11250

Inter-Mountain Basins Big Sagebrush Steppe

BpS Model/Description Version: Aug. 2020

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Vegetation Type

Steppe/Savanna

Map Zones

6, 12, 13, 15, 16, 17, 18, 23, 24, 25, 28

Geographic Range

This widespread matrix-forming biophysical setting (BpS) occurs throughout much of the Columbia Plateau, northern Great Basin, and Wyoming and is found at slightly higher elevations farther south.

Biophysical Site Description

Sagebrush steppe is found in a continental, semi-arid climate with highly variable annual precipitation from 7-12in (~180-300mm, McArthur 2000) and possibly up to 14in. Common on foothills, undulating terraces, slopes, and plateaus but also in basins and valley bottoms. This BpS typically occurs <5,000ft (1,524m) elevation in the northern Great Basin and <6,000ft (1,828m) in the southern Great Basin. It can occur at higher elevations on southerly aspects and in areas further east (e.g., may be found up to 7,600f in map zone [MZ] 28). Soil depths range from shallow to moderately deep, well-drained with an effective rooting depth of <40in (~1m). NRCS Range Sites: Loamy 8-10in and 10-12in precipitation zones and Shallow Loam 10-14in precipitation zones.

Because sagebrush steppe occupies soil types that are readily invaded by conifers in other adjacent MZs and because of the lack of tree invasion due to limited biogeographic distributions of pinyon and juniper, the lack of tree seed sources might be the defining factor of this BpS compared to big sagebrush shrubland on upland soils (10-14in precipitation zone) but with trees present. The steppe quality of this system will further increase with effective soil moisture.

Vegetation Description

This shrub-steppe is dominated by perennial grasses and forbs (>25% cover) with *Artemisia tridentata* ssp. *tridentata*, *Artemisia tridentata* ssp. *xericensis*, *Artemisia tridentata* ssp. *wyomingensis*, *Artemisia tripartita* ssp. *tripartite*, and/or *Purshia tridentata* dominating or co-dominating the open to moderately dense (10-40% cover) shrub layer. In southern Idaho and northern Utah, *Artemisia tridentata* ssp. *wyomingensis* dominates large landscapes. *Atriplex confertifolia*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa* or *Tetradymia* spp. or *Artemisia frigida* may be common, especially in disturbed stands. Associated graminoids include *Achnatherum hymenoides*, *Calamagrostis montanensis*, *Elymus lanceolatus* ssp. *lanceolatus*, *Festuca idahoensis*, *Festuca campestris*, *Koeleria macrantha*, *Poa secunda*, and *Pseudoroegneria spicata*. Common forbs are *Phlox hoodii*, *Arenaria* spp., *Astragalus* spp., *Crepis* spp., *Erigeron* spp., *Eriogonum* spp., and *Lomatium* spp. Areas with deeper soils more commonly support *Artemisia tridentata* ssp. *tridentata* but have largely been converted for other land uses.

The sagebrush steppe landscape is a mosaic of shrub-dominated and herbaceous-dominated phases (West 2000). Forbs have low diversity but are important for wildlife, including the greater sage grouse. Species diversity is lower in Wyoming big sagebrush communities than in other big sagebrush types (Howard 1999). Wyoming big sagebrush communities are critical habitat for greater sage grouse and other sagebrush-obligate species.

BpS Dominant and Indicator Species

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

Disturbance Description

Historically, fire was the principal disturbance within this vegetation type. However, recent research shows that Aroga-moth-induced mortality might have been as important as fire in northeastern California, Idaho, northern Nevada, Oregon, and northern Utah (Bolshakova and Evans 2014, 2016). In areas where Aroga moth outbreaks are not a factor, proximity of sagebrush steppe to biophysical settings with short mean return interval, such as ponderosa pine, probably maintains fire as a dominant process that prevents tree establishment. Therefore, decrease in the importance of Aroga moth outbreaks might be replaced by shorter fire return intervals (FRIs) in these zones, although this trade-off has not been demonstrated.

Intervals between natural wildfires varied between 25yrs (e.g., northern Yellowstone National Park [Houston 1973, cited in West 2000] and 100yrs+ [West 2000]). West (1983) and Miller and Eddelman (2000) cite mean fire return intervals (MFRIs) of <100yrs for replacement fire. Howard (1999) cites fire return interval (FRI) ranges between 10-70yrs with a mean of 40yrs for Wyoming sagebrush steppe. Studies cited in Howard (1999) may underestimate FRIs or not hold up to scrutiny (Welch and Criddle 2003).

During model sensitivity analysis of the MFRI, it was found that rather large differences in the MFRI only produced at most 5-10% change in reference class proportions. It was assumed that dominant fires were stand-replacement due to the continuity of fine fuels typical of steppe ecosystems, the high fire sensitivity of sagebrush wood, and the high flammability of volatile oils in sagebrush. Sagebrush does not underburn; therefore, mixed-severity and surface fires do not exist in this BpS. Reestablishment following fire is from seed germination and establishment. Establishment is dependent upon soil seedbank and/or proximity of seed sources, fire size and continuity, and climatic conditions.

Aroga moth is capable of defoliating large areas (i.e., >1000ac), but usually outbreaks range from 10-100ac. Aroga moth outbreaks are more prevalent in lower-elevation sagebrush (where there are fewer flowering plants and less nectar to feed the parasitic wasps that attack the moth). Aroga moth outbreaks either kill or thin older sagebrush classes. In MZs 12 and 17, Aroga moth outbreaks are more prevalent in the northern part of Nevada closer to the Idaho and Oregon borders. The moth appears to be common in MZs 07, 09, and 18. However, Aroga moth outbreaks do not appear to be as important, or even present, in central and southern Nevada and Utah where most of MZs 12 and 17 are located. Outbreaks are most likely during years when the months of June and July are substantially wetter than average but temperature is about average (Bolshakova and Evans 2014, 2016). The return interval of moth outbreaks is about 8-15yrs (rate = 0.067/yr for a 15yr return interval) in both the Columbia Plateau ecoregion of southern Idaho and Oregon and northern Nevada and Utah. The 15yr return interval is based on the examination of monthly minimum temperature (from 1896-2015 PRISM climate time series) deviations from the average (where average minimum monthly temperature was <+1 and >-1 standard deviations from the mean) and Standard Precipitation Index values >100 (=+1 stdev) for July lagged for two months (i.e., June, and July) of the same year. Outbreaks can partially thin late-development sagebrush classes to the previous succession classes (i.e., from late-development to mid-development classes) or completely kill sagebrush cover and cause a transition to the early-development class. Choosing the proportions of partial thinning versus full woody thinning events will affect the reference proportions; however, no data can be found on these proportions. A proportion of 75% was used for partial thinning and 25% for complete sagebrush thinning. Using proportions of 90% for partial thinning and 10% for stand-replacing events only changed the reference proportions by 5% (i.e., 20% for A, 50% for B, and 30% for C). *Note*: LANDFIRE models do not use the proportion function, but the same result is achieved by multiplying the probability by the proportion and using the result as the modeled probability.

Drought is only modeled as severe drought based on Biondi et al. (2007). It is assumed that non-severe drought will not appreciably thin or kill patches of sagebrush, salt desert, and subxeric woodlands. Severe drought is defined as ≥5 consecutive years of well below-average soil moisture (narrow tree rings) and will kill subxeric shrubs and trees. A severe drought return interval rate of ~142yrs (a rate of 1/142yr = 0.007/yr) is used based on the analysis of a standardized (deviation from the average) 2,300yr time series of western juniper (*Juniperus occidentalis)* tree ring data from the Walker River drainage of eastern California and western Nevada (Biondi et al. 2007). These data highly correlate with other regional datasets for other tree species. To determine severe droughts, all 5yr sequences of below-average tree ring width deviation (i.e., negative deviation) were identified. Second, average tree ring deviations (average of the negative sequence), which were narrower than ≤1 Standard Deviation Unit, were further identified in those sequences. Fourteen such events occurred during the last 2,300yrs. We calculated the number of years between severe drought events, which yielded an average of 142yrs. In most models and vegetation classes, severe drought generally has two effects: 1) thinning shrubs or trees without causing a transition to another class for 90% of chosen pixels (but age is reset to the youngest age of the class) and 2) thinning shrubs or young trees to the previous succession class for 10% of the remaining pixels (age is reset to the youngest age of that class). *Note*: LANDFIRE models do not use the proportion function, but the same result is achieved by multiplying the probability by the proportion (e.g., .007 x .9) and using the result as the modeled probability.

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

Sagebrush steppe covers vast landscapes >10,000ac with inclusions of low sagebrush and basin big sagebrush. Historic disturbance (fire) likely ranged from small (<10ac) to large (>10,000ac) depending on conditions, time since last ignition, and fuel loading. Assumed the average patch size is 250ac. Aroga moth outbreaks appear to be 10-100ac. Severe drought is regional, but local soil conditions and patchy precipitation result in scales of thinning and mortality of 100-50,000ac.

Adjacency or Identification Concerns

The NatureServe description of this BpS includes different species of sagebrush and steppe ecosystems that are structurally and ecologically different, such as *Artemisia tridentata* ssp. *tridentata*, *Artemisia tridentata* ssp. *wyomingensis*, and *Artemisia tripartita* ssp. *tripartita*. Review indicated that these species, especially *Artemisia tridentata* ssp. *tridentata*, should be modeled separately, but another reviewer indicated that it would be very difficult to map the types separately using 30m imagery.

Wyoming big sagebrush is known to hybridize with other subspecies of the big sagebrush complex, i.e., basin big sagebrush (*A. tridentata* ssp. *tridentata*) and mountain big sagebrush (*A. tridentata* ssp. *vaseyana*) (Freeman et al. 1991; McArthur et al. 1998). Across ecotones, populations of Wyoming big sagebrush probably intergrade with basin big sagebrush and mountain big sagebrush. Soils and elevation may help determine which species is present.

The main difference between big sagebrush shrubland with trees (BpS 10802, Inter-Mountain Basins Big Sagebrush Shrubland-Upland) and this big sagebrush steppe is the distributional absence of trees or inability of trees to invade. It is conceivable for MZs where trees are found adjacent to big sagebrush steppe that fire importation from BpSs with short FRIs maintains the steppe character and could partly account for past disagreement in the literature. This needs to be investigated.

BpS 1125 represents the dominant sagebrush type in MZ18; however, this type may be confused with BpS 1080 (Inter-Mountain Basins Big Sagebrush Shrubland) on the transition of the Great Basin and Columbia Plateau.

Bitterbrush is not found in a large area of north-central Nevada on the more alkaline soils of Pleistocene Lake Lahontan.

Invasion of cheatgrass has transformed this BpS into large areas of uncharacteristic annual grasslands and shrublands with understories where annual grasses have replaced perennial grasses. Medusahead, another exotic annual grass, is also becoming an issue in finer-textured soils.

Issues or Problems

West (2000) cites a wide range in MFRIs (25-100yrs+). West (1983) and Miller and Eddelman (2000) recommend an MFRI of <100yrs for replacement fire. Howard (1999) gives 10-70yr range (40yr average, but see Welch and Criddle 2003). Mike Pellant, BLM Range Ecologist on the Great Basin Restoration Initiative, estimates a natural FRI of ~100yrs (confirmed by Stephen Bunting and Dave Pyke).

Only a handful of papers have documented the ecology and cases of outbreaks for Aroga moth. All evidence suggests climate conditions for outbreaks occur every 8-15yrs, but the intensity of thinning is not documented at landscape scale. Aroga moth outbreaks appear to be important in succession dynamics.

Native Uncharacteristic Conditions

The most common native uncharacteristic classes are 1) late-succession sagebrush cover with no herbaceous understory, most likely caused by historic non-native ungulate grazing, and 2) areas dominated by early-succession shrubs such as rabbitbrush and snakeweed, again due to historic non-native ungulate grazing. The proportion of early-succession shrubs increases with soil productivity.

Comments

During the 2016 system-wide review, this BpS was reviewed by Louis Provencher, Tanya Anderson, Bob Unnasch, and Joel Tuhy of The Nature Conservancy, and several changes were made:

1. The duration of Class B was shortened as the change in shrub cover from 10% to 20% occurs rapidly after Class A. The choice of age intervals will change the proportion of reference classes. A shorter age interval for Class B will increase the importance of Class C;
2. Data supported return intervals for Aroga moth outbreaks, and severe droughts replaced those of the original models. In the original model, both the rates of insect/disease and weather/stress were generated by expert opinion. Since that time, new data have become available that warranted changing disturbance rates; and
3. The rate of replacement fire in the late-development class and the proportion of stand-thinning for Aroga moth outbreaks were varied to test effects on the reference proportions presented below. When the MFRI of Class C was shortened from 100yrs to 75yrs (as in the original model), the reference proportions changed from A: 25% -- B: 50% -- C: 25% to A: 30% -- B: 50% -- C: 20%, respectively. When the moth outbreak proportions for partial thinning to full thinning were changed from 75% and 25% to 90% and 10%, respectively, the reference proportions changed from A 25% -- B 50% -- C 25% to A 20% -- B 50% -- C 30%, respectively. Therefore, quite different changes in rates and proportions only caused a 5% reallocation of the reference proportion.

MZs 06, 12, 13, 15, 16, 17, 23, and 24 were combined during 2015 BpS Review. MZs 18 and 28 were lumped into the MZ06 et al. group during the 2017 review because the models were identical, the descriptions were nearly identical, Blankenship felt the minor differences in the succession class mapping rules were resolvable, and Sands recommended including MZ28 with the MZ06 et al. model and, for consistency, with the Inter-Mountain Basins Montane Sagebrush Steppe (BpS 11260) system where MZs 18 and 28 were included with theMZ06 et al. model centered on the Great Basin. Louisa Evers, who contributed to the model for this BpS in MZs 01, 07, 08, 09, 10, and 19 suggested that MZ18 could be included with the MZ01 et al. model, but Blankenship felt that MZ06 et al. was a better place to lump MZ18 for the reasons listed previously.

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

For the LANDIFRE National MZ18 model, Eric Limbach was a modeler and Jon Bates was a reviewer; for MZ28 model, Don Major was a modeler and Vic Ecklund, Chuck Kosteka, and an anonymous contributor reviewed the model.

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 24 Early Development 1 - Open

Indicator Species

Description

Perennial grasses and forbs dominate where woody shrub canopy has been killed and removed by wildfire. Shrub cover <10%.

*Maximum Tree Size Class*  
None

Class B 50 Mid Development 1 - Open

Indicator Species

Description

Shrubs dominate with diverse and abundant perennial grass and forb understory.

*Maximum Tree Size Class*  
None

Class C 26 Late Development 1 - Closed

Indicator Species

Description

Mature shrub canopy with proportional reduction in understory productivity as canopy cover increases. Aroga moth outbreaks are tied to favorable June and July precipitation and temperature levels about every 15yrs.

*Maximum Tree Size Class*  
None

Model Parameters

Deterministic Transitions

Probabilistic Transitions

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