

LANDFIRE Biophysical Setting Model

Biophysical Setting 2911260

Inter-Mountain Basins Montane Sagebrush Steppe

- ☐ This BPS is lumped with:
☐ This BPS is split into multiple models:

General Information

Contributors (also see the Comments field)

Date 6/13/2006

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Vegetation Type

Upland
Savannah/Shrub
Steppe

Dominant Species

ARTRV
PSSP6

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Northern Plains
☐ N-Cent. Rockies

General Model Sources

- ☒ Literature
☐ Local Data
☒ Expert Estimate

FEID
POSE
SYOR2
BAIN
BASA3
GEVI2

- ☐
☐ Great Basin
☐ Great Lakes
☐ Hawaii
☐ Northeast
☒
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Geographic Range

Scattered throughout the montane zones of the Bighorns in northcentral WY and Pryor Mountains (342Ad) in southcentral MT.

Biophysical Site Description

This type can occur from 4500-8800ft in the Pryor Mountains in southcentral MT; from 4500-9800ft in the Bighorn Mountains.

It is scattered in forest openings throughout the zone, and adjacent to lower forested areas.

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. Soils are deep, well drained.

Vegetation Description

Mountain sagebrush steppe dominated by mountain big sagebrush, with a frequent presence of mountain snowberry and with a continuous grass and forb understory is believed to be a presettlement vegetation type within this map zone, although the exact composition of the community before settlement is unknown.

Dominant shrubs include mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and mountain snowberry (*Symphoricarpos* spp). Other common shrubs include serviceberry (*Amelanchier alnifolia*),

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wild cherry (PRVI), rose and currant. Other shrubs may be locally common.

Herbaceous cover is moderate to abundant ranging from 40-85%. Common grasses include: *Festuca idahoensis*, *Agropyron spicata*, *Elymus elymoides*, *Elymus trachycaulus*, *Elymus caninus*, *Stipa occidentalis*, *Hesperostipa comata*, *Koeleria cristata* and *Poa secunda*. Common forbs include *Geum triflorum*, *Eriogonum umbellatum*, *Antennaria microphyla*, *Balsamorhiza incana*, *Balsamorhiza sagittata*, *Lupinus* spp, *Delphinium* spp, *Castilleja* spp and *Astragalus* species. *Geranium viscosissimum* is an indicator of a more mesic phase of this type.

Purshia tridentata is typically NOT present in this type in MZ29.

This vegetation type may occur as inclusions within forested types.

Disturbance Description

GENERAL

Fire is a major disturbance factor for mountain big sagebrush (Blaisdell et al 1984, Johnson 2000). The fire return intervals reported in the literature for this type vary from 10-70yrs (Hironaka et al. 1983, Miller and Rose 1999, Wright and Bailey 1982; Houston 1973; Arno and Gruell 1983) and up to 200yrs (Baker, in press).

The model for MZ21 was based on the model for MZs 10 and 19; however, major quantitative changes were made. The model for MZs 10 and 19 employed an overall fire return interval of 26yrs (100yrs for replacement fire; 35yrs for mixed fire). The model for MZ21 was originally modeled with a FRI of 175yrs in A, 130yrs in B, and 130yrs in C, for an overall FRI of 135yrs. Initial reviewers suggested an overall 50-70yr interval. After much debate, as described below, the regional lead chose an interval of 50yrs, which was accepted by Tart and Kitchen. An anonymous contributor disagreed and presented evidence to the contrary. The regional lead, therefore, chose an interval of 80yrs, which was then met with disapproval by Tart, Kitchen, and others, which led to the request that these issues be elevated to LANDFIRE leadership. Kitchen recommended an interval of 60yrs in order to reach a compromise.

20-50yr INTERVAL

Tart (personal correspondence) states that the studies most relevant to MZ21 are Houston (1973) and Arno and Gruell (1983). Neither reported CFI over a large area. Houston (1973) reported single tree FI from 36-108yrs for the life of the tree up to 1970; the average for the subunits of the study area ranged from 53-96yrs on trees (adjacent to shrubland); they adjusted to account for fire frequencies prior to modern man, to get an MFRI resulting in 32-62yrs on representative, unprotected sites for the period through 1890 (pre-suppression), with a mean of 49yrs. Also, to evaluate single-tree values, Houston used six groups of 2-3 cross-dated trees to account for missing scars. Trees within a group were 5-25m apart. The MFRI resultant values ranged from 17-26yrs with a mean of 22yrs on representative, unprotected sites.

Arno and Gruel (1983) reported intervals between 22-60yrs, with a mean of 43yrs for the Douglas-fir/shrub/grass ecotone, based on tree fire scars adjacent to shrubland. They both report MFRI values for either single trees or small areas (Tart, personal correspondence).

However, an anonymous contributor to MZ21 (personal correspondence) states that Houston's (1973) value of 53-96yrs (and 32-62yrs in pre-Euro) is a composite fire interval estimate from 34 trees in a set of seven units, within which trees were composited (Houston Table 1). The individual tree values are only given in the text as "36-108yrs" across the sample (p. 1112). Houston's "intrastand" estimates of 20-25yrs are CFI estimates. Note that these trees also are not scattered within the steppe as in the first sample, but

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are from along the forest ecotone (p. 1113). Thus, Houston's estimate of 20-25yrs requires correction for adjacency and for unburned area.

An anonymous contributor to MZ21 (personal correspondence) also states that Arno and Gruell also used an extreme form of targeting and a very insufficient sample size ($n = 1$) at eight sites and did, in fact, make a composite at the other four sites. Houston (1973) and Arno and Gruell (1983) do need correction for unburned area and adjacency in both cases, as both were collected along the forest-grassland ecotone (anonymous contributor, personal correspondence; Baker, in press), and neither used crossdated scars.

An anonymous contributor to MZ21 also states that Houston (1973) and Arno and Gruell (1983) are about grasslands, not mountain big sagebrush stands in the pre-Euro landscape (see below regarding adjacency issues). He also states that neither study crossdated scars, so we really cannot tell whether fires did or did not burn among trees scattered across landscapes in the Houston study area or whether separate fire years really are valid in the Arno and Gruell study.

35-40yr INTERVAL

Heyerdahl et al. (in press) document four large fires in Douglas-fir/mountain big sagebrush sites during their reporting period of 1700 to 1860 (figure 3b) and possibly two more between 1650 and 1700 (figure 2). Using these values gives MFRI of between 35-40yrs, or 37yrs on average. The range of variation in fire occurrence under this regime was 2-84yrs. In other words, between 1700-1860, on some portions of the landscape, fire had a point or plot interval of about 37yrs with intervals as short as two years and as long as 84yrs. This frequency is also comparable to the frequency estimated by modeling studies to exclude Douglas-fir (approximately 30yrs, Keane et al. 1990), and to that reconstructed from tree rings in Douglas-fir/mountain big sagebrush elsewhere in southwestern MT (20-40 mean intervals, Houston 1973, Arno and Gruell 1983, Littell 2002) where frequent past fires are also thought to have prevented the establishment of Douglas-fir. They believe that fires likely burned the area between plots with evidence of fire in the same year, including across historical sagebrush-grass plots (Heyerdahl et al in press).

Heyerdahl et al (in press) also state that after fire, mountain big sagebrush at sites in southwestern MT required up to 30yrs to return to >20% cover (Wambolt et al. 2001 in Heyerdahl et al. in press).

As per Tart (personal correspondence), another approach to estimating MFRI in the shrub/grass areas beyond the forest ecotone is to consider only large fires documented from both sides or scattered across the shrub/grass area (Baker, in press; Kitchen, personal communication). This method can be used with the data of Houston (1973) (see his Table 3) and Miller and Rose (1999) (see their Figure 4). Applying this approach to both data sets to calculate MFRI for large fires for the period 1650 to 1890, the results are: Miller and Rose (1999) between 27-34yrs MFRI; Houston (1973) between 30-40yrs MFRI. Using the more restrictive definitions of large fire for the period 1700-1890 gave an MFRI of 32yrs for both study areas.

50yr INTERVAL

According to Miller and Rose (1999) and Wright and Bailey (1982), there is a 50yr MFRI. However, those studies did not take into account the limitations of fire history data or the recovery rate.

Based on what has been shown through different approaches and field experience of those who know the system, the estimate of total MFRI for mountain big sagebrush steppe is between 40-80yrs (Kitchen, personal correspondence).

50yr+ INTERVAL

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Welch and Criddle (2003) report greater than 50yr interval. They also report the following "10 biological and ecological characteristics of mountain big sagebrush do not support the idea that mountain big sagebrush evolved in an environment of frequent fires of 20 to 30yrs: (1) a life expectancy of 70yrs+; (2) highly flammable bark (this stringy bark makes excellent fire starting material); (3) production of highly flammable essential oils; (4) a low growth form that is susceptible to crown fires (5) nonsprouting; (6) seed dispersal occurs in late fall or early winter long after the fire season has ended; (7) lack of a strong seed bank in the soil; (8) seed lack anatomical fire resistance structures or adaptations – that is, a thick seed coat; (9) seeds must lie on the soil surface, which exposed them to higher temperatures than seeds that occur deeper in the soil; and (10) seeds lack any adaptations for long distance dispersal, hence, mountain big sagebrush lack the ability for rapid reestablishment. Thus it appears that an estimated fire interval of 20-30yrs for mountain big sagebrush is too low and that the natural or normal fire interval is much longer, perhaps 50yrs or more."

70-200yr INTERVAL and RECOVERY

Recovery rates should also be taken into account (Baker, in press). Mountain big sagebrush has the fastest recovery rate of the three subspecies of big sagebrush (Johnson 2000; local data). Rates of recovery under the natural disturbance regime most likely were longer than we see in small burns today (anonymous contributor, personal correspondence). It is not necessarily preferred to use a fixed percent cover as a standard for recovery, as the percent cover of ARTRV varies widely with environment.

An anonymous contributor to MZ21 (personal correspondence) suggested a 70-200yr MFRI interval. Recent data from long term vegetation transects collected over a 20yr period in WY suggest that the recovery of mountain sagebrush steppe communities following fire requires at least 25yrs in northwestern WY and at least 40yrs in southern WY 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, fire return intervals may lie somewhere between 40-60yrs. However, recent data show that fire return intervals may be twice or more as long as recovery periods, indicating a fire return interval of 70-200yrs (Baker, in press). If FRI is 2x as long as recovery, it might be that the MFRI in this system is at least between 50yrs to at least 80yrs. However, the reason the range goes up to 200yrs is because Bruce Welch at USFS Provo Shrub Lab has observed that in large fires, ARTRV reseeds very slowly, creeping in from the edge at rates that suggest it will require perhaps 100yrs to fully recover. There is wide variation in recovery rate (Lesica et al 2005). In recent work and new data (Lesica et al. 2005), it seems that most ARTRV will not recover in 25-40yrs, but some will. So the lower end of recovery would be 25-40, and the upper end of the recover curve may be quite long, 100yrs. Thus, the 100yr figure gets multiplied by 2 to produce the high end estimate of 200yrs (Baker, in press). The midpoint would probably lie in the 100yrs+ range (anonymous contributor, personal correspondence).

This methodology has been debated by some researchers. Some do not advocate the use of the 2 multiplier of the recovery rate, to arrive at the fire interval.

A fall 2005 burn of predominantly mountain big sagebrush (patches and stands of low sagebrush were also burned) mature to decadent stands was conducted at Fossil Butte National Monument resulting in nearly total consumption of the shrubs. Only a few patches of living shrubs remain. Plot data were collected prior to this burn which could be used to provide baseline conditions, as can 2002 aerial photographs at the 1:12,000-scale. Accuracy assessment data collected in the fall of 2006 (to evaluate a vegetation mapping project for FOBU) resulted in the sites previously occupied by mountain big sagebrush being labeled "Post-burn Herbaceous Vegetation" as predominantly annual herbaceous vegetation had become established.

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Very few seedling mountain big sagebrush were observed in the fire aftermath and these on a very local basis, eg, not widespread in the burn area. The most common shrub observed post-burn was viscid rabbitbrush, with annual forbs (*Lupinus*, *Chenopodium* and *Aster*), and pre-burn perennial grasses most abundant. Shrubs that had resprouted following the burn included snowberry and serviceberry (Von Loh, pers comm).

CORRECTION FACTORS – 60 VS 240yrs

An anonymous contributor to MZ21 (personal correspondence) advocates use of correction factors for most of the studies above. If applying correction factors to Heyerdahl's study, a fire rotation of between 240yrs (anonymous contributor, personal correspondence) is reached. Fire rotation is: (period of estimate)/fraction of area burned. He estimated the fires to be 10, 160, 70, 35, 100, 210, 30, 40, and 210 hectares for a total of 865ha, but each fire has unburned area. Using the 21% correction for sagebrush fires gives an estimated total of 683ha burned in a study area of 1030ha (66.3% of the area or a fraction of 0.663) over the period from 1700 to 1860 (160yrs). Thus, the fire rotation is estimated as: 160yrs/0.663 = 241yrs. The fire rotation/population mean fire interval is thus about 6 to 7 1/2 times the composite fire intervals, consistent with what has been seen in other empirical comparisons.

Kitchen (personal correspondence) counters that by stating that to calculate an accurate estimate of fire rotation using the anonymous contributor's approach, a basal area considerably smaller than the 1030ha (study area) would have to be used. Just as one cannot assume a fire interval for the non-recording portions of the landscape, one also cannot assume a fire free period for the whole test period. Either assumption introduces bias. Therefore all of the unsampled but fire scarred portions of the landscape would have to be subtracted from the base study area before calculation. In other words, Heyerdahl's fire sizes are at most conservative estimates of actual areas burned and probably miss fires that went unrecorded. Kitchen therefore used a modified approach to arrive at a fire rotation interval. He visually added up total burn area from figure 2 as the anonymous contributor did and got 1340ha in 11 fires. An unburned area correction factor should not be used. If it is assumed that the sampled area (portion of study area with fire record) was half the total study area (ball park guess looking at the map) or 515ha then a fire rotation of 61.5yrs is reached.

Kitchen (personal correspondence) also counters the anonymous contributor's estimate by stating that in Heyerdahl's study, fire was largely lost from the system after 1860 (figure 2). Concurrent with that loss just 146yrs ago, the range and density of Douglas-fir and lodgepole pine trees has increased dramatically throughout the study area. The beginning of heavy use by livestock coincides with the late 1800s shift. If that much has changed in 146yrs, it is not possible that a fire rotation of 241yrs would have been sufficient to maintain the pre-1860 woodland/shrubland mosaic documented by this study.

ADJACENCY

Tart (personal correspondence) states that this BpS in this map zone was occupied by a mosaic of grassland and varying densities of big sagebrush. The FRI of sagebrush Bps sites historically maintained as grasslands is generally reported to be 10-40yrs (Winward 1991; Arno and Gruel 1983; Houston 1973). The longer intervals reported by Baker (in press) and Welch and Criddle would imply that there was little grassland (Tart, personal correspondence).

There is some disagreement as to whether the sites studied by Arno and Gruell, and Houston, apply to a BpS of mountain big sagebrush or sites invaded by sagebrush. An anonymous contributor to MZ21 states that in western MT (Sindelar 1981), grasslands invaded by ARTRV are not fire maintained, and instead livestock grazing removes the grass competition leading to ARTRV invasion.

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For those areas that might be maintained as grassland along ponderosa pine or Douglas-fir ecotones, FRI, reported as CFI, has been indicated between 10-40yrs (Winward 1984; Winward 1991; Johnson 2000; Miller and Tausch 2001; Tart 1996) and greater than 50yrs (Welch and Criddle 2003) and between 35-100yrs (Baker, in press). Again, interpretation of the estimates and corrections used varies.

Estimating historic fire regimes for sagebrush ecosystems is tenuous at best and often based on fire scar and age structure data from adjacent forest types (eg, ponderosa pine and pinyon/juniper), shrub age structure and fuel characteristics. Mountain big sage is also adjacent to Douglas-fir and lodgepole pine and intervals for those could be used, which could range from 30-130yrs. This is a vegetation type for which we do not have much confidence in the intervals or interpretation of intervals in the literature (Romme, personal correspondence).

SEVERITY

The severity of fire is also debated in this system. While the majority of fires were likely stand-replacing, some mixed severity fire may have occurred, though there is little 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. Lightning ignitions are variable and affect fire frequency on regional landscapes in the Northern Rockies. Fire may spread from adjacent forested communities.

ERRORS, VARIABILITY AND SUMMARY

Just as there exists a potential for error from estimating a shorter than real FI when compositing, there is also an opposing risk of estimating a longer than real FI by using an incomplete record of fire (temporally due to missed fires or spatially due to underestimation of fire size, or both). Both sources of error should receive further attention (Kitchen, personal correspondence). If we base estimates of the extent of historical fires on the evidence recovered, much will be lost, as evidence tends to be lost due to decay, erosion, subsequent fires, etc. There is therefore a good probability we will consistently underestimate fire size and frequency. Missed fires result in longer than real estimates of fire rotation (Kitchen, personal correspondence).

There is much variability in the fire intervals in this system. In the late 1800s the interval was shorter than the early 1800s (Romme, personal correspondence). There was a big shift in the late 1800s with fire intervals, whereas it could have been longer in the early 1800s, more akin to present day, due to climate (Tausch, personal correspondence). 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. The climate, slope, aspect, soil and elevation can vary widely and thus the fire interval for this system can be as low as 30yrs to several hundred years, depending on what is surrounding the system. Although an average value could be chosen, and perhaps it lies in the 50yr range, most fire intervals would probably not be at the average value (Tausch, personal correspondence).

We have no means to accurately measure historic fire frequency in sagebrush communities (Kitchen, personal correspondence), and there are conflicting opinions as to the approaches taken to determine MFRI for these systems. We really do not know how fire might have behaved across the fuel threshold at the forest/shrubland ecotone. Therefore, we do not know how accurately proxy fire chronologies derived from fire-scarred trees predict fire regimes in nearby shrublands (Kitchen, personal correspondence).

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When inputting differing fire probability values in VDDT, the following class percentages were output (early 0-13; mid 14-40; late 41--):

30-year interval: 35/45/20

50-year interval: 25/45/30

80-year interval: 15/45/40

100-year interval: 10/45/45

When the longer fire interval parameters were used in VDDT, the proportion of the landscape in the earlier classes declined. Tart and other experts felt that those percentages of the landscape successional classes were not indicative of what would have been found historically. Succession class A needed to incorporate grass/forbs, and it should have been more prevalent on the landscape. Whereas an anonymous contributor to MZ21 and others contended that there is no knowledge of what percentage of the successional classes could be found on the landscape historically.

After these issues were elevated to LANDFIRE leadership/guidance, the 50yr interval was decided upon. This interval is still considered on the longer side of the range by some (A Winward, pers comm). This interval was also that used in MZs 18 and 23. MZs 10 and 19 used a 26yr FRI, and MZ22 used a 80yr FRI.

Other disturbances, including drought stress, insects and native grazing, were present under presettlement conditions in this type. Most of these disturbances were mixed-severity, resulting in thinning of sagebrush. In MZ21, deer and elk, at high density, can use sagebrush on winter ranges.

In MZ29, these systems are predominantly adjacent to Douglas-fir fire regimes in the Pryor Mountains and predominately adjacent to lodgepole pine fire regimes in the Bighorns. Also, both areas are at higher elevations with the mesic phases (sticky geranium) being prevalent. Some south slope xeric phases of this type also occur. Baker (in press) describes mountain sagebrush having a fire recovery within about 35-100yrs after fire. He also mentions that xeric sites in eastern OR (Waichler et. al.) could be much longer than 75-100yrs. Baker (in press) also states that fires are stand replacing. Thinning fires do not occur, but rather, a mosaic of burned and unburned areas can occur.

The 10-70yr fire return interval (Hironaka et al. 1983, Miller and Rose 1999, Wright and Bailey 1982; Houston 1973; Arno and Gruell 1983) is being applied to MZ29 rather than the upper level of 200yrs (anonymous contributor) since the upper range related to xeric aspects to this type and MZ29 mesic types are prevalent. Some xeric aspects also occur.

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 (ie, species concepts become blurred).

Adjacent plant associations on shallow clay soils are dominated by Wyoming big sagebrush.

In MZ29, there is most commonly Douglas-fir and sometimes lodgepole pine encroachment. Douglas-fir and limber pine trees have encroached into sagebrush-grasslands from historically stable tree islands and tree density has increased on the tree islands (Heyerdahl et al. in press). Mountain big sagebrush cover decreases rapidly as juniper dominance increases today (Miller et al. 2000 in Heyerdahl et al. in press).

Nearly all sagebrush communities today have been grazed and there are no refugia to use as reference conditions.

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Some grassland systems are invaded by sagebrush today in larger quantities - in grassland areas that are adjacent to sagebrush. There might have been an expansion into the grassland systems. These grassland systems might today have mountain big sagebrush, and pre-European settlement, might have had a bit of mountain sage. Pre-European settlement they would have been grassland systems, whereas today they might be confused for mountain big sagebrush systems. It might therefore be difficult to distinguish the early seral stages of this class from the grassland BpS 1139 system. It should be distinguished by elevational component.

There is also a difference in FRI in grassland vs sagebrush systems - frequent enough fire, and it would be maintained as grassland.

Historically, this BpS in MZ21 was likely dominated by grassland such as that in succession class A along the forest ectonoe (Houston 1973; Arno and Gruel 1983). Since this type is largely interspersed with forest or occupies a narrow band adjacent to lower timberline, class A is likely to have dominated the landscape.

Mountain big sagebrush was probably not as abundant in presettlement conditions (Arno and Gruell 1983), since the original vegetation of sagebrush-grass consisted of a dense cover of perennial grasses among which were scattered moderate-sized shrubs.

Fire exclusion is a major effect of livestock grazing (removal of fuel) in dynamic sagebrush/grassland systems (Miller et al. 1994; Miller and Rose 1999; Gruel 1999; Miller et al. 2000; Miller and Eddleman 2001; Crawford et al. 2004).

Native Uncharacteristic Conditions

Shrub cover >45% cover or taller than one meter are uncharacteristic. Greater than 10% canopy cover by conifers can be considered uncharacteristic. Potential causes of encroachment include grazing and lack of fire, as well as climatic episodes favorable to tree regeneration.

Scale Description

Fires burn in patchy mosaics in this type, and scales ranged from small (tens of acres) to moderate (possibly of thousands of acres).

On the widely distributed loamy soils, prior to 1900, sagebrush might have been restricted to small patches or widely spaced plants (Arno and Gruell 1983).

Issues/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 known refugia to use as reference conditions.

Furthermore, in MZ29, non-native species such as *Phleum pratense*, *Cynoglossum officinale* and others may occur.

Sagebrush may have invaded some grasslands due to fire exclusion, overgrazing by livestock and/or climate change.

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There was a big shift in the the late 1800s with fire intervals, whereas the fire intervals could have been longer in the early 1800s, more akin to present day, due to climate (Tausch, personal correspondence per MZ22 type).

Comments

This model for MZ29 is based on the model from MZ21 remodeled by Dave Tart and Stan Kitchen and reviewed by Steve Kilpatrick and Klara Varga. MZ29 changes included descriptive additions/changes for Bighorns and Pryors. Other reviewer for MZ29 was Jim Von Loh.

This model for MZ21 is based on the LANDFIRE model for the same BpS 1126 for MZs 10 and 19, created by Kathy Geier-Hayes (kgeierhayes@fs.fed.us), Steve Rust (srust@idfg.idaho.gov) and Susan Miller (smiller03@fs.fed.us), reviewed by Dana Perkins (dana_perkins@blm.gov), Carly Gibson (cgibson@fs.fed.us) and Mary Manning (mmanning@fs.fed.us). Original modelers for MZ21 were Tim Klukas (tim_klukas@nps.gov), Reggie Clark (rmclark@fs.fed.us), John Simons (john_simons@blm.gov) and an anonymous contributor. Original reviewers for MZ21 were Steve Kilpatrick, Klara Varga, Stan Kitchen (skitchen@fs.fed.us), Dave Tart and Brenda Fiddick. Because there were significant differences of opinion between the original modelers and the reviewers, no compromise could be reached. After an extensive model review process, LANDFIRE leadership/guidance determined that the original modelers used an interpretation of the fire information available on sagebrush systems that did not represent the majority expert opinion/interpretation of the fire literature. Therefore, the original MZ21 model was altered to reflect majority opinion/interpretation of literature regarding the fire regime of this sagebrush system.

For MZs 10 and 19, modifications were made to the structural data to adhere to LANDFIRE standards (Pohl 11/14/2005).

For MZs 10 and 19, this BpS was adapted from the Rapid Assessment model R0SBMT (Mountain Sagebrush) which was created by Mark Williams and reviewed by Bill Baker (bakerwl@uwyo.edu), Dennis Knight (dhknight@uwyo.edu), Ken Stinson (ken_stinson@blm.gov), Thor Stephenson (thor_stephenson@blm.gov), Gavin Lovell (gavin_lovell@blm.gov), Curt Yanish (curt_yanish@blm.gov) and Eve Warren (eve_warren@blm.gov).

For the Rapid Assessment, this model combined two additional Rapid Assessment models after peer-review: R0MTSBSb (workshop code MSHB2), modeled by Diane Abendroth (Diane_Abendroth@nps.gov) and reviewed by Dennis Knight (dhknight@uwyo.edu), Don Bedunah (bedunah@forestry.umn.edu), Shannon Downey (shannon_downey@blm.gov), Bill Baker (bakerwl@uwyo.edu), Ken Stinson (ken_stinson@blm.gov), Thor Stephenson (thor_stephenson@blm.gov), Curt Yanish (curt_yanish@blm.gov) and Gavin Lovell (gavin_lovell@blm.gov); and R0SBCL (workshop code CSAG1) modeled by George Soehn (george_soehn@blm.gov) and reviewed by Eldon Rash (erash@fs.fed.us) and Reggie Clark (rmclark@fs.fed.us).

Rapid Assessment peer review suggested lumping R0SBMT with R0MTSBSb as their disturbance regimes and vegetation composition were nearly identical. R0SBMT was very different from the model, R0SBCL in fire regime, but the other characteristics were the same. Based on the abundant peer review for R0SBMT, R0SBCL was combined here. Reviewers during RA disagreed about the range of fire frequency for this vegetation type. See RA models for resulting changes.

Vegetation Classes

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Class A 25 %

Early Development 1 All Structure

Upper Layer Lifeform☒ Herbaceous☐ Shrub☐ Tree**Fuel Model**

1

Indicator Species and Canopy Position

FEID

Lower

PSSP6

Lower

FORBS

Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	30 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

☒ Upper layer lifeform differs from dominant lifeform.

Grasses and forbs are the dominant lifeform in this class. They have a cover between 0-30% with a height of between 0-0.5 meters. Shrubs are the upper-layer lifeform and have <10% cover, as this class is dominated by grasses, forbs and recovering early shrubs.

Description

Shrub cover is low, and typically ranges from 0-10%. Five percent shrub cover indicates good establishment of a post-fire cohort. Herbaceous cover is variable, but is typically at least 30%. This class lasts approximately 13yrs, and then succeeds to mid-development open (class B).

Historically, this BpS in MZ21 was likely dominated by grassland such as that in succession class A along the forest ectonoe (Houston 1973; Arno and Gruel 1983). Since this type is largely interspersed with forest or occupies a narrow band adjacent to lower timberline, class A is likely to have dominated the landscape.

Replacement fire occurs at approximately every 50yrs.

Grazing occurs, but modeled infrequently (0.002 probability).

In this environment (and a number of the other grassland, shrub steppe types) forb density and cover are most responsive to climatic conditions. Hence fire response will vary according to precipitation patterns before and immediately after the fire. Grasses are less “ephemeral” and tend to respond to the fire directly. That’s why we elected to not identify specific forb species response.

Based on MZ29 review, it would seem as if there should be more of this class historically than 25%, based on 50-yr FRIs. However, did not want to alter model based on review. Currently, there is probably less A on the landscape.

Class B 50 %

Mid Development 1 Open

Upper Layer Lifeform☐ Herbaceous☒ Shrub☐ Tree**Fuel Model**

6

Indicator Species and Canopy Position

ARTRV

Upper

FEID

Lower

PSSP6

Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	30 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

(This class would also include shrubs >0.5m tall but <25% cover.)

Description

Shrub cover is <25%. Reaching 20% sagebrush cover following a stand-replacing fire takes between 10-33yrs (Tart, personal correspondence).

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

Welch (2005) per Tisdale et al. 1965 and Winward (1991) describes presettlement canopy cover being 10-20%, composed mostly as open stands.

There is a 40% herbaceous canopy cover across this class.

Replacement fire causes transition to A every 50yrs, while insects (0.005 probability) and drought (100yrs), and native grazing (0.002 probability) may thin the stand, but maintain it in class B.

This class transitions to a late closed state after 30-40yrs. For MZ29, the class B and C ages of the VDDT model were changed to reflect the statement that B lasts 30-40yrs; therefore, class B age became 14-45yrs instead of 14-40yrs, as it was in MZ21. This changed class B from 45% to 50% and class C from 30% to 25%, which was more in line with what reviewers thought was the percent of C on the landscape historically.

Herbaceous cover is variable in this class. Native grazing on winter ranges by elk and deer typically may decrease sagebrush cover but doesn't cause a transition to another class. Insects and drought may occur but don't cause a transition to another class.

Class C 25 % Late Development 1 Closed Upper Layer Lifeform ☐ Herbaceous ☒ Shrub ☐ Tree Fuel Model 2	<u>Indicator Species and Canopy Position</u> ARTRV Upper PSSP6 Lower FEID Lower	<u>Structure Data (for upper layer lifeform)</u> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;"><i>Min</i></th> <th style="text-align: center;"><i>Max</i></th> </tr> </thead> <tbody> <tr> <td><i>Cover</i></td> <td style="text-align: center;">31 %</td> <td style="text-align: center;">50 %</td> </tr> <tr> <td><i>Height</i></td> <td style="text-align: center;">Shrub 0m</td> <td style="text-align: center;">Shrub 1.0m</td> </tr> <tr> <td><i>Tree Size Class</i></td> <td colspan="2" style="text-align: center;">None</td> </tr> </tbody> </table> ☐ Upper layer lifeform differs from dominant lifeform.		<i>Min</i>	<i>Max</i>	<i>Cover</i>	31 %	50 %	<i>Height</i>	Shrub 0m	Shrub 1.0m	<i>Tree Size Class</i>	None	
	<i>Min</i>	<i>Max</i>												
<i>Cover</i>	31 %	50 %												
<i>Height</i>	Shrub 0m	Shrub 1.0m												
<i>Tree Size Class</i>	None													

Description

Sagebrush cover is from 26-45%. Sagebrush cover rarely exceeds 40% cover, and over 45% cover would be uncharacteristic. Mountain big sagebrush canopy cover is constrained by competition from herbaceous vegetation on all but the wettest sites (Tart 1996). Competition between herbs and sagebrush is less pronounced on cooler, wetter sites. High canopy cover of mountain big sagebrush only develops after removal of herbaceous vegetation. Some researchers believe that mountain big sagebrush can never exceed 25% cover (Pedersen et al. 2003). Understory vegetation has low cover in this class.

Insects (75yrs) and drought stress (100yrs) cause transitions to class B by thinning sagebrush cover every 50-100yrs. If no disturbance occurs, this condition can persist.

Native grazing occurs (0.002 probability), but maintains the stand.

Replacement fire occurs every approximately 50yrs.

It seems as if there would be less of this class on the landscape historically, based on the 50-yr FRI. However, review did not want to necessarily alter model. Currently, however, there is probably more of class C on the landscape due to lack of fire. (For MZ29, the class B and C ages of the VDDT model were changed to reflect the statement that B lasts 30-40yrs; therefore, class B age became 14-45yrs instead of 14-40yrs, as it was in

**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement severity.

MZ21. This changed class B from 45% to 50% and class C from 30% to 25%, which was more in line with what reviewers thought was the percent of C on the landscape historically.)

Class D **0 %**
[Not Used] [Not Used]

Indicator Species and Canopy Position

Structure Data (for upper layer lifeform)

Upper Layer Lifeform

- ☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**
[Not Used] [Not Used]

Indicator Species and Canopy Position

Structure Data (for upper layer lifeform)

Upper Layer Lifeform

- ☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** **IV**

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- ☒ Literature
☐ Local Data
☒ Expert Estimate

Additional Disturbances Modeled

- ☒ Insects/Disease ☒ Native Grazing ☐ Other (optional 1)
☒ Wind/Weather/Stress ☐ Competition ☐ Other (optional 2)

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	50	10	70	0.02	100
Mixed					
Surface					
All Fires	50			0.02002	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

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