

11250

Inter-Mountain Basins Big Sagebrush Steppe

BpS Model/Description Version: Aug. 2020

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Reviewer: Alan Sands

Vegetation Type

Steppe/Savanna

Map Zones

20, 29, 30, 31, 33

Geographic Range

This Biophysical Setting (BpS) is found in the Wyoming Basins, central Montana, and north and east onto the western fringe of the Great Plains in South Dakota. It is found in southeastern Montana, but this could be due to a soil anomaly. It probably occurred historically all through southeastern Montana.

For map zone (MZ) 29, it would occur in northeastern Wyoming (Powder River Basin Section, 331G, Cleland 2007), Thunder basin grasslands; and northeast of subsection 331Gg (Dissected High Plains). In MZ30, this BpS is found in subsection 331Mi (Sagebrush Steppe) in the western Dakotas and the lower portion of 331Md. To the north, in subsection 331Md (Little Missouri), there is less of this type. It probably does not occur in subsection 331Mc (Missouri Plateau).

Biophysical Site Description

For MZ29, this description is intended to describe sagebrush wheatgrass steppe, where western wheatgrass is dominant.

Soils are primarily dry from sedimentary processes and less fertile, sometimes more calcareous. The Great Plains expression is found exclusively on "heavy"-textured soils derived from shale and mudstones and can be strongly correlated with particular geologic formation or members thereof.

Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) generally occurs in the 5-15in precipitation zones. Soil depth and accumulation of snow enhances these communities in lower precipitation zones (Knight 1994). April, May, and June have by far the most precipitation with precipitation peaking in late May, early June. This pattern carries throughout the Montana portion of the Great Plains, though there is a gradient of increasing summer precipitation moving eastward. Summer precipitation becomes predominant where tallgrass prairie grows.

Wyoming big sagebrush occupies plains, foothills, terraces, slopes, plateaus, basin edges, and even lower mountain slopes. In MZ29, Wyoming big sagebrush can occur from 2,200ft up to

8,000ft. Soils are shallow to moderately deep, moderate to well drained, and almost exclusively fine-textured soils.

The bluebunch/Wyoming big sagebrush type is probably an inclusion in this BpS occurring on steep, south aspect slopes, typically on badland formations.

Vegetation Description

Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) is the dominant mid- to late seral species within this plant assemblage. Mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) is not part of the species mix in MZ20 and MZ29, and basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) is very uncommon in MZ29. Wyoming big sagebrush is found where basin big sagebrush is not present. It can occur with greasewood and silver sage as well as rabbitbrushes and saltbush.

In Montana and Wyoming, this BpS tends to be more mesic with more biomass contributed by grasses than in areas farther west. Cool-season grasses such as Indian ricegrass, bluebunch wheatgrass (Indian ricegrass and bluebunch wheatgrass occur only where coarser-textured soils prevail), needle-and-thread (needle-and-thread grass has a broad ecological amplitude but more typically abundant on coarse soils; however, under heavy grazing, it does quite well on fine-textured soils), blue grama, Sandberg bluegrass, squirreltail, threadleaf sedge, and infrequently Thurber's needlegrass can be found. Rhizomatous wheatgrasses, such as western wheatgrass and thickspike wheatgrass and plains reedgrass, are common species in MZs 20 and 29. Junegrass also occurs. Western wheatgrass and thickspike wheatgrass are by far the dominant grasses in MZ20 whereas western wheatgrass, needle-and-thread, and blue grama are the dominant grasses found in the MZ29 expression of this BpS.

Common forbs are species of *Astragalus*, *Crepis*, *Delphinium*, *Phlox*, and *Castilleja*, while associated shrubs and shrub-like species can include small green rabbitbrush, fringe sagewort, winterfat, and broom snakeweed. Other dominant species of forbs include upright prairie coneflower (*Ratibida columnifera*), scarlet globemallow (*Sphaeralcea coccinea*), dotted blazing star (*Liatris punctate*), and spiny phlox (*Phlox hoodia*). Forbs most important for MZ20 include scarlet globemallow, purple prairie clover (*Dalea purpurea*), spiny phlox, upright prairie coneflower, and plains pricklypear (*Opuntia polyacantha*). Other forbs more common in MZ29 include hawksbeard (*Crepis acuminata*), bird's beak (*Cordylanthus* spp.), bluebell (*Mertensia* spp.), Rocky mountain aster (*Aster scopulorum*), Phlox species, and buckwheat (*Eriogonum* spp).

Herbaceous species usually dominate the site prior to reestablishment. Site reestablishment is by seed bank, seed production from remnant plants, and seeds from adjacent (untreated) plants.

Wyoming big sagebrush in upland sites have fewer understory species relative to the mountain big sagebrush subspecies, though at higher elevations or moister areas of this vegetation community, there is a higher potential for herbaceous species, relative to mountain big sagebrush sites; no definitive statement on undergrowth herbaceous diversity can be made for Wyoming big sagebrush sites. Herbaceous cover increases transitioning into the mixedgrass prairie.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
ARTRW 8	<i>Artemisia tridentata ssp. wyomingensis</i>	Wyoming big sagebrush
PASM	<i>Pascopyrum smithii</i>	Western wheatgrass
BOGR2	<i>Bouteloua gracilis</i>	Blue grama
CHRY9	<i>Chrysothamnus</i>	Rabbitbrush
PSSP6	<i>Pseudoroegneria spicata</i>	Bluebunch wheatgrass
HECO26	<i>Hesperostipa comata</i>	Needle and thread
NAVI4	<i>Nassella viridula</i>	Green needlegrass
CAFI	<i>Carex filifolia</i>	Threadleaf sedge

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

Disturbance Description

Many researchers believe fire was the primary disturbance factor within this plant assemblage. A 1999 literature review reported mean fire return intervals (MFRIs) for this type from 10-70yrs (Howard 1999). Baker (2006) estimated fire rotation for Wyoming big sagebrush of 100-240yrs or more.

Contributors to this BpS disagreed about the fire frequency:

- In MZ20, some model contributors estimated that replacement fires occurred approximately every 30yrs in some of the succession classes (based on BLM Fire Management plans and local expert estimate, Downey).
- Contributors estimates of the recovery time required for Wyoming big sagebrush following fire in MZ20 varied from 50-150yrs (mostly ~100yrs). Cooper (personal communication) stated that 29yrs after prescribed fires in some areas in MZs 29 and 30, there was still no recovery of Wyoming big sagebrush. It was also noted that the Bighorn battlefield, which historically had sagebrush, showed no evidence of sagebrush reestablishment 10yrs after a burn in the mid-1980s. Cooper (personal communication) argued that with slow recovery, if fires returned to the site in 30yrs, eventually the whole landscape would lose the late development mature sage succession class.
- Benkobi (personal communication) stated that in MZ29, fire frequency could range from 36-40yrs (<http://gisdata.usgs.net>), but reviewers did not want to change the model.
- There was likely geographic variation in the fire frequency. In northern and eastern Montana, a heavy grass component, relatively connected topography, and a lot of wind probably contributed to more frequent fires (Downey, personal communication).

Following fire or other significant disturbance, herbaceous species will dominate the site and recovery to pre-disturbance canopy cover is quite variable and may take 50-120yrs but occasionally occurs within a decade (Baker 2006). Site reestablishment is by seed production from remnant plants and seeds from adjacent (undisturbed) plants. Discontinuity of fuel in Wyoming big sagebrush communities can result in mosaic burn patterns, leaving remnant plants for seed, but there can be large expanses of complete mortality (Bushey 1987; Baker 2006). Fire does not stimulate germination of soil-stored Wyoming big sagebrush, but neither does it inhibit its germination (Chaplin and Winward 1982). Regeneration may occur in pulses linked to high precipitation events (Maier et al. 2001).

Discontinuity of fuel in Wyoming big sagebrush communities often result in mosaic burn patterns, but large expanses can burn with complete mortality under extreme conditions (Bushey 1987; Baker 2006).

Other disturbance factors may include insects, rodents and lagomorphs, drought, wet cycles, gradual changes in climate, and native grazing (Wyoming Interagency Vegetation Community 2002). Drought may have been a more significant disturbance than native grazing or insects. Native grazing by antelope, mule deer, pygmy rabbits, and insects occurred. Sage grouse might also have had an impact. In MZ29, contributors noted that pygmy rabbit grazing was not likely and that the impact/frequency of antelope and mule deer was questionable.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	92	100		
Moderate (Mixed)				
Low (Surface)				
All Fires	92	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

Occurrences may cover between 100s and 1,000s of hectares.

Disturbance patch sizes range from 10s-1,000s of hectares. The patch and disturbance size gets larger as this shrub BpS intergrades with the grassland BpS and also gets larger from MZs 19 and 20 into MZ29.

Adjacency or Identification Concerns

Plant associations are similar between this BpS and Inter-Mountain Basins Big Sagebrush Shrubland (BpS 1080). The only difference between the two is in the amount of herbaceous cover. In MZ20, BpS 1080 is by far the more prevalent type, when considering pre-European reference conditions, but BpS 1125 might be more prevalent today due to overgrazing. Much of 1080 has been lost due to land clearing for agriculture or converted to a cheatgrass or greasewood type. For basin big sagebrush in MZ29, this is the case. For Wyoming big sagebrush in MZ29, much has been lost due to burning for modern grazing. The understory is currently more annual bromes due to increased grazing.

It might be difficult to distinguish Northwestern Great Plains Shrubland (BpS 1085) from this BpS. BpS 1085 has a higher grass component than BpS 1125, and the types differ in terms of setting, precipitation patterns, and continuity of fuel.

This type is difficult to distinguish from mixedgrass prairie with a high shrub component. It is possible that with severe disturbance, a state change might occur to mixedgrass prairie -- which in turn changes the potential for the site to return to sagebrush. Extensive severe burns for want of an adjacent seedbank would take extensive periods before Wyoming big sagebrush was again a significant component. The reference condition might have been sagebrush, but now the abiotic factors and biophysical gradients indicate a mixedgrass prairie.

Secondary shrub and herbaceous components may vary considerably across the range of this type. Wyoming big sagebrush sites may be a mosaic with or abut juniper, ponderosa pine, salt desert shrub, and grassland vegetation types across its range. However, the most common accompanying vegetation is Northern Great Plains midgrass prairie. Juniper increase might be occurring due to lack of fire today, but it is not developing into a true juniper woodland, especially in MZ29.

Broom snakeweed and halogeton may dominate sites disturbed by overgrazing, oil and gas development, or other disturbances. Club moss in this system increases with the intensity and duration of grazing. Japanese brome (*Bromus japonicus*) can be an increaser with burning/grazing. There is also cheatgrass (*Bromus tectorum*) invasion in MZ29.

Shrub cover increases with overgrazing, and herbaceous layer decreases dramatically. Needle-and-thread grass (*Hesperostipa comata*) and prairie Junegrass (*Koeleria macrantha*) increase (in MZ20) where grazing is intense and protracted. Contributors were not sure whether prairie Junegrass increased or decreased with grazing. Bluegrasses increase with overgrazing in some areas of MZ29.

In Bighorns battlefield (around Hardin in Montana), historic photos showed dense shrub cover (up to 20%-30%), but currently the area supports mostly grass -- due to fires that burned there (Clark et al. 1995 DRAFT).

If this type is found adjacent to pine systems, tree encroachment might be occurring today. This was seen in historic photographs throughout southeastern Montana and through western South Dakota (Clark et al. 1995 DRAFT).

Issues or Problems

Difficult to identify where hybrids occur with other big sagebrush taxa.

Modelers and reviewers noted that the area east of the continental divide is not Inter-Mountain Basins and that the name of this Ecological System should be revised to either Big Sagebrush Steppe or Great Plains Sagebrush Steppe.

Native Uncharacteristic Conditions

Extreme overgrazing, absence of fire, or changes in the fire regime can lead to increases in shrub cover. The maximum possible shrub cover for this BpS under the reference condition may have varied. Some contributors in MZ20 felt that >45% shrub cover was uncharacteristic, but others felt that >30% would be uncharacteristic. In MZ29, contributors said that >40% cover was uncharacteristic. A reviewer of this BpS across its range stated that cover >30% was uncharacteristic.

Comments

MZs 29, 30, and 31 were combined during the BpS Review in 2015. In 2017, MZs 20 and 33 were added to this group as a result of review by Alan Sands. The model for MZ20 had identical disturbance probabilities to MZs 29, 30, and 31, but it had slight differences in the succession class age ranges, cover definitions, and description. Kori Blankenship noted that the differences

were likely not significant enough to warrant a distinct model, and Sands indicated that MZ20 was very similar ecologically to MZs 29, 30, and 31.

This BpS was never modeled in MZ33 during LANDFIRE National because it was lumped with Inter-Mountain Basins Big Sagebrush Shrubland (BpS 1080). Sands stated that there was probably no Big Sagebrush Shrubland in MZs 29, 30, and 31 and that although there could have been some of this type in the drier areas of MZ20, it was not enough for LANDFIRE to model and map separately from the Big Sagebrush Steppe in his opinion. MZ33 was therefore added to the MZs 20, 29, 30, 31 group, which represents the eastern extent of the BpS.

Sands suggested making a break between Big Sagebrush Steppe and Big Sagebrush Shrubland at 9-10in annual precipitation, arguing that Big Sagebrush communities <9in are likely to be Big Sagebrush Shrubland

This description contains many zone-specific comments, especially for MZs 20 and 29, and it is unclear how well these comments apply to MZs 30, 31, and 33. Future review should evaluate this grouping of zones, consider the need for finer-level models to represent differences, and/or edit the description to better represent conditions across the geography to which it applies.

For LANDFIRE National, Shannon Downey was a modeler and Steve Barrett a reviewer in MZ20; in MZ29, additional reviewers were Bobby Baker and Jim Von Loh.

Succession Classes

Mapping Rules

Upper Layer Lifeform	Height (m)	Canopy Cover (%)									
		0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Herb	0-0.5	A	A	A	A	A	A	A	A	UN	UN
Herb	0.5-1.0	A	A	A	A	A	A	A	A	UN	UN
Herb	>1.0	A	A	A	A	A	A	A	A	UN	UN
Shrub	0-0.5	B	B	C	C	UN	UN	UN	UN	UN	UN
Shrub	0.5-1.0	B	B	C	C	UN	UN	UN	UN	UN	UN
Shrub	1.0-3.0	B	B	C	C	UN	UN	UN	UN	UN	UN
Shrub	>3.0	B	B	C	C	UN	UN	UN	UN	UN	UN
Tree	0-5	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	5-10	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	10-25	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	25-50	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	>50	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN

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	35	Early Development 1 - All Structures
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
NAVI4	Nassella viridula	Green needlegrass	Upper
PASM	Pascopyrum smithii	Western wheatgrass	Upper
BOGR2	Bouteloua gracilis	Blue grama	Lower
CAFI	Carex filifolia	Threadleaf sedge	Lower

Description

Herbaceous-dominated. Primarily grasses with forbs. Exact species will vary depending on location. Western wheatgrass, Sandberg bluegrass, plains reedgrass, needle-and-thread, bluebunch wheatgrass, threadleaf sedge, plains junegrass, and blue grama would be dominant grasses. Forbs may include *Astragalus*, *Crepis*, *Castilleja*, *Delphinium*, *Agoseris*, *Phlox*, and others. There may also be significant component of small green rabbitbrush.

Sagebrush recovery times may have varied. Shrub cover is <5%.

Maximum Tree Size Class

None

Class B	39	Mid Development 1 - Open
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRW8	Artemisia tridentata ssp. wyomingensis	Wyoming big sagebrush	Upper
PASM	Pascopyrum smithii	Western wheatgrass	Mid-Upper
NAVI4	Nassella viridula	Green needlegrass	Mid-Upper
HECO26	Hesperostipa comata	Needle and thread	Middle

Description

Sagebrush canopy 5-15%. Understory is well represented by herbaceous species as described for Class A. Prairie sagewort (*Artemisia frigida*) may also be present in lower canopy.

Maximum Tree Size Class

None

Class C	26	Late Development 1 - Closed
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRW8	Artemisia tridentata ssp. wyomingensis	Wyoming big sagebrush	Upper

PASM	Pascopyrum smithii	Western wheatgrass	Mid-Upper
NAVI4	Nassella viridula	Green needlegrass	Mid-Upper
HECO26	Hesperostipa comata	Needle and thread	Middle

Description

Sagebrush canopy is >15%. Understory is well represented by herbaceous species as described for Class A. This class is more common on drier sites. Prairie sagewort (*Artemisia frigida*) may also be present in lower canopy.

Maximum Tree Size Class

None

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:OPN	40
Mid1:OPN	41	Late1:CLS	100
Late1:CLS	101	Late1:CLS	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
Insects or Disease	Early1:ALL	Early1:ALL	0.001	1000	No	0
Wind or Weather or Stress	Early1:ALL	Early1:ALL	0.01	100	No	0
Replacement Fire	Early1:ALL	Early1:ALL	0.0111	90	Yes	0
Native Grazing	Early1:ALL	Early1:ALL	0.1	10	No	0
Insects or Disease	Mid1:OPN	Mid1:OPN	0.001	1000	No	0
Wind or Weather or Stress	Mid1:OPN	Mid1:OPN	0.01	100	No	0
Replacement Fire	Mid1:OPN	Early1:ALL	0.0111	90	Yes	0
Native Grazing	Mid1:OPN	Mid1:OPN	0.1	10	No	0
Insects or Disease	Late1:CLS	Mid1:OPN	0.001	1000	Yes	0
Native Grazing	Late1:CLS	Mid1:OPN	0.002	500	Yes	0
Wind or Weather or Stress	Late1:CLS	Mid1:OPN	0.005	200	Yes	0

Wind or Weather or Stress	Late1:CLS	Late1:CLS	0.005	200	No	0
Replacement Fire	Late1:CLS	Early1:ALL	0.01	100	Yes	0
Native Grazing	Late1:CLS	Late1:CLS	0.1	10	No	0

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