

10940

Western Great Plains Sandhill Steppe

BpS Model/Description Version: Aug. 2020

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Vegetation Type

Shrubland

Map Zones

31, 38

Geographic Range

This system occurs in eastern Colorado, part of southwestern Nebraska, western Kansas, southeastern Wyoming (although it's questionable whether this occurs in Wyoming). Range is essentially limited to the Central Shortgrass, Southern Shortgrass, and Central Mixedgrass Prairie ecoregions, although it may be peripheral in a few other ecoregions. The greater part of the system occurs in the Central Shortgrass Prairie Ecoregion in eastern Colorado, western Kansas, and southwestern Nebraska.

This occurs throughout most of map zone (MZ) 27 and MZ33 in Colorado, except that it is not found in ECOMAP (Cleland et al. 2007) section 332 and not much in 331Fk. In MZ27, it goes south, including ECOMAP subsection 331Bc, but not in 331Bd, excluding the 331F sections.

In eastern Colorado, this system is found in extensive tracts on Quaternary eolian deposits along the South Platte, Arikaree, and Republican rivers, between Big Sandy and Rush creeks, and along the Arkansas and Cimarron rivers, where it is contiguous with areas in Kansas (Comer et al. 2003).

For MZ31, this system occurs in ECOMAP subsections 331Fn, 332Cd, and 332Ca, but in the latter two, it is primarily just north of the North Platte River. It is in the extreme western sandhills in Nebraska, including smaller dune areas in the panhandle west of the contiguous Great Sandhills.

In MZ38, this system is likely to occur in limited areas in the western part of the zone in subsections 332Cf, 332En, and 331Cd.

Biophysical Site Description

The area is dissected by several rivers and includes wetlands, wet prairies, and fens, which decrease in frequency from east to west.

Soils are going to be sands to loamy sands in this Biophysical Setting (BpS). Soils are highly permeable and low in organic matter. This system is found on somewhat excessively to

excessively well-drained, deep sandy soils that are often associated with dune systems and ancient floodplains.

The climate is semi-arid to arid for much of the region in which this system occurs.

Blowouts and sand draws characterize some of the wind-driven disturbances of the region. When disturbed, the fragile nature of the soils can profoundly impact vegetation composition and succession within this system. On a coarse scale, the system may be divided into sands and choppy sands, each of which supports slightly different fire behavior and vegetation dynamics. Similar site is sandy bottomlands.

Precipitation can range from 12-16in as we move east. As precipitation increases, percent of shrub species changes -- from sandsage to leadplant, which some believe has mostly been extirpated from much of the drier (western) parts of the range. There might be little data available to document this.

In eastern Colorado, this system is found in extensive tracts on Quaternary eolian deposits along the South Platte, Arikaree, and Republican rivers, between Big Sandy and Rush creeks, and along the Arkansas and Cimarron rivers, where it is contiguous with areas in Kansas (Comer et al. 2003).

Colorado's eastern plains exhibit climatic differences from north to south, which may be reflected in the local expression of sandsage prairie. Occurrences in southern Colorado experience a longer growing season, lower annual precipitation, and differences in precipitation patterns (Western Regional Climate Center 2004).

Vegetation Description

This BpS is distinguished by a sparse to moderately dense shrub layer dominated by *Artemisia filifolia*. These shrubs usually do not grow as clumps but as individuals, and the intervening ground is most often dominated by a sparse to moderately dense layer of tallgrasses, midgrasses, or shortgrasses. Associated species can vary with geography, precipitation, disturbance, and soil texture.

Some consider western sandcherry and leadplant part of the climax vegetation for this type, but both species are currently uncommon in this type.

Graminoid species, such as *Andropogon hallii*, *Sporobolus cryptandrus*, *Calamovilfa longifolia*, *Hesperostipa comata*, *Bouteloua gracilis* (dominant), and *Bouteloua hirsuta*, can also be found within this system.

Other shrub species, such as *Yucca glauca*, *Rhus trilobata*, and *Prunus* spp., may be present. Also present -- *Panicum virgatum*, *Schizachyrium scoparium*, *Pascopyrum smithii*, and more rarely, *Sorghastrum nutans*. A few species, such as the shrubs *Prunus pumilla* var. *besseyi* and *Amorpha canescens* and the grasses *Panicum virgatum* and *Sorghastrum nutans*, are believed to have been formerly more common but now much decreased, most likely by cattle grazing throughout the year (personal communication, Harvey Sprock and Ben Berlinger, Colorado NRCS via NatureServe).

In the southern range of this system, *Quercus havardii* may also be present and represents one succession pathway that develops over time following a disturbance.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
ARFI2	<i>Artemisia filifolia</i>	Sand sagebrush
ANHA	<i>Andropogon hallii</i>	Sand bluestem
CALO	<i>Calamovilfa longifolia</i>	Prairie sandreed
PAVI2	<i>Panicum virgatum</i>	Switchgrass
BOGR2	<i>Bouteloua gracilis</i>	Blue grama
SONU2	<i>Sorghastrum nutans</i>	Indiangrass
SPCR	<i>Sporobolus cryptandrus</i>	Sand dropseed
PRPUB	<i>Prunus pumila var. besseyi</i>	Western sandcherry

Species names are from the NRCS PLANTS database. Check species codes at <http://plants.usda.gov>.

Disturbance Description

Grazing, drought, and fire were the primary disturbances. Fire and drought disturbances were cyclic with the earliest and latest seral stages fluctuating widely on a scale of centuries in accordance with changes in climate. Fire and grazing are the most important dynamic processes for this type, although drought stress can impact this system significantly in some areas (Ramaley 1939).

Every year, there was probably some grazing -- intensity and number of animals probably varied greatly over time. The principal large grazer of the sandhills was most likely bison (*Bison bison*), which when occurring in large numbers, would have locally disturbed large areas and physical disturbances such as trampling and wallowing. Elk and deer and occasionally pronghorn antelope were other large grazers. Other ubiquitous grazers of the sandhills would have been numerous rodent species such as pocket gophers and kangaroo rats. Gophers can provide significant local disturbance, burying shorter vegetation and promoting annual forbs.

More evenly dispersed bison (and other herbivores) were probably part of the grazing history as well, at least in some years. Large herbivores typically congregate more in herds during droughts and disperse when resources are more widely available (wet years). Both probably happened historically, resulting in more of a mosaic of classes.

Prairie dogs were a minor component of the sandhill shrublands, with towns located only in areas of finer textured soils. Where they occurred, prairie dogs grazed vegetation close to the ground, which provided a local firebreak. These towns were unlikely to persist for more than a few decades due to the dynamic characteristics of the sandhills system. There are very few prairie dog communities in this system compared to shortgrass prairie. Prairie dogs in sandsage prairie occur in pockets. In general, they need loamy or clay soil. Probably <1-5% of the landscape was occupied by prairie dogs in this system historically.

Extended periods of severe drought are likely to affect both species composition and the stability of the sandhill soil, particularly when compounded by effects of wind, grazing, and fire. These

conditions may have led to the development of blowouts, making it difficult for vegetation to reestablish quickly.

Grazing and drought modify fire effects. Fires occur in a mosaic pattern. The most extensive fires are likely to have occurred in years with wet springs followed by hot, dry summers when grazing pressure was low or when hot, dry years occurred after a series of productive years. Wet growing seasons would have resulted in more productive and more continuous plant cover (i.e., fuel) that would have supported and expanded fires ignited under dry conditions occurring later in the season. In addition, litter accumulation over several fire-free years would also have supported widespread fire, in any conditions. The litter component, a determining factor in fire size and frequency, is correlated with seral stage.

Fire intervals could have ranged from a few years to >50yrs and maybe averages ~20-25yrs. The range really varies. Post-fire shifts in species composition depend on the timing and condition of fire. Fire may set succession back to an earlier seral stage in the sense of topkill; vegetative state may change.

Fire would vary depending on where on landscape. For instance, in Weld County, small lightning ignitions caused fires. However, out east in the higher precipitation zones in Colorado, it occurred more frequently and covered bigger areas because there was more fuel. Native Americans also started many fires. Fire was modeled with a frequency of approximately every 25yrs. (In current conditions, there is probably not much fuel load due to grazing.) Fuels are only one part of the fire equation. Other important factors such as lightning, extreme winds, and weeks of dry conditions also contribute greatly to fire probabilities. Fires seem to be able to occur nearly any year and are thought to have a return interval of approximately every 20-25yrs in general. The fire return interval (FRI) is similar to that for shortgrass, although it's on sandier soil with higher grass biomass that leads to fuel loading.

After fire, sandsage can resprout and can grow back in the first year. Sandsage, *Artemisia filifolia*, is very fire-tolerant within the shortgrass. It evolved in such areas with fire.

Artemisia filifolia in shortgrass behaves very differently than big sagebrush, *Artemisia tridentata*, and other forms in Wyoming and the northern Rockies or northern Plains. The other species of *Artemisia* have much longer mean fire return intervals (MFRIs), whereas *Artemisia filifolia* has a very short FRI in these areas -- ~20yrs around the mountainous areas.

Major wind events also occur. They can create an annual-forb-dominated stage.

Many of the disturbances and processes for this system are modeled similarly to the disturbances modeled (frequency and transitions and probabilities) for Shortgrass Prairie.

In current conditions, frequency, intensity, and duration of grazing have a dramatic effect on species composition (see Adjacency/ID concerns box). Excessive grazing can lead to decreasing dominance of some of the grass species such as *Andropogon hallii*, *Sorghastrum nutans*, *Panicum virgatum*, *Calamovilfa gigantea*, and *Calamovilfa longifolia*.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	23	100		
Moderate (Mixed)				
Low (Surface)				
All Fires	23	100		

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

This is a large patch to matrix system. In portions of the Western Great Plains, this system occurs in very large contiguous areas, and its resilience and resistance to large-scale disturbances make it function as a matrix-forming system. However, throughout its range, it is closely tied to sandy soils, and this edaphic restriction is characteristic of large patch systems (The Nature Conservancy 1998).

Droughts could affect the entire region, but deep percolation of precipitation in the coarse-grained sandy soils would have ameliorated the effects of moderate or short droughts in the uplands. The shallow water table would have protected vegetation of the lowland valleys from the effects of short droughts. During drought periods, grazing pressure would be more concentrated near water sources.

This system and disturbances occur in matrix -- small to large patches. It is defined by sand substrate.

Adjacency or Identification Concerns

This BpS is very similar to 1148 Western Great Plains Sand Prairie. The presence of sandsage in this BpS is the defining species that will distinguish it. In this BpS, there is less total production (less precipitation) and less sandcherry, leadplant, and yellow indiangrass than in BpS 1148.

In addition, this system occurs adjacent to heavier soils and shortgrass and midgrass prairie. It can form a locally patchy sandsage/shortgrass matrix.

There is a much smaller amount of this type today than historically. However, sandsage can occur in more easterly sandhills areas after chronic heavy grazing in MZ31.

This system has largely been converted to a shortgrass sandsage plant community primarily due to long-term continuous grazing and/or overstocking in Colorado and southwest Nebraska. However, not much of MZ31 has been converted to agriculture.

In current conditions in this BpS, there are much less tallgrasses than historically -- switchgrass, sand bluestem, and yellow indiangrass -- and there is more blue grama. There is also a greater amount of sandsage and shortgrass (blue grama) (denser, more basal area) today than there was historically. There is probably an increase in shrub density and cover.

Historically, there would have been a mosaic of the classes on the landscape. However, currently, there is probably more of Class B -- the sage and perennial grass stage with blue grama and prairie sandreed.

Muhlenbergia pungens has increased with continuous grazing on the steepest areas. Excessive grazing can lead to decreasing dominance of species such as *Andropogon hallii*, *Sorghastrum nutans*, *Panicum virgatum*, *Prunus besseyi*, *Amorpha canescens*, *Calamovilfa longifolia*, and *Schizachyrium scoparium*.

Properly stocked grazing systems that allow for adequate recovery periods following each grazing event can restore the historic climax plant community. See NRCS ESDs for sands and choppy sands.

In some areas, this system may actually occur as a result of overgrazing in Western Great Plains Tallgrass Prairie (CES303.673) or Western Great Plains Sand Prairie (CES303.670). For instance, sandsage can occur in more easterly sandhills areas after chronic heavy grazing in MZ31.

Much of this type in far eastern Colorado, western Kansas, and western Nebraska has also been converted to center-pivot irrigation (estimates compiled from literature from The Nature Conservancy [1998] suggest ~37% converted in southwest Kansas [Robel et al. 2004], less conversion further west). It has been plowed and planted. This does not apply for MZ31.

There are also hog farms, etc., as well as conversion to residential development, but this is only locally extensive and does not impact the ecological system to the extent that conversion to cropland has. This does not apply for MZ31.

Spraying of sandsage in the recent past has also had an impact on this system -- since the spraying kills most forbs and shrubs.

There are also annual brome exotics.

The changes in grazing in current conditions have had a much greater effect on this system than changes in fire regimes -- i.e., fire suppression.

This habitat was important to greater prairie chicken and plains sharp-tailed grouse and a variety of other declining grassland birds.

Artemisia filifolia in shortgrass behaves very differently than big sagebrush, *Artemisia tridentata*, and other forms in Wyoming and the northern Rockies or northern Plains. The other species of *Artemisia* have much longer MFRIs, whereas *Artemisia filifolia* has a very short FRI in these areas -- ~20yrs around the mountainous areas.

Issues or Problems

Native Uncharacteristic Conditions

There has been a decline of tallgrass species and an increase in shrub density.

A plant community dominated almost entirely with sand sagebrush with little understory species present would be uncharacteristic. Favorable species that remain are few and are protected by the

Sagebrush cover >20% cover would be uncharacteristic.

Wind/weather stress was modeled as the combined impacts of drought as well as wind in the model.

This model for MZ31 was adapted from the model from the same BpS from MZ27 and MZ33 created by Harvey Sprock, Steve Kettler, and Keith Schulz and reviewed by Terri Schulz, Chris Pague, and David Augustine. Minor descriptive additions and changes were made for MZ31 to better represent the area.

The model for MZ27/MZ33 was adapted from the Rapid Assessment model R4NESP created by Tom Bragg, Mary Lata, and Dave Shadis and reviewed by John Ortmann. Other modelers for MZ27/MZ33 were Rich Sterry, Lorenz Sollmann, Dan Nosal, and Randy Reichert.

Mapping Rules

[illegible]

Tree	>50	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
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Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

Description

Class A 5 Early Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSLA3	Psoralidium lanceolatum	Lemon scurfpea	Upper
MUPU2	Muhlenbergia pungens	Sandhill muhly	Upper
VUOC	Vulpia octoflora	Sixweeks fescue	None

Description

Class A represents an array of early species. Vegetation cover is very sparse. Biomass is low. This stage corresponds to the ESDs of annuals, early perennials, and blowouts. Class A represents a mix of annuals and forbs, some perennial grasses, and areas of sparse vegetative cover and bare sand, including blowouts and sand draws. For most years, this stage would be small patches. However, after extended drought, this stage could cover a significant portion of the area. (Some of the modelers wanted to have a separate blowout stage with <10% canopy cover; however, because that is not mappable, we did not create that stage -- especially because there are blowout areas in current conditions, which would not be picked up if we defined our class with <10% cover. Therefore, this Class A contains the blowout stage lumped in with the other annuals and forbs and perennial grasses.)

Drought and fire might have been one or two of the main causes of this condition, so the area occupied by this class is likely to have varied considerably, expanding during severe, extended droughts and contracting during wetter years. The persistence of this class depends on continual disturbance that inhibits the establishment of vegetation. Long-term extensive drought as a single factor could lead to this stage. Otherwise, a combination of disturbances such as fire, hailstorms (questionable), and continuous grazing (combined?) could cause a transition to this stage.

Low fuel levels and areas of open sand tend to prevent fire spread and make fire infrequent.

If this class is bare sand and there's a blowout, this stage could last decades. But what typically comes in, since we are combining this with the forbs and annuals, is lemon scurfpea and other forbs, needle-and-thread, indian ricegrass, and sixweeks fescue. There might be some shrubs coming in here. There might be some prairie sandreed and bluestem.

For a moderate blowout, this stage could last a few decades. This will depend on size of blowout, type of grazing, and climatic conditions. So this year-end covers part of the wind disturbance and

environmental factors. If there are good climatic conditions, this stage can cycle more quickly, so this was modeled as alternate succession.

What creates the annual-forb-dominated stage is the movement of sand dunes and scouring from major wind events. Wind events are a normal occurrence. If there is drought, fire, and abnormal disturbance, wind events can create more or larger blowouts. Wind/weather stress in this class is referring to high-wind events, which occur normally. But the fire and drought combined (not separately) is what creates the conditions to have the wind affect the class and reset it.

Native grazers can accelerate or maintain this stage or slow the successional process, depending on when the grazing occurs and intensity. All of these effects occur naturally and frequently.

Maximum Tree Size Class

None

Class B	38	Mid Development 1 - Closed
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
BOGR2	Bouteloua gracilis	Blue grama	Low-Mid
ARFI2	Artemisia filifolia	Sand sagebrush	Upper
CALO	Calamovilfa longifolia	Prairie sandreed	Mid-Upper
SPCR	Sporobolus cryptandrus	Sand dropseed	Mid-Upper

Description

Class B corresponds to the ESD blue grama/sand sagebrush class. This is the sand sage and perennial grasses stage. Class B is the mid-biomass stage. There is much variation in this class.

As per NRCS's ESD, the blue grama sand sagebrush community might evolve with continuous grazing without adequate recovery periods between grazing events during the growing season. Blue grama and sand sagebrush are the dominant species. Other indicator species: prairie sandreed, switchgrass, sand dropseed and possibly yellow indiangrass, sandsage, leadplant (questioned by some), western sandcherry, needle-and-thread, and many forbs. Sand bluestem, prairie sandreed, yellow indiangrass, switchgrass, western sandcherry, and leadplant are less in frequency and production than in Class C. Red threeawn, slimflower scurfpea, hairy goldaster, croton, western ragweed, stickleaf, lupine, loco, and milkvetch can also be present.

Canopy cover for this class can truly start at <20% cover, but for mapping rules, we changed it to 20% cover. So on the ground, please note that canopy cover could be very low even in this class. Canopy cover can vary dramatically, however, due to grazing, hail, etc.

Upper-layer lifeform is shrubs but <10% cover historically. Currently, you will see lots more shrub cover -- up to 20% cover -- which would be uncharacteristic.

This class transitions to the high biomass sand bluestem sandsage stage after a few years under the right conditions and disturbance patterns and processes. For the purposes of modeling, this

class transitions out after 10yrs with no disturbance. However, under the right conditions, it can move out more quickly; therefore, alternate succession was modeled, bringing this class to Class C, the high biomass stage.

For this stage, fires were modeled as not causing a transition, as the sage and grasses resprout quickly.

There was much native grazing occurring every year throughout all of the classes on the landscape. Not much documentation on this, though. Grazing periods were very short, and recovery periods could be 6mo-1yr. Herds followed green-up and rains. This doesn't remove the grasses. This recycles the nutrients and doesn't change species composition (as does continuous grazing currently).

In terms of cover, there has probably not been much departure. In terms of species -- departure -- more sandsage, blue grama today. There is probably more shrub cover today. Currently, there is probably much of this stage on the landscape -- blue grama/sandsage, although that was not necessarily the situation historically.

Maximum Tree Size Class

None

Class C 57 Mid Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARFI2	Artemisia filifolia	Sand sagebrush	Upper
ANHA	Andropogon hallii	Sand bluestem	Mid-Upper
CALO	Calamovilfa longifolia	Prairie sandreed	Mid-Upper
PRPUB	Prunus pumila var. besseyi	Western sandcherry	Upper

Description

Class C represents the historical climax plant community in choppy sands/sands from NRCS ESDs, in part. This class corresponds to the ESD sand bluestem/prairie sandreed, western sandcherry plant communities. The historic climax plant community consists of tall warm-season grasses. This is the bluestem, sagebrush, prairie sandreed perennial grass stage mosaic. Other species include sand dropseed, threeawn, switchgrass, and Indian ricegrass. As per NRCS's ESD, sub-dominant grasses include needle-and-thread, blue grama, and little bluestem. Significant forbs and shrubs are evening primrose, prairie clovers, leadplant, and western sandcherry.

As per NRCS ESD, the potential vegetation is ~70-85% grasses and grass-like plants, 8-15% forbs, and 7-15% woody plants.

Class C is the high biomass class.

This plant community evolved with grazing by large herbivores (NRCS). Evenly dispersed bison (and other herbivores) were probably part of the grazing history in some years. Large herbivores typically congregate more in herds during droughts and disperse when resources are more widely available (wet years).

Fire and continuous grazing combined without adequate recovery periods could shift this community toward the annual and forb stage or the perennial grass and sage stage. That would be the only way to remove the bluestem component temporarily.

Lack of fire and grazing could shift this community to an uncharacteristic excessive litter plant community.

Maximum Tree Size Class

None

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:OPN	0	Mid1:CLS	15
Mid1:CLS	16	Mid1:OPN	25
Mid1:OPN	26	Mid1:OPN	999

Probabilistic Transitions

Disturbance Type	Disturbance occurs In	Moves vegetation to	Disturbance Probability	Return Interval (yrs)	Reset Age to New Class Start Age After Disturbance?	Years Since Last Disturbance
Replacement Fire	Early1:OPN	Early1:OPN	0.005	200	No	0
Alternative Succession	Early1:OPN	Mid1:CLS	0.1	10	Yes	0
Wind or Weather or Stress	Early1:OPN	Early1:OPN	0.125	8	No	0
Native Grazing	Early1:OPN	Early1:OPN	0.75	1	No	0
Optional 2	Mid1:OPN	Early1:OPN	0.005	200	Yes	0
Optional 1	Mid1:OPN	Early1:OPN	0.005	200	Yes	0
Replacement Fire	Mid1:OPN	Mid1:CLS	0.05	20	Yes	0
Native Grazing	Mid1:OPN	Mid1:CLS	0.05	20	Yes	0
Wind or Weather or Stress	Mid1:OPN	Mid1:OPN	0.125	8	No	0
Native Grazing	Mid1:OPN	Mid1:OPN	0.7	1	No	0
Optional 1	Mid1:CLS	Mid1:CLS	0.005	200	No	0
Replacement Fire	Mid1:CLS	Mid1:CLS	0.04	25	No	0

Alternative Succession	Mid1:CLS	Mid1:OPN	0.1	10	Yes	0
Wind or Weather or Stress	Mid1:CLS	Mid1:CLS	0.125	8	No	0
Native Grazing	Mid1:CLS	Mid1:CLS	0.7	1	No	0

Optional Disturbances

Optional 1: prairie dogs

Optional 2: heavy grazing and fire

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