11260
Inter-Mountain Basins Montane Sagebrush Steppe

BpS Model/Description Version: Oct. 2019

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Reviewer: Alan Sands

Vegetation Type
Steppe/Savanna

Map Zone
22

Geographic Range
Occurs throughout foothills and at higher, cooler elevations of Wyoming and the map zone (MZ). Mountain big sagebrush (*Artemisia tridentata* spp. *vaseyana*) occurs throughout most of the western United States.

Biophysical Site Description
This vegetation type is found on all aspects. Pure stands are found in areas with deeper soils and less topographic relief, but it is also common on slopes with a gradual shift to a mixed mountain shrub community on steeper slopes and in drainages. Elevation ranges from 5,000-10,000ft and precipitation from 12-20in. Soils are deep, well drained with a pH +/- 7.0. Soil moistures are udic (not dry for as long as 90 cumulative days) and soil temperatures cryic (very cold soils of the Rocky Mountain Region).

Vegetation Description
Mountain sagebrush steppe dominated by mountain sage, western snowberry, and bitterbrush with a grass and forb understory is believed to be a major pre-settlement vegetation type for Wyoming, although the exact composition of the community before settlement is unknown.

Dominant shrubs include mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), antelope bitterbrush (*Purshia tridentata*), and mountain snowberry (*Symphoricarpos oreophilus*). In the Big Horn Basin of Wyoming, green rabbitbrush (*Chrysothamnus viscidiflorus*) may be a common co-dominant. Other common shrubs include serviceberry (*Amelanchier alnifolia*), mountain mahogany (*Cercocarpus montanus*), spineless horsebrush (*Tetradymia canescens*), and black sagebrush (*Artemisia nova*). Other shrubs may be locally common.

Herbaceous cover is moderate to abundant, ranging from 40-85%. Common grasses include: *Festuca idahoensis*, *Elymus elymoides*, *Pascopyrum smithii*, *Hesperostipa comata*, *Nassella viridula*, *Poa fenderiana*, *Poa juncifolia* var. *ampla*, and *Pseudoroegneria spicata*. Indicator

forbs include *Eriogonum umbellatum*, *Antennaria rosea*, *Balsamorhiza sagittata*, *Lupinus argenteus*, *Delphinium nuttallianum*, and *Phlox multiflora*.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
ARTRV	*Artemisia tridentata ssp. vaseyana*	Mountain big sagebrush
FEID	*Festuca idahoensis*	Idaho fescue
POA	*Poa*	Bluegrass
HECO6	*Hemitomes congestum*	Coneplant

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

Disturbance Description

Fire is a major disturbance factor for mountain sage (Blaisdell et al. 1982; Johnson 2000). Mountain big sagebrush has the fastest recovery rate of the three subspecies of big sagebrush (Johnson 2000; local data). Fire size for this type is larger than other big sagebrush species because of greater fine fuel load, but some unburned pockets remain after fires, often resulting in a patchy mosaic. Mountain big sagebrush does not resprout following fire, and recolonization of burned areas must come from either a short-lived seed bank or seed dispersed by plants in unburned patches or adjacent stands (Johnson and Payne 1968; Bushey 1987). Sagebrush may also establish during recruitment pulses related to precipitation in single or successive growing seasons (Anderson and Inouye 2001).

There was considerable debate between model contributors about the fire frequency and severity for this BpS (see MZ21 Disturbance Description for further discussion). Fire regimes vary considerably across the biogeographic range of mountain big sagebrush, based on factors like elevation, soil depth, slope, aspect, adjacent vegetation, frequency of lightning, and climate. Estimating historic fire regimes for sagebrush ecosystems is difficult and often based on fire scar and age structure data from adjacent forest types (e.g., ponderosa pine and pinyon/juniper), shrub age structure, and fuel characteristics. Composite fire intervals for this type vary from 10-100yrs (Bunting et al 1987; Harniss and Murray 1973; Hironaka et al. 1983; Miller and Rose 1999; Wright and Bailey 1982). Baker (2006) estimated that low estimates of fire rotations are 70-200yrs or more. Reviewers disagreed about the frequency of fire in mountain big sagebrush systems and suggested mean fire intervals (MFIs) ranging from 25-135yrs. A summary of the evidence supporting the various fire frequency provided by reviewers follows:

- Data from long-term vegetation transects collected over a 20yr period in Wyoming suggest that the recovery of mountain sagebrush steppe communities following fire requires at least 25yrs in northwestern Wyoming and at least 40yrs in southern Wyoming to reach a late seral state with >30% sagebrush cover (Grand Teton National Park/Bridger Teton National Forest Fire Effects Monitoring Data, Southern Wyoming Fire Zone BLM Fire Effects Monitoring Data). If recovery rates are correlated with composite fire return intervals (FRIs), FRIs may lie somewhere between 40-60yrs.
- FRIs may be twice or more as long as recovery periods, indicating an FRI of 70-200yrs (Baker 2006). Baker (2006) suggests the low estimate of the fire interval would be 70-200yrs, and an anonymous contributor suggested that 80yrs, used in the modeling group, was too low. The group chose to use a low estimate of the return interval, in part so the estimate would be less than that for basin big sagebrush.

- The FRI for mountain big sagebrush in Wyoming could be longer than MFIs in other areas, such as Yellowstone, as recovery times in this area are longer than in Yellowstone (Williams, personal communication). Because mountain big sagebrush extends throughout Cody, Lander, and Rawlins, very different FRIs for mountain big sagebrush are seen in the different areas. Cody conceivably has a more frequent FRI than the other areas; however, overall in Wyoming, it was thought that an 80yr interval is a good median (Williams, personal communication).

The severity of fire is also contested in this system. While the majority of fires were likely stand-replacing, some mixed-severity fire may have occurred, though there are few data documenting mixed-severity fires (Sapsis and Kaufmann 1991). Mixed-severity fires were likely small in area, but ignitions may have occurred as frequently as 5-20yrs. There were probably also portions of this system that never carried fire because of sparse fuel (Bushey 1987). Historic fires likely occurred during the summer months and were wind-driven events.

Other disturbances, including drought stress, insects, and native grazing, were present under pre-settlement conditions in this type. Most of these disturbances were mixed-severity, resulting in thinning of sagebrush.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	85	100	50	200
Moderate (Mixed)				
Low (Surface)				
All Fires	85	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

Fires burn in patchy mosaics in this type, and scales ranged from small (10s of acres) to very large (possibly 10s of 1,000s of acres). Landscape-scale assessments should probably be in the order of 10,000ac for mountain sagebrush steppe communities because of the mosaic nature of vegetation communities, the moderate to long mean fire return intervals, and the size and amount of vegetation community.

Adjacency or Identification Concerns

Differentiation of mountain big sagebrush steppe from Wyoming big sagebrush may be difficult at the ecotone due to physical similarities and hybridization zones (i.e., species concepts become blurred). Probably cannot be distinguished from black sagebrush in satellite imagery.

Nearly all sagebrush communities today have been grazed, and there are few refugia to use as reference conditions.

Issues or Problems

There is a limited amount of information available on fire regimes and reference conditions in sagebrush due to modern overgrazing (the herbaceous component is severely impacted and current information cannot exclude the effects of cattle). Nearly all sagebrush communities today have been grazed -- there are few refugia to use as reference conditions.

Can experience invasions of some weed species (e.g., Canada thistle and musk thistle) under certain grazing regimes. Can also have cheatgrass in some stands in the lower part of the elevational gradient.

Native Uncharacteristic Conditions
Greater than 60% cover of mountain big sagebrush in Class D is uncharacteristic

Comments
Alan Sands reviewed this BpS in 2017 as part of the BpS Review and suggested that the herbaceous succession class (A), which was modeled with a duration of 4yrs, should last at least 10yrs. Kori Blankenship reviewed the models for this BpS and noted that all but this one had an herbaceous class that lasted at least 9yrs. Blankenship changed the duration of the herbaceous class to 11yrs to match the duration from adjacent MZs 16 and 23. This change increased the percent of the landscape in A and decreased the amount in B. Classes D and E did not change. Sands also stated that a tree-dominated class was needed to represent areas adjacent to forest communities where tree encroachment occurs. See more information on this below.

During the BpS Review in 2017, this model was part of a "macro-review" where all models representing this BpS were reviewed and evaluated relative to one another. One goal of the review was to check for logical consistency between the models. Outstanding questions from this review that should be evaluated in the future include:
-Should all models for this BpS include a tree succession class? The current model set includes models that have tree succession classes and those that do not. The models representing MZ06 et al. and MZ13 note that the Ecological Systems classification does not distinguish between mid- to high-elevation mountain big sagebrush communities that can be invaded by conifers and those at elevations too high for tree encroachment. The MZ06 et al. description also notes that where tree encroachment is impossible, a three-box model (i.e., this model without tree classes D and E) should be used. Sands, during the 2017 BpS Review, suggested that all models for this BpS include a tree succession class.
-Does the low sagebrush versus mountain big sagebrush split applied in the model representing MZs 16, 23, and 24 apply elsewhere? This split was implemented by modelers to allow low sagebrush communities to have a much lower fire frequency than mountain big sagebrush communities. MZ06 et al. notes that mountain low sagebrush communities should be classified as Columbia Plateau Low Sagebrush Steppe **(**BpS 1124). MZ13 notes that extensive areas of low/black sagebrush should be considered Great Basin Xeric Mixed Sagebrush Shrubland (BpS 1079).
-What is an appropriate fire frequency and severity for this BpS? Estimates for these fire regime parameters vary widely (see Innes 2017), and during LANDFIRE National, there was considerable debate about these values in some areas (see LANDIFRE MZ21 description for this BpS)

An anonymous modeler also contributed to this model, and Eve Warren (eve_warren@blm.gov) was a LANDFIRE National reviewer not listed above. Reviewers disagreed about the range of fire frequency for this vegetation type.

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	UN	UN	UN	UN
Herb	0.5-1.0	A	A	A	A	A	A	UN	UN	UN	UN
Herb	>1.0	A	A	A	A	A	A	UN	UN	UN	UN
Shrub	0-0.5	B	B	C	D	D	D	UN	UN	UN	UN
Shrub	0.5-1.0	B	B	C	D	D	D	UN	UN	UN	UN
Shrub	1.0-3.0	B	B	C	D	D	D	UN	UN	UN	UN
Shrub	>3.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	0-5	C	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	5-10	D	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 14 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
FEID	Festuca idahoensis	Idaho fescue	Upper
PASM	Pascopyrum smithii	Western wheatgrass	Upper
MEVI	Medeola virginiana	Indian cucumber	Middle
LUAR	Lupinus arboreus	Yellow bush lupine	None

Description

Sagebrush cover ranges from 0-5%. Herbaceous cover is variable but is typically at least 30%.

Maximum Tree Size Class

None

Class B 9 Mid Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRV	Artemisia tridentata ssp. vaseyana	Mountain big sagebrush	Upper
FEID	Festuca idahoensis	Idaho fescue	Mid-Upper
ERUM	Eriogonum umbellatum	Sulphur-flower buckwheat	Middle
PSSP	Psilostrophe sparsiflora	Greenstem paperflower	Mid-Upper

Description
Sagebrush increasing in cover.

Maximum Tree Size Class
None

Class C 26 Late Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRV	Artemisia tridentata ssp. vaseyana	Mountain big sagebrush	Upper
FEID	Festuca idahoensis	Idaho fescue	Mid-Upper
PASM	Pascopyrum smithii	Western wheatgrass	Mid-Upper
ERUM	Eriogonum umbellatum	Sulphur-flower buckwheat	Low-Mid

Description
Sagebrush is the dominant lifeform.

Maximum Tree Size Class
None

Class D 51 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRV	Artemisia tridentata ssp. vaseyana	Mountain big sagebrush	Upper
FEID	Festuca idahoensis	Idaho fescue	Mid-Upper
PASM	Pascopyrum smithii	Western wheatgrass	Mid-Upper
ERUM	Eriogonum umbellatum	Sulphur-flower buckwheat	Low-Mid

Description
Late development sagebrush. Cover rarely exceeds 60%.

Maximum Tree Size Class
None

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:OPN	11
Mid1:OPN	12	Late1:OPN	20
Late1:OPN	21	Late1:CLS	49
Late1:CLS	50	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
Native Grazing	Early1:ALL	Early1:ALL	0.001	1000	No	0
Replacement Fire	Early1:ALL	Early1:ALL	0.005	200	Yes	0
Wind or Weather or Stress	Early1:ALL	Early1:ALL	0.01	100	No	0
Native Grazing	Mid1:OPN	Mid1:OPN	0.001	1000	No	0
Insects or Disease	Mid1:OPN	Mid1:OPN	0.001	1000	No	0
Wind or Weather or Stress	Mid1:OPN	Early1:ALL	0.002	500	Yes	0
Replacement Fire	Mid1:OPN	Early1:ALL	0.0125	80	Yes	0
Native Grazing	Late1:OPN	Late1:OPN	0.001	1000	No	0
Insects or Disease	Late1:OPN	Late1:OPN	0.001	1000	No	0
Wind or Weather or Stress	Late1:OPN	Late1:OPN	0.002	500	No	0
Replacement Fire	Late1:OPN	Early1:ALL	0.0125	80	Yes	0
Native Grazing	Late1:CLS	Late1:CLS	0.001	1000	No	0
Insects or Disease	Late1:CLS	Late1:CLS	0.001	1000	No	0
Wind or Weather or Stress	Late1:CLS	Late1:OPN	0.002	500	Yes	0
Replacement Fire	Late1:CLS	Early1:ALL	0.0125	80	Yes	0

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