU	Lygodesmia juncea	Spring Perennial Forb
Russian thistle	SAKA	Salsola kali	Spring Annual Forb(I)
saline saltbush	ATSU2	Atriplex subspicata	Spring Annual Forb
sand bluestem	ANHA	Andropogon hallii	Summer Tallgrass

Common Name	Accepted Symbol	Scientific Name	Functional Group
sand dropseed	SPCR	Sporobolus cryptandrus	Summer Midgrass
sand muhly	MUAR2	Muhlenbergia arenicola	Summer Midgrass
sand sagebrush	ARFI2	Artemisia filifolia	Evergreen Shrub
Sandberg bluegrass	POSE	Poa secunda	Spring Shortgrass
sandcherry	PRPU3	Prunus pumila	Deciduous Shrub
sanddune wallflower	ERCA14	Erysimum capitatum	Spring Perennial Forb
scaly blazing star	LISQ	Liatris squarrosa	Summer Perennial Forb
scarlet beeblossom	GACO5	Gaura coccinea	Summer Perennial Forb
scarlet globemallow	SPCO	Sphaeralcea coccinea	Spring Perennial Forb
Schweinitz's flatsedge	CYSC3	Cyperus schweinitzii	Summer Perennial Grasslike
scouringrush horsetail	EQHY	Equisetum hyemale	Fern
scratchgrass	MUAS	Muhlenbergia asperifolia	Summer Rhizomatous Grass
scurfpea	PSORA2	Psoralidium	Spring Perennial Forb
sedge	CAREX	Carex	Spring Perennial Grasslike
seepweed	SUAED	Suaeda	Evergreen Subshrub
sheep fescue	FEOV	Festuca ovina	Spring Midgrass
shortawn foxtail	ALAE	Alopecurus aequalis	Spring Midgrass
shortbeak sedge	CABR10	Carex brevior	Spring Perennial Grasslike
shortbristle nneedleandthread	HECU9	Hesperostipa curtiseta	Spring Midgrass
shy wallflower	ERIN7	Erysimum inconspicuum	Spring Perennial Forb
Siberian elm	ULPU	Ulmus pumila	Deciduous Tree
sideoats grama	BOCU	Bouteloua curtipendula	Summer Midgrass
silver buffaloberry	SHAR	Shepherdia argentea	Deciduous Shrub
silver cinquefoil	POAR8	Potentilla argentea	Summer Perennial Forb(I)
silver sagebrush	ARCA13	Artemisia cana	Evergreen Subshrub
silverberry	ELCO	Elaeagnus commutata	Deciduous Shrub
silverleaf Indian breadroot	PEAR6	Pediomelum argophyllum	Summer Perennial Forb
silverscale saltbush	ATAR2	Atriplex argentea	Summer Annual Forb
silverweed cinquefoil	ARAN7	Argentina anserina	Spring Perennial Forb
sixweeks fescue	VUOC	Vulpia octoflora	Spring Annual Grass
skeletonplant	LYGOD	Lygodesmia	Spring Perennial Forb
skullcap	SCUTE	Scutellaria	Spring Annual Forb
skunkbush sumac	RHTR	Rhus trilobata	Deciduous Shrub
slender goldenweed	MAGR10	Machaeranthera gracilis	Spring Annual Forb
slender milkvetch	ASGR3	Astragalus gracilis	Spring Perennial Forb
slender wheatgrass	ELTR7	Elymus trachycaulus	Spring Midgrass
slimflower scurfpea	PSTE5	Psoralidium tenuiflorum	Summer Perennial Forb
small geranium	GEPU2	Geranium pusillum	Spring Annual Forb(I)
small tumbleweed mustard	SILO3	Sisymbrium loeselii	Summer Annual Forb(I)
small-flower fame flower	PHPA29	Talinum parviflorum	Summer Perennial Forb

Common Name	Accepted Symbol	Scientific Name	Functional Group
small-leaf pussytoes	ANPA4	Antennaria parvifolia	Summer Perennial Forb
smooth blue aster	SYLA3	Symphyotrichum laeve	Summer Perennial Forb
smooth brome	BRIN2	Bromus inermis	Spring Rhizomatous Grass(I)
smooth horsetail	EQLA	Equisetum laevigatum	Fern
smoothsheath sedge	CALA14	Carex laevivaginata	Summer Perennial Grasslike
snowberry	SYMPH	Symphoricarpos	Deciduous Shrub
soapweed yucca	YUGL	Yucca glauca	Monocot Shrub
spiderwort	TRADE	Tradescantia	Summer Perennial Forb
spikeoat	AVHO3	Helictotrichon hookeri	Spring Midgrass
spiny phlox	PHHO	Phlox hoodii	Spring Perennial Forb
Sporobolus spp.	SPORO	Sporobolus	Summer Midgrass
Sprengel's sedge	CASP7	Carex sprengelii	Spring Perennial Grasslike
spurge	EUPHO	Euphorbia	Summer Perennial Forb
stemless four-nerve daisy	TEAC	Tetraneuris acaulis	Summer Perennial Forb
stickseed	HACKE	Hackelia	Summer Perennial Forb
stickseeds	LAPPU	Lappula	Spring Annual Forb
sticky cinquefoil	POGL9	Potentilla glandulosa	Spring Perennial Forb
stickywilly	GAAP2	Galium aparine	Spring Annual Forb
stiff goldenrod	OLRI	Oligoneuron rigidum	Summer Perennial Forb
stiff sunflower	HEPA19	Helianthus pauciflorus	Summer Perennial Forb
stiffstem flax	LIRI	Linum rigidum	Summer Annual Forb
sunflower	HELIA3	Helianthus	Summer Annual Forb
sweetclover	MELIL	Melilotus	Spring Annual Forb(I)
sweetclover	MEOF	Melilotus officinalis	Spring Annual Forb(I)
switchgrass	PAVI2	Panicum virgatum	Summer Tallgrass
tall cinquefoil	POAR7	Potentilla arguta	Summer Perennial Forb
tall yellow sweetclover	MEAL3	Melilotus altissimus	Summer Perennial Forb(I)
tanseyleaf tansyaster	MATA2	Machaeranthera tanacetifolia	Spring Perennial Forb
tansymustard	DESCU	Descurainia	Spring Annual Forb
tarragon	ARDR4	Artemisia dracunculus	Summer Perennial Forb
textile onion	ALTE	Allium textile	Spring Perennial Forb
thickspike wheatgrass	ELLA3	Elymus lanceolatus	Spring Tallgrass
thistle	CIRSI	Cirsium	Summer Perennial Forb
threadleaf sedge	CAFI	Carex filifolia	Spring Perennial Grasslike
Threeawn	ARIST	Aristida	Summer Midgrass
trefoil	LOTUS	Lotus	Spring Perennial Forb
triangle orache	ATPR	Atriplex prostrata	Summer Annual Forb
trumpet flower	COLLO	Collomia	Summer Annual Forb
tumblegrass	SCPA	Schedonnardus paniculatus	Summer Midgrass
tumblemustard	THELY3	Thelypodiopsis	Spring Annual Forb
twistspine pricklypear	OPMA2	Opuntia macrorhiza	Cacti

Common Name	Accepted Symbol	Scientific Name	Functional Group
upright prairie coneflower	RACO3	Ratibida columnifera	Summer Perennial Forb
velvety goldenrod	SOMO	Solidago mollis	Summer Perennial Forb
vetch	VICIA	Vicia	Herbaceous Vine
violet woodsorrel	OXVI	Oxalis violacea	Spring Perennial Forb
wallflower	ERYSI	Erysimum	Spring Perennial Forb
wavyleaf thistle	CIUN	Cirsium undulatum	Summer Perennial Forb
western daisy fleabane	ERBE2	Erigeron bellidiastrum	Summer Annual Forb
western poison ivy	TORY	Toxicodendron rydbergii	Deciduous Subshrub
western ragweed	AMPS	Ambrosia psilostachya	Summer Perennial Forb
western rockjasmine	ANOC2	Androsace occidentalis	Summer Annual Forb
western snowberry	SYOC	Symphoricarpos occidentalis	Deciduous Shrub
western wheatgrass	PASM	Pascopyrum smithii	Spring Rhizomatous Grass
Wheat	TRITI	Triticum	Spring Annual Grass(I)
white ash	FRAM2	Fraxinus americana	Deciduous Tree
white heath aster	SYER	Symphyotrichum ericoides	Summer Perennial Forb
white pasqueflower	PUOC	Pulsatilla occidentalis	Spring Perennial Forb
white penstemon	PEAL2	Penstemon albidus	Spring Perennial Forb
white prairie aster	SYFA	Symphyotrichum falcatum	Summer Perennial Forb
white prairie clover	DACA7	Dalea candida	Summer Perennial Forb
white sagebrush	ARLUL2	Artemisia ludoviciana ssp. ludoviciana	Spring Perennial Forb
white sagebrush	ARLU	Artemisia ludoviciana	Summer Perennial Forb
white sweetclover	MEOF	Melilotus alba	Spring Annual Forb(I)
whitetop	CADR	Cardaria draba	Spring Perennial Forb(I)
whorled milkweed	ASVE	Asclepias verticillata	Summer Perennial Forb
whorled milkwort	POVE	Polygala verticillata	Summer Annual Forb
whorled milkwort	POAM9	Polygala ambigua	Summer Annual Forb
wild bergamot	MOFI	Monarda fistulosa	Summer Perennial Forb
wild mint	MEAR4	Mentha arvensis	Summer Perennial Forb
wild oat	AVFA	Avena fatua	Spring Annual Grass(I)
windflower	ANEMO	Anemone	Summer Perennial Forb
winterfat	KRLA2	Krascheninnikovia lanata	Evergreen Subshrub
witchgrass	PACA6	Panicum capillare	Summer Annual Grass
Woods' rose	ROWO	Rosa woodsii	Deciduous Shrub
woodsorrel	OXALI	Oxalis	Spring Perennial Forb
woolly plantain	PLPA2	Plantago patagonica	Spring Annual Forb
wormwood	ARAB3	Artemisia absinthium	Spring Perennial Forb(I)
Wyoming besseya	BEWY	Besseya wyomingensis	Spring Perennial Forb
yellow owl's-clover	ORLU2	Orthocarpus luteus	Spring Annual Forb
yellow salsify	TRDU	Tragopogon dubius	Spring Annual Forb(I)
yellow sundrops	CASE12	Calylophus serrulatus	Summer Perennial Forb
Yucca spp.	YUCCA	Yucca	Monocot Shrub

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