11260

Inter-Mountain Basins Montane Sagebrush Steppe

BpS Model/Description Version: Aug. 2020

Reviewer: Louisa Evers, Alan Sands

Vegetation Type

Steppe/Savanna

Map Zones

1, 7, 8, 9, 10, 19

Geographic Range

This Biophysical Setting (BpS) occurs across the Great Basin, Snake River Plains, Modoc Plateau, and Columbia Plateau. It is also found throughout foothills and at higher, cooler elevations of the Boise River, Salmon River, Seven Devils Mountains, and throughout western Montana and central Idaho. It can occur along the eastern edge of map zone (MZ) 01.

Biophysical Site Description

Inter-Mountain Basins Montane Sagebrush Steppe (cool, moist sagebrush) is typically found on moderately deep to deep soils where the soil temperature regime is frigid to cryic and the soil moisture regime is xeric. In MZs 10 and 19, the soil moisture was described as udic (not dry for as long as 90 cumulative days). Soils are typically well drained and are predominantly Mollisols. However, where the soil temperature regime is cryic, this setting can occur on shallower and rockier soils. It also includes shallow soils that saturate at least once every 10 years but are otherwise highly productive. Bare ground is uncommon, often <15%, especially in later stages.

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. This setting typically occurs >3,250 ft elevation (1,000 m) in the Columbia Plateau (MZs 01 and 08), >5,000 ft (1,524 m) elevation in the northern Great Basin (MZs 07, 09, 10, and 18), >6,000 ft (1,828 m) in the southern Great Basin (MZs 12 and 17), but it can occur lower on northerly aspects and from 4,000 to 10,000 ft in Montana and central Idaho (MZs 10 and 19).

Precipitation is between 12-20in annually, with most precipitation in the winter and spring months; winter precipitation is typically snow, with typical snow depth of 15in (38 cm) and greater.

Vegetation Description

Mountain big sagebrush (*Artemisia tridentata* spp. *vaseyana*) is the dominant big sagebrush subspecies. Some authors recognize snowfield big sagebrush (*A.t.* spp. *spiciformis*) as a separate species or subspecies from mountain big sagebrush and found where the soil temperature regime is cryic and xeric big sagebrush (*A.t.* spp. *xericensis*) as a separate subspecies and found at the ecotone between cool-moist (i.e. Montane) and warm-dry (i.e. Big Sage) sagebrush steppe where the soil moisture regime is aridic bordering on xeric. However, field identification of these two additional subspecies is difficult and still somewhat controversial. Antelope bitterbrush (*Purshia tridentata*) is a common co-dominant on warmer sites. On cooler sites, mountain big sagebrush can be mixed with other sprouting shrub species such as Saskatoon serviceberry (*Amelanchiar alnifolia*) and mountain snowberry (*Symphoricarpos oreophilis*), grading into the mountain shrub communities. However, sprouting shrub species, with the exception of antelope bitterbrush, are only a minor component in the mature stages of this BpS. At lower elevations, mountain big sagebrush may be intermingled with pockets of threetip sagebrush and with Wyoming big sagebrush where the soil moisture regime is xeric bordering on aridic. Highly productive little sagebrush communities are intermingled with mountain big sagebrush communities, occurring on shallower soils that saturate at least once roughly every 10yrs but with Idaho fescue or Idaho fescue-bluebunch wheatgrass as the dominant grasses. Shrub cover typically varies between 10-30%, with cover >40% in the late successional closed stage where one or more fire return intervals (FRIs) have been missed. Sagebrush is the dominant shrub species in later successional stages while rabbitbrush can be the dominant shrub species in earlier successional stages.

Herbaceous diversity is typically high with over 40 vascular plant species potentially present on the most productive sites. Dominant grasses are deep-rooted, moist-site bunchgrasses such as Idaho fescue and rough fescue. Somewhat drier sites often include a deep-rooted, drier site bunchgrass, such as bluebunch wheatgrass, or Columbia needlegrass, as a co-dominant. Shallow-rooted bunchgrasses, such as Sandberg's bluegrass, can occur occasionally and primarily in earlier successional stages. Other common grasses include: squirreltail (*Elymus elymoides*), slender wheatgrass (*Elymus trachycaulus*), needle-and-thread (Hesperostipa comate), and prairie Junegrass (*Koeleria macrantha*). Grass production usually >600 lbs/ac (672 kg/ha) in average and high production years. These sites support a variety of deep-rooted perennial forbs. Forb abundance is variable year to year, affected by the amount and timing of precipitation. Indicative forbs include *Eriogonum umbellatum*, *Antennaria microphyla*, *Balsamorhiza sagittata*, *Lupinus* spp., *Delphinium* spp., *Castilleja* spp., and *Geranium viscosissimum*. *Astragalus purshii* may be present in the early growing season.

BpS Dominant and Indicator Species

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

Disturbance Description

This BpS is subject to stand-replacing fires historically with a mean return interval ranging from 10yrs at the ponderosa pine ecotone to 40yrs at the Inter-Mountain Basins Big Sagebrush Steppe (warm-dry sagebrush steppe) ecotone. In most years, the resulting burn pattern is patchy with large, homogeneous burn patterns rare. While this BpS is less fuel limited than other sagebrush systems, the burning practices of Native Americans were still likely very influential in community dynamics. At least 5% of a given watershed needs to burn each decade to prevent conifer expansion; in many locations, lightning fires are too infrequent to provide this level of burning. 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 were limited. Deliberate use of fire by Native Americans most likely occurred in late winter-early spring and in fall and produced patchy burns, while accidental ignitions could occur whenever conditions were dry enough and fuels continuous enough. Lightning-caused fire occurred in summer, primarily in July and August.

The mosaic burn pattern is largely a function of fires of 100-5,000 ac in size, creating several age classes across the larger landscape that shifted from place to place. 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.

Recovery rates for shrub canopy cover vary widely in this type, depending on post-fire weather conditions, abundance of resprouting shrubs, and size and severity of the burn. 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). It typically reaches 5% canopy cover in 8-14yrs but may occur in as little as 4yrs during cooler, wetter periods or longer than 25yrs in warmer, drier periods. It typically reaches 25% canopy cover in about 25yrs, but this may take as few as 9yrs or >40 yrs. Mountain snowberry and resprouting forms of bitterbrush may return to pre-burn cover values in a few years. Bitterbrush plants <50yrs old are more likely to resprout than older plants.

Montane sagebrush communities are also subject to periodic mortality due to drought, insects, freezekill, snowmold, and vole outbreaks. However, these disturbance types remain little studied in sagebrush ecosystems. These disturbances in combination with fire likely reduced the development of very dense sagebrush stands over large areas.

Severe drought can kill sagebrush, as happened in the 1930s, but little is known about the severity or duration of drought needed. Droughts similar to that in the 1930s occurred every 100-200yrs in the past and affected millions of acres.

Several insects can reduce sagebrush canopy cover, but mortality has been documented only for aroga moth (*Aroga websteri*). Outbreaks are associated with near-average temperatures from mid-May to mid-June with high precipitation in June and July. Such conditions occur every 40-60yrs. Aroga moth outbreaks thin sagebrush stands at the least and may cause larger-scale mortality in particularly severe outbreaks, affecting millions of acres. 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.

Vole outbreaks, freezekill, and snowmold thin sagebrush canopies and result in patches of mortality ranging from scattered single shrubs to patches 10s of acres in size. The most widespread mortality is associated with subregional to regional freezekill. Freezekill typically occurs when below-average snowpacks or late starts to snow accumulation combined with episodes of very cold temperatures freeze soils deeper than usual but leave sagebrush incompletely or uncovered by snow. A subsequent warm spell in late winter or early spring triggers physiological activity in sagebrush while soils are still frozen, triggering physiological drought. Freezekill episodes are believed to have occurred every 40-60yrs.

Fire Frequency

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 type occupies areas ranging in size from 100s to 10,000s of acres. Disturbance patch size can range from 10s of acres to 100s or 1,000s of acres.

Adjacency or Identification Concerns

This type may be adjacent to forests dominated by aspen or conifers; juniper, pinyon-juniper, and mountain-mahogany woodlands; and mountain shrub communities. At the lower elevation, at the dry end of the type, this BpS could be confused with warm-dry sagebrush steppe (LANDFIRE’s Inter-Mountain Basin Big Sagebrush Steppe, BpS 11250, or Great Basin Xeric Mixed Sagebrush Shrubland, BpS 10790). Since this BpS also includes very productive little sagebrush sites with Idaho fescue or Idaho fescue-bluebunch wheatgrass, it could be confused with shallow-dry sagebrush steppe (LANDFIRE’s Columbia Plateau Low Sagebrush Steppe, BpS 11240, or Great Basin Xeric Mixed Sagebrush Shrubland, BpS 10790).

This BpS can have scattered trees intermixed at the ecotone with forests and woodlands but not enough to warrant development of a different BpS description. Tree cover does not exceed 5%. Greater tree cover would indicate an uncharacteristic condition within this type. Otherwise, this type could be confused with pinyon-juniper woodland or open ponderosa pine.

Juniper and pinyon encroachment is so extensive that this type can be misclassified as Columbia Plateau Juniper (BpS 10170) or Great Basin Pinyon-Juniper (BpS 10190). In the northern Great Basin, the primary encroaching species is western juniper. In the southern Great Basin, Colorado Plateau, and eastern Idaho, the primary encroaching species are Utah juniper and either single-leaf pinyon or both single-leaf and two-leaf pinyon. Other encroaching conifers include Rocky Mountain juniper, ponderosa pine, lodgepole pine, and Douglas-fir. Soil depth is a key indicator of whether a site is likely Inter-Mountain Basins Montane Sagebrush Steppe with extensive conifer encroachment.

Shrub height and cover may serve to separate the Inter-Mountain Basins Montane Shrubland setting from the Inter-Mountain Basins Montane Sagebrush Steppe setting as many of the associated sprouting shrubs are taller than mountain big sagebrush. Another indicator of the change to Inter-Mountain Basins Montane Shrubland is the proportion of the shrub vegetation that are sprouting species. While there are no clear breakpoints, if sprouting shrubs other than rabbitbrush comprise >30% of the shrub canopy cover, the type is Montane Shrubland instead of Montane Sagebrush Steppe.

Invasive forbs and annual grasses are increasing in this type as well. As the climate warms, cheatgrass appears to be increasing at the warmer, drier end of the BpS. Ventenata (*Ventenata dubia*) may be increasing at the cooler, moister end and appears to be spreading through adjacent open conifer BpS in the northern Great Basin and Snake River Plains.

The persistent legacy of past grazing practices in combination with aggressive fire suppression have resulted in much more extensive areas of the late-closed class and a higher proportion of rabbitbrush than were likely typical under historical disturbance regimes.

This BpS lies adjacent to a wide variety of other BpSs too numerous to list.

Issues or Problems

Separating this BpS from adjoining higher-elevation settings has proven difficult, as mountain big sagebrush is often a component of those other settings. Elevation thresholds vary through the Inter-Mountain Basins, typically occurring at lower elevations in the northern latitudes and higher elevations in the southern latitudes of this setting, making rule development difficult. A precipitation threshold may be more useful, such as using 20in average annual precipitation, but this factor has not been studied for this purpose. Use of tree cover is also problematic given the degree of conifer encroachment, particularly where the encroaching trees are ponderosa pine, lodgepole pine, or Douglas-fir, as these species occur on deeper soils, unlike the historical pinyon and juniper BpS.

At the upper end of this BpS snowbrush ceanothus (*Ceanothus velutinus*) may be present in the seedbank, although absent from the pre-fire plant community. Post-fire, snowbrush ceanothus may exceed 30% canopy cover, causing confusion over which BpS is present: Montane Shrubland or Montane Sagebrush Steppe. Such sites may be ecotonal between the two BpSs as the pre-fire community may also contain several other sprouting shrub species with low canopy cover.

The FRIs reported in the literature for this type vary widely (Innes 2017). Estimating historical 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. Fire regimes also 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.

Native Uncharacteristic Conditions

Greater than 5% tree cover indicates an uncharacteristic type if the trees are juniper or a change to a different BpS if the trees are ponderosa pine or Douglas-fir. Shrub cover >30% indicates one or more FRIs have been missed.

Comments

The primary successional pathway is from Early to Mid-Open to Late-Open to Late-Closed. The Mid-Closed class does not occur. Sagebrush establishment is episodic, with establishment episodes occurring approximately every other year in this setting. 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 the Mid-Open class, shrubs and the herbaceous layer have co-equal control of site resources. In the Late-Open class, shrubs have primary control over site resources. The Late-Closed class develops when one or more fire intervals have been missed. Some research suggests that significant portions of the landscape may have cycled rapidly between the Mid-Open, Late-Open, and Late-Closed classes due to rapid recovery rates.

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. The Early, Mid-Open, and Late-Open classes can support both heterogeneous and homogeneous burn patterns although heterogeneous burn patterns are thought to be the rule in these classes. Late-Closed tends to support primarily homogeneous burn patterns.

In the state-and-transition model, drought is represented by the wind/weather/stress transition.

During the BpS Review, MZs 01, 07, 08, and 09 were combined because they were identical.

During the review, Louisa Evers substantially revised this description and model. Many of the changes were made to remove information related to montane shrub communities that is covered by the Inter-Mountain Basins Montane Shrub BpS. Evers suggested that the name of this BpS be changed to Inter-Mountain Basins Cool-Moist Sagebrush Steppe.

Evers intended her revised model to cover MZs 01, 07, 08, 09, 10, 12, 17, and 18. Kori Blankenship decided that the final model would apply to MZs 01, 07, 08, 09, 10, and 19.

-MZs 12 and 17 were not included in the MZ01 et al. model because they were part of a larger group of models centered on the Great Basin and because the models were substantially different, thus making them difficult to combine.

-There was disagreement among reviewers about where MZ18 belonged. One reviewer suggested that MZ18 should be included with the MZ 01 et al. model while another suggested that it belonged with the MZ06 et al. model. Blankenship decided to lump MZ18 with MZ06 et al. because the models were identical. In the future, a finer level spilt of MZ18 could be considered: the northern part of MZ18, which falls within the Snake River Plain ecoregion (US EPA 2013), could be lumped with MZ01 et al., and the southern part, within the Northern Basin and Range ecoregion, could be lumped with MZ06 et al. MZs 10 and 19 were lumped in with MZ01 et al.

Evers had suggested that MZ 01 et al. and the MZ10/19 model were very similar; and the species composition between the two models was similar. There were two key differences between the models. First, the MZ10/19 model included native grazing for ungulates at a very low probability (.002), and the Evers model did not. When combining the models, Blankenship did not include the native grazing transitions from MZ10/19 because the impact of the transitions on the model results was minimal (the probability was so low and only one of the three native grazing transitions caused a state change) and because a reviewer indicated the native grazing was not a significant factor in this BpS. (The reviewer stated: “I don't think elk/deer/pronghorn antelope grazing are an important disturbance factor in any of the MZs [i.e., MZ01 et al. or MZ10/19). The vegetation in these areas evolved without high densities of native ungulates. The paucity of growing season precipitation (i.e., almost all in winter and spring with very little in the summer) caused a nutritional bottleneck, and this kept their populations relatively low.”) Second, the Evers model resulted in most of the landscape in the Late Closed state whereas the MZ10/19 model resulted in most of the landscape in the Mid development state.

Alan Sands reviewed the model and description after the Evers modifications and generally agreed with the description and model, but he listed several areas of disagreement:

-Sands felt that the FRI was too frequent to maintain a sagebrush community and suggested an FRI of ~50yrs (with a range of 10-75yrs). Blankenship did not make adjustments to the model based on this comment because there is considerable debate over the fire frequency in this BpS (see Innes 2017 and the LANDFIRE MZ21 description for this BpS).

-Sands felt the model should include a conifer class because this type is frequently adjacent to tree communities (see below for more discussion).

-Based on personal experience, Sands felt that canopy cover for this type is often in the low 40s, seldom in the 50s, and would never reach 60%. Because both the revised Evers model and the MZ10/19 model described the maximum shrub canopy cover for this type as 60%, Blankenship did not change the maximum cover value.

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)

The LANDFIRE National model for MZs 01, 07, 08, and 09 was developed by Louisa Evers, John Bates, Jim Evans, and Rod Clausnitzer (rclausnitzer@fs.fed.us) with review from Jeff Rose and Gregg Riegel. The MZ 10/19 model was developed by Kathy Geier-Hayes (kgeierhayes@fs.fed.us), Steve Rust (srust@idfg.idaho.gov), and Susan Miller (smiller03@fs.fed.us). Reviewers were Dana Perkins (dana\_perkins@blm.gov), Carly Gibson (cgibson@fs.fed.us), Mary Manning (mmanning@fs.fed.us), Lois Olsen (lolsen@fs.fed.us), and Robert Wooley (rwooley@fs.fed.us).

Succession Classes

**Mapping Rules**

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 10 Early Development 1 - All Structures

Indicator Species

Description

Sagebrush canopy cover is <10%. Herbaceous canopy cover is variable but typically >50%. Initial sagebrush and bitterbrush establishment is relatively slow, and canopy cover is usually not much more than a trace. When sprouting shrubs such as rabbitbrush are present, total shrub cover ranges from 5-15%. Sagebrush establishment is episodic, typically occurring every 5-6yrs. Plant cover may be sparse for the first 1-2yrs post-fire but quickly recovers to high levels. Typically present for ~18yrs post-fire.

*Maximum Tree Size Class*  
None

Class B 23 Mid Development 1 - Open

Indicator Species

Description

Sagebrush or sagebrush-bitterbrush canopy cover is 1-10%. If sprouting shrubs such as rabbitbrush are present, total shrub cover may reach 20%, but sprouting shrubs show signs of declining. The dominant lifeform visually is herbaceous. Herb cover is typically >50% but ranges from 30-70% and herb height is up to 1m tall. Although forbs and grasses may be visually dominant, the shrub and herbaceous layers are co-dominant below-ground. Mountain big sagebrush is scattered throughout. Formation is sagebrush savannah.

*Maximum Tree Size Class*  
None

Class C 20 Late Development 1 - Open

Indicator Species

Description

Sagebrush or sagebrush-bitterbrush cover is 11-30%. Species such as snowberry, rabbitbrush, and serviceberry may be present in small clumps. Mature mountain big sagebrush and bitterbrush are widespread. Plants have noticeable dead material in the crowns. The dominant lifeform is herbaceous. Herb cover ranges from 30-70%, and herb height is up to 1m tall. Formation is sagebrush steppe.

*Maximum Tree Size Class*  
None

Class D 47 Late Development 1 - Closed

Indicator Species

Description

Shrub canopy cover >30% with mountain big sagebrush or sagebrush-bitterbrush dominant. Dead shrubs, either sagebrush or other species, may be present, and crowns of living shrubs contain a significant proportion of dead material in their crowns. Herbaceous cover is <30%. Grasses and forbs tend to be limited to the dripline of shrubs, with bare ground in the interspaces increasing.

*Maximum Tree Size Class*  
None

Model Parameters

Deterministic Transitions

Probabilistic Transitions

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