

11250

Inter-Mountain Basins Big Sagebrush Steppe

BpS Model/Description Version: Aug. 2020

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Vegetation Type

Steppe/Savanna

Map Zones

1, 7, 8, 9, 10, 19

Geographic Range

This biophysical setting (BpS) is found throughout the Northern Great Basin, Snake River Plains, Modoc Plateau, Columbia Plateau, and extending north into the Okanogan Valley and into southern British Columbia. It is the most extensive sagebrush steppe type.

Biophysical Site Description

This BpS is typically found in lower elevations, on shallow to moderately deep soils where the soil temperature regime is mesic and the soil moisture regime is aridic. Rooting depth is typically limited to 12-22in (30-56cm) by a restrictive layer. This setting can occur on alluvium with a deeper restrictive layer. Soils have a variety of textures, ranging from sandy to clayey to pumice, and are predominantly Aridisols and aridic Mollisols. A mollic epipedon may be present. Twenty-five percent or more of bare ground is common in all stages. This BpS typically occurs below 5,000ft (1,524 m) elevation in the northern Great Basin and below 6,000ft (1,828 m) in the southern Great Basin but can occur higher on southerly aspects. Precipitation is between 6-14in (15-36cm) annually with a majority of the precipitation coming in the winter and spring months; winter precipitation is typically mixed rain and snow or rain. Interannual precipitation amount varies widely.

Vegetation Description

Wyoming big sagebrush (*Artemisia tridentata* spp. *wyomingensis*) is the dominant big sagebrush subspecies but mountain big sagebrush (*A.t.* ssp. *vaseyana*) may be found on the ecotone with Inter-Mountain Basins Montane Sagebrush Steppe (BpS 11260, i.e. cool-moist sagebrush) and moderately productive little sagebrush sites. Some authors recognize xeric big sagebrush (*A.t.* spp. *xericensis*) as a separate species or subspecies of big sagebrush found at the ecotone between the Montane Sagebrush Steppe and the Sagebrush Steppe, where the soil moisture regime is aridic bordering on xeric. Basin big sagebrush (*A.t.* spp. *tridentata*) can occur on deeper soils that are partially subirrigated. Sagebrush cover varies between 8-25% in the mature stage but averages ~12%. Other shrubs associated with sagebrush are green rabbitbrush

(*Chrysothamnus viscidiflorus*), gray rabbitbrush (*Ericameria nauseosa*), and horsebrush (*Tetradymia*). Antelope bitterbrush (*Purshia tridentata*) can be a major component at the ecotone with Inter-Mountain Basins Montane Sagebrush Steppe. On the very dry end of the distribution, scattered salt-desert shrubs will also occur within the plant community.

Perennial bunchgrasses and forbs predominate in the herbaceous layer. Dry-site, deep-rooted bunchgrasses, such as bluebunch wheatgrass (*Pseudoroegneria spicata*), needle-and-thread grass (*Hesperostipa comata*), and Thurber's needlegrass (*Achnatherum thurberianum*), are dominant with some inclusion of shallow-rooted bunchgrasses, such as Sandberg's bluegrass (*Poa secunda*). Idaho fescue (*Festuca idahoensis*) occurs on more mesic sites within this BpS, often with three-tip sagebrush (*Artemisia tripartita*). Generally, these settings produce at least 600lb/ac (672 kg/ha) of grass only in high-production years. The forb component can be quite rich with 200+ different species identified over the range of this type. Native annual forbs may dominate the community following disturbance. Cover of herbaceous plants will vary between 10-45%, with most sites 20-30%. The dry nature of these communities limits the inherent productivity. Forb cover and diversity varies widely from year to year, governed primarily by the amount and timing of precipitation.

A non-vascular plant layer, known as a biological soil crust, occurs in this setting. Under the shrub canopy, moss is the principal component. Moss cover ranges from 3-15%, averaging ~7%. Algae are the principle components in the interspaces, appearing most obviously in wet years. Otherwise, the interspaces are largely bare soil and rock.

Historically, this BpS may have resembled a grassland with interspersed shrubs instead of a shrubland with interspersed grass, particularly in map zone (MZ) 08 and the northern part of MZ09. Further south in MZ09, in the northern part of MZ12, and the western part of MZ18, sagebrush and grass were visually co-dominant. In the eastern part of MZ18 and southern part of MZ12, the sagebrush was more visually dominant.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
ARTRW 8	<i>Artemisia tridentata ssp. wyomingensis</i>	Wyoming big sagebrush
ARTRT	<i>Artemisia tridentata ssp. tridentata</i>	Basin big sagebrush
PUTR2	<i>Purshia tridentata</i>	Antelope bitterbrush
PSSP6	<i>Pseudoroegneria spicata</i>	Bluebunch wheatgrass
ACTH7	<i>Achnatherum thurberianum</i>	Thurber's needlegrass
POSE	<i>Poa secunda</i>	Sandberg bluegrass
HECO26	<i>Hesperostipa comata</i>	Needle and thread
ELTR7	<i>Elymus trachycaulus</i>	Slender wheatgrass

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

Disturbance Description

Fire, climate, and insects all played a role in the disturbance history of these sites. The dry nature and inherently low productivity of these plant communities limits fire occurrence. These fuel-limited systems require one or more years of average to above-average winter and spring

precipitation to produce sufficient grass fuel to carry a fire readily. Anthropological literature suggests that the burning practices and escaped campfires of various Native American tribes and bands were a significant source of ignitions and shaped sagebrush community structure, potentially limiting the sizes and burn patterns of lightning fires. Given the purposes for burning by Native Americans, fires probably were not as limited by fuel production as lightning fires are limited. Deliberate use of fire by Native Americans most likely occurred in late winter to early spring and in fall, while accidental ignitions could occur whenever conditions were dry enough and fuels continuous enough. Lightning-caused fires occurred in summer, primarily in July and August.

Although fire ignition and spread in big sagebrush is considered to be largely (90%) a function of herbaceous cover, live fuel moisture in shrubs appears to be an important local control on the resulting burn pattern. Patchy fires would be <1,000ac, while stand-replacement fires can exceed 10,000ac with fewer and smaller unburned patches. The combination of human and lightning-caused fires likely created a highly variable fire return interval (FRI). Fires may have occurred as frequently as every 50yrs to as infrequently as every 150yrs. However, questions have recently been raised about the frequency of fire as related to neighboring vegetation types (Baker 2006).

This BpS is prone to multi-year droughts instead of single-year droughts. Periodic drought may have reduced the density and cover of sagebrush by reducing canopy size and killing individual plants. However, droughts that affect the entire area where this BpS occurs are rare, with subregional droughts more common. Area-wide droughts are typically prolonged (>4yrs) and very severe, while subregional droughts are shorter (2-4yrs) and less severe. The size of the area affected by subregional drought would vary from 10,000s to 100,000s of acres, and sagebrush mortality may be related to soil type.

Several species of insects feed on big sagebrush, although only a few species have been documented as causing reductions in canopy cover and sagebrush mortality. The aroga moth (*Aroga websteri*), a defoliator, is the best known and can reduce sagebrush canopy cover over millions of acres during severe outbreak years. Outbreaks are associated with near-average temperatures from mid-May to mid-June with high precipitation in June and July. Such conditions occur every 40-60 years. Sagebrush mortality is somewhat more likely on southerly aspects, although defoliation may be greater on northerly aspects and in sites with higher sagebrush cover and large shrubs.

This BpS is also winter range for pronghorn antelope and mule deer. In years with high ungulate populations and severe winters with deep, prolonged snowpacks, ungulate browsing likely thins sagebrush canopy cover of areas 100s to 1,000s of acres in size, mostly in rolling terrain. Some mortality may occur but likely only on the scale of individual plants. Recovery was likely rapid, providing drought conditions were not present in the following years. Conditions that resulted in significant ungulate browsing likely occurred about every 50yrs.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	61	100		
Moderate (Mixed)				

Low (Surface)				
All Fires	61	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

Patches occur on the scale of 100s to 100,000s of acres.

Adjacency or Identification Concerns

This vegetation type occurs in a mosaic of Wyoming, xeric, and basin big sagebrush, low sagebrush, black sagebrush, and salt-desert shrub plant communities. The complexity of the mosaic is based on soils, elevation, aspect, and proximity to the Polar Front climatic boundary. Sites with relatively dense sagebrush cover may be misclassified as Inter-Mountain Basins Sagebrush Shrubland; instead, dense canopy cover may represent a degraded site or an uncharacteristic condition caused by lack of mosaic fire combined with various types of land use changes.

In the southern part of the Great Basin, this vegetation type will transition to Inter-Mountain Basins Montane Sagebrush Steppe with increasing elevation, Inter-Mountain Basins Semi-Desert Shrub-Steppe (BpS 11270) with decreasing elevation and increasing soil alkalinity, and Inter-Mountain Basins Big Sagebrush Shrublands (BpS 10800) in the rainshadows of major peaks and ridges and adjacent to Pliocene lakebeds. The boundaries between these BpSs are often diffuse.

In the Columbia Plateau, this vegetation type will transition with increasing elevation to East Cascades Oak-Ponderosa Pine Forest and Woodland along the western edge of the BpS and to Northern Rocky Mt. Ponderosa Pine Woodland on the northern boundary; it will transition to Columbia Steppe and (Palouse) Grassland and to Columbia Plateau Scabland Shrubland to the east and to Inter-Mountain Basins Semi-Desert Shrub-Steppe in extreme low elevations in the Pasco Basin.

Invasive annual grasses have taken over patches of varying size; cheatgrass is the most widespread, but medusahead and ventenata are increasingly common. Invasive annual grasslands range in size from a few hundred acres to 100,000s of acres. A number of invasive forbs can also be dominant in patches 10s to 1,000s of acres in size. Non-native perennial bunchgrass seedings, some quite large, are interspersed throughout this type. Crested/desert wheatgrass (*Agropyron cristatum* and *A. desertorum*) is the most widespread and was seeded extensively in the 1960s and '70s to restore degraded rangelands and continues to be widespread in post-fire seedings. Forage kochia (*Bassia prostrata*) is widespread non-native subshrub seeded in burned areas and in fuel breaks or along road edges.

Issues or Problems

While long-persisting invasive annual grasslands are most widespread in this BpS, the presence of invasive annual grassland is not fully diagnostic. As the climate continues to warm and dry, persistent invasive annual grasslands are beginning to develop in other sagebrush-dominated BpSs. Factors such as soil depth, aspect, elevation, and proximity to other non-sagebrush BpSs are indicators of whether the site historically was Inter-Mountain Basins Big Sagebrush Steppe or another sagebrush type.

Native Uncharacteristic Conditions

The lack of fire and the persistent impacts of past grazing have resulted in a greater proportion of the late-seral closed canopy class than would have occurred in the past. Shrub canopy closure of 30-40% may occur but is considered rare; greater shrub canopy closure indicates either an uncharacteristic type or an inclusion of a different BpS on deeper, more productive soils. In central Oregon, juniper encroachment is starting to become widespread at the upper end of this BpS. Grazing has increased the proportion of rabbitbrush and decreased the native bunchgrasses in all seral stages.

Comments

The primary successional pathway is from Early to Mid Open to Late Open to Late Closed. In sagebrush ecosystems, the primary competition occurs below ground for water and nutrients, with competition for water likely the primary factor governing succession, and above-ground elements such as shrub and herbaceous canopy cover and extent of bare ground in the absence of other disturbances, such as uncharacteristic levels of herbivory or disturbance types other than fire. In the Early class, grasses and forbs control site resources. In Mid Open, shrubs and the herbaceous layer have co-equal control of site resources. In Late Open, shrubs have primary control over site resources. Late Closed develops when the fire-free interval is longer than the mean. This class is described as “closed” due to full or nearly full occupancy of the soil by roots, greatly limiting establishment of any additional native plants.

In the model, wind/weather/stress transitions represent drought, native grazing represents pronghorn herbivory, and insects/disease represent the aroga moth. A reviewer disagreed with the impact of pronghorn herbivory, noting that pronghorn were never abundant enough in the area to be much of an influence on vegetation. The reviewer noted that jackrabbits and voles irruptions were an occasional disturbance but probably didn't result in a class transition. Both the reviewer and modeler agreed on the importance of aroga moths. Age reset is used to reset the age of a class after “maintenance” (i.e., a transition that does not change the class) native grazing transitions. The Early to Early fire transition that does not reset age as well as the fire pathways that transition to classes other than Early represent patchy replacement fires.

Historically, use of fire by Native Americans and lightning fires combined to produce heterogeneous burn patterns and a complex mosaic of sagebrush cover on the landscape. Occasionally, weather conditions and successional stage resulted in a homogeneous burn pattern over a large area. Classes A, B, and C can support both heterogeneous and homogeneous burn patterns, although heterogeneous burn patterns are thought to be the rule in these classes. Class E tends to support primarily homogeneous burn patterns.

Establishment of big sagebrush is episodic rather than continuous, depending on favorable weather conditions. Establishment episodes occur approximately every 6yrs. As succession proceeds, the rate of change between succession classes increases due to both increasing numbers of seed sources and increasing site amelioration by established plants (shading, capture of snow, and hydraulic lift of water). Initial establishment in the early seral phase is quite slow following a stand-replacement fire due to very limited seed sources. Cover classes refer only to sagebrush cover. Cover by sprouting species such as rabbitbrush is highly variable and declines

as succession proceeds. Research is lacking, but rabbitbrush may provide some site amelioration and accelerate sagebrush succession in the early stages.

During the BpS Review in 2017, revisions were made to this model based on reviews from Alan Sands and Louisa Evers. Evers made substantial revisions to both the model and description. Evers suggested that her model should also cover MZ18. Kori Blankenship did not implement this suggestion because the MZ18 model was identical to the MZ06 et al. model and for consistency with the Inter-Mountain Basins Montane Sagebrush Steppe (BpS 11260) and the Inter-Mountain Basins Big Sagebrush Shrubland (BpS 10800) systems, where MZ18 was included with the MZ06 et al. model centered on the Great Basin.

Sands, after reviewing all the models for this BpS, suggested that MZs 10 and 19 should be lumped with this model for MZs 01, 07, 08, and 09. Blankenship evaluated this suggestion and decided to implement it for several reasons: the same MZ grouping was used for the Inter-Mountain Basins Montane Sagebrush Steppe (BpS 11260), the models had nearly identical overall fire frequencies, and the descriptive information was similar. A couple of differences between the models were that the MZ10/19 model was represented by three classes versus the four classes used in the MZ 01, 07, 08, 09 model and that there were minor differences in the percentage of shrub cover described for the succession class mapping rules (+/-10%).

Sands reviewed the Evers model, and while Sands largely agreed with the Evers model and description, there were several areas of disagreement:

- 1) Sands disagreed with the ~60yr all FRI because he felt it was too frequent to maintain Wyoming big sagebrush cover. He suggested a 90-100yr all FRI, but did not provide literature or other references. Blankenship evaluated this suggestion but did not revise the modeled fire frequency, noting that there is considerable debate about the fire regime of sagebrush systems and that there has been disagreement among modelers and reviewers of the major sagebrush system in the west (for example, see BpS 11260-21 description, Baker 2006). Furthermore, the ~60yr interval is within the range reported for Wyoming big sagebrush (Howard 1999). If/when there is greater consensus on sagebrush fire regimes, the modeled fire frequency should be reevaluated.
- 2) Sands noted that fire events should cause a transition to the early class, which is not always the case in this model. Evers used these non-replacing fire events to represent fires that burn in a very patchy distribution.
- 3) Sands suggested that this system could be represented by a 3-class model, rather than 4 classes, and that the possibility for transition to juniper should be included. He added that juniper invasion was common in much of MZs 09 and 18. Evers indicated that historically trees would not be present. Blankenship allowed for the possibility of very sparse tree cover in the succession class mapping rules.
- 4) Sands disagreed on the role of grazers in this system. Ungulate grazing was represented in the Evers model, but Sands noted that pronghorn were never abundant enough to impact the successional dynamics. He did state that jackrabbit and vole herbivory could be important. Blankenship retained the native grazing transition in the model to represent ungulate, rabbit, or vole herbivory. Currently, the native grazing transitions do reset the class age.

- 5) 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.

Rod Clausnitzer contributed to the development of the MZ08 LANDFIRE National model.

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	UN	UN	UN	UN	UN
Herb	0.5-1.0	A	A	A	A	A	UN	UN	UN	UN	UN
Herb	>1.0	A	A	A	A	A	UN	UN	UN	UN	UN
Shrub	0-0.5	B	B	C	D	UN	UN	UN	UN	UN	UN
Shrub	0.5-1.0	B	B	C	D	UN	UN	UN	UN	UN	UN
Shrub	1.0-3.0	B	B	C	D	UN	UN	UN	UN	UN	UN
Shrub	>3.0	B	B	C	D	UN	UN	UN	UN	UN	UN
Tree	0-5	D	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	D	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 18 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSSP6	<i>Pseudoroegneria spicata</i>	Bluebunch wheatgrass	Mid
ACTH7	<i>Achnatherum thurberianum</i>	Thurber's needlegrass	Mid
ELEL5	<i>Elymus elymoides</i>	Squirreltail	Low-Mid
COLLI	<i>Collinsia</i> spp.	blue eyed Mary	Low-Mid

Description

This class is dominated by grasses and forbs. Bare ground is common and may exceed 50%, especially in the first few years following fire. Post-fire cover and recovery rates vary greatly depending on fire severity and post-fire precipitation amounts and timing as well as pre-fire species composition. This stage lasts up to 50yrs, depending on how quickly sagebrush is able to

begin reoccupying the area. Sagebrush establishment episodes occur approximately every 6 years, but cover is generally <1% in this class. Severe drought kills what sagebrush may be present.

Maximum Tree Size Class

None

Class B 26 Mid Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSSP6	Pseudoroegneria spicata	Bluebunch wheatgrass	Middle
ACTH7	Achnatherum thurberianum	Thurber's needlegrass	Middle
CREPI	Crepis	Hawksbeard	Low-Mid
ARTRW8	Artemisia tridentata ssp. wyomingensis	Wyoming big sagebrush	Upper

Description

Shrub savanna. Scattered sagebrush is present, but perennial grasses and forbs continue to dominate visually. Ecologically, the shrub and herbaceous layers (herbs 20-40% cover; up to 1m tall) are co-dominant in control of site resources. Sagebrush cover is usually 1-10% in this stage. Rabbitbrush cover may reach 20%.

Maximum Tree Size Class

None

Class C 22 Late Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRW8	Artemisia tridentata ssp. Wyomingensis	Wyoming big sagebrush	Upper
PSSP6	Pseudoroegneria spicata	Bluebunch wheatgrass	Middle
ACTH7	Achnatherum thurberianum	Thurber's needlegrass	Middle
CREPI	Crepis	Hawksbeard	Low-Mid

Description

Shrub-steppe. Sagebrush is co-dominant with the perennial grasses and forbs visually but dominant ecologically.

Maximum Tree Size Class

None

Class D 34 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRW8	Artemisia tridentata ssp. Wyomingensis	Wyoming big sagebrush	Upper
PSSP6	Pseudoroegneria spicata	Bluebunch wheatgrass	Middle
ACTH7	Achnatherum thurberianum	Thurber's needlegrass	Middle
CREPI	Crepis	Hawksbeard	Low-Mid

Description

Shrubland. Sagebrush is dominant with relatively low cover of perennial grasses and forbs. Sagebrush cover can be variable, with the lowest productivity sites reaching only about 15% canopy cover with large areas of bare ground and rock in the interspaces. Stands are typically older than ~80yrs.

Maximum Tree Size Class

None

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:OPN	49
Mid1:OPN	50	Late1:OPN	66
Late1:OPN	67	Late1:CLS	79
Late1:CLS	80	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
Wind or Weather or Stress	Early1:ALL	Early1:ALL	0.0065	154	No	0
Replacement Fire	Early1:ALL	Early1:ALL	0.02	50	No	0
Replacement Fire	Mid1:OPN	Early1:ALL	0.0045	222	Yes	0
Wind or Weather or Stress	Mid1:OPN	Mid1:OPN	0.0065	154	No	0
Replacement Fire	Mid1:OPN	Mid1:OPN	0.02	50	No	0
Native Grazing	Mid1:OPN	Mid1:OPN	0.02	50	Yes	0
Replacement Fire	Late1:OPN	Early1:ALL	0.0045	222	Yes	0
Wind or Weather or Stress	Late1:OPN	Mid1:OPN	0.0065	154	Yes	0
Replacement Fire	Late1:OPN	Mid1:OPN	0.02	50	Yes	0

Insects or Disease	Late1:OPN	Mid1:OPN	0.02	50	Yes	0
Native Grazing	Late1:OPN	Late1:OPN	0.02	50	Yes	0
Replacement Fire	Late1:CLS	Early1:ALL	0.0045	222	Yes	0
Wind or Weather or Stress	Late1:CLS	Late1:OPN	0.0065	154	Yes	0
Insects or Disease	Late1:CLS	Late1:OPN	0.02	50	Yes	0
Native Grazing	Late1:CLS	Late1:CLS	0.02	50	Yes	0

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