LANDFIRE Biophysical Setting Model

Biophysical Setting **2910110** **Rocky Mountain Aspen Forest and Woodland**

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

General Information

Contributors (also see the Comments field **Date** 6/16/2006

Modeler 1	Steve Barrett	sbarrett@mtdig.net	**Reviewer**	Mary Lata	mlata@fs.fed.us
Modeler 2			**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type
Forest and Woodland

Map Zone
29

Model Zone
☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*
POTR5 PIEN
PSME GRASS
PICO
ARTR2

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This ecological system is widely distributed in MZs 21 and 20 within a mosaic of other communities in the northern US Rockies. But in MZ20, this BpS is limited to very limited in abundance. Communities are usually small in spatial extent, generally <25ac (10ha) in size in the northern portions of this zone, in contrast to larger communities in the central and southern Rockies. Subsections M331Dd, M331Dm, 342Dg, M331Db, 342Dd have communities in patches ranging from 25-100ac (10-40 ha).

We cannot state empirically that it occurs in 331fj (the extreme NW corner of NE), but it does occur in the Pine Ridge escarpment which runs through this area. Generally, they are small areas in protected canyons/small valleys with a northerly aspect. However, the elevation of the Pine Ridge is mostly lower than that described below, although near the WY border there are areas within the given range. Although we're not sure where the aspen of the Pine Ridge will show up in the LANDFIRE mapzones, we are fairly sure there was more of it historically than there is today. In MZ29, it also might be in the Bighorns in WY.

Biophysical Site Description

Most aspen in MZ21 occurs at elevations from 1525-2285m (5000-7500ft) in the northern portion of the zone and up to 8500ft or 2590m in the southern portion of the zone. Aspen typically occurs in the ecotone between grasslands/shrublands and the coniferous forest (montane/subalpine), usually in close association with Douglas-fir forest as well as other conifer forests. Aspen is occasionally found at lower and higher elevations, but these stands are often isolated and small. Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand, and secondarily is limited by the length of the growing season or low temperatures. In the long term absence of fire, these sites may transition to Douglas-fir or spruce, so there is likely some overlapping with those BpS's.

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In the Pine Ridge escarpment of NE, this system encompasses small areas in protected canyons/small valleys with a northerly aspect. However, the elevation of the Pine Ridge is mostly lower than that described above, although near the WY border there are areas within the given range.

Vegetation Description

These are upland forests dominated by Populus tremuloides both with and without a significant conifer component (less than five percent to over 40% relative conifer tree cover). Conifer species include Douglas-fir, lodgepole pine, subalpine fir, limber pine and Engelmann spruce. The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse and dominated by graminoids or forbs.

Common shrubs include Amelanchier alnifolia, Artemisia tridentata, Prunus virginiana, Rosa woodsii, Shepherdia canadensis, Potentilla gracilis, Symphoricarpos albus and Vaccinium spp.

Native grasses could include Calamagrostis canadensis, Calamoagrostis rubescens, Carex geyeri, Carex rossii, Elymus glaucus, Elymus trachycaulus and Hesperostipa comata.

Associated forbs may include Taraxacum officinale, Achillea millefolium, Aster conspicuus, Delphinium spp, Geranium viscosissimum, Solidago missouriensis, Senecio triangularis, Lupinus spp, Osmorhiza berteroi (=Osmorhiza chilensis), Rudbeckia occidentalis, Thalictrum occidentalie, Valeriana occidentalis and many others.

Disturbance Description

Replacement fire and patchy replacement fires were moderately frequent historically and helped maintain this ecological system on the landscape. Replacement fire was modeled, with an overall MFRI of 100yrs. Frequency-size class fire distributions are not readily available, but fire sizes may be highly variable given the widely ranging vegetation composition and topography. The clonal aspen root system can persist through long periods of disturbance-free conditions. This root system is also able to rapidly respond by sprouting or root suckering after disturbances. Fires may have been more frequent (eg, <25yrs) where aspen was adjacent or closely associated with grassland or shrubland communities, at approximately 40yrs in a montane aspen-conifer mix, and less frequent when adjacent to subalpine zone lodgepole pine or closed-canopy Douglas-fir, at approximately 100-300yrs (Bradley 1992, Barrett 2004), which could maintain most seral aspen stands. The 100-110yr estimate was a consensus of the reviewers and modelers based on experience in modern landscapes and based on literature (Barrett 2004).

For MZ21, fire was modeled in the replacement regime due to aspen's high fire susceptibility; fire was considered as an either/or event resulting in canopy mortality rather than as mixed or stand-replacing in severity. Modelers also disregarded the argument of whether aspen is seral or climax and recognized that late successional aspen stages could be mixed with conifers in the absence of fire. Moreover, they included native ungulate browsing as a dirturbance regime that could influence successional pathways.

After review of MZ21, another reviewer of MZ21 commented that there should be mixed and low-severity fires in this system, and that conifer encroachment should be considered and modeled separately (Tart, personal correspondence). However, this was not modeled in MZ21 as original modelers were unable to respond. In MZ20, however mixed severity fire was considered as a component of this BpS (20%).

This BpS can display varying fire severities (FRG II, III and IV) depending on tree species composition, but we chose to model for sites heavily dominated by aspen (FRG IV). Fire return intervals in aspen are heavily influenced by adjacent community disturbance dynamics and could vary dramatically on a

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landscape and through time as conditions change (20-150yrs between disturbances).

Under presettlement conditions, disease and insect mortality probably influenced the stand structure (degree of canopy closure, age classes, etc.) of aspen woodlands in this zone. We assumed that outbreaks would thin older trees >40yrs. Disturbance effects would also have varied from clone to clone. Many aspen clones situated on steep slopes are prone to disturbance caused by avalanches and mud/rock slides. Riparian aspen is prone to flooding and beaver clear cutting.

Adjacency or Identification Concerns

In this zone, aspen stands tend to be dynamic in size and distribution and interact with adjacent communities. Because patch sizes tend to be small, and because one state in the disturbance model can include aspen in the understory of a predominantly coniferous stand, they may be difficult to map and identify.

Aspen decline varies across the region. Factors affecting aspen currently include drought, fire suppression and ungulate browsing. These factors have reduced aspen patch sizes and composition, and/or created senescent stands lacking suckers for regeneration of tree-sized aspen.

In the long term absence of fire, these sites may transition to Douglas-fir or spruce, so there is likely some overlapping with those BpS's.

Depending on ungulate influence, herbaceous layers may be lush and diverse or depauperate and dominated by exotic grasses. Common exotic graminoids may include Bromus inermis, Poa pratensis and Phleum pratense.

Herbivory also affects the growth rates of aspen sprouts or suckers and, at high levels, has the potential to overwhelm the sprouting or suckering response and prevent overstory recruitment from occurring. Current browing regimes are likely to not be representative of historic browsing regimes. Cattle and elk can hammer young aspen seedlings/resprouts.

Native Uncharacteristic Conditions

Scale Description

Patch size for this type ranges from less than one hectare to 10ha; occasionally, aspen occurs in patches larger than 10ha in the northern portion of the zone. In the southern portion of the zone, patches from 10-40ha are more common in low elevation. Patches may be linear along riparian areas and the forest/grassland ecotone. Nonlinear patches are often localized in swales, depressions and toeslopes.

Communities are usually small in spatial extent, generally <10ha in size in the northern portions of this zone, in contrast to larger communities in the central and southern Rockies. Subsections M331Dd, M331Dm, 342Dg, M331Db and 342Dd have communities in patches ranging from 25-100ac (10-40ha).

Issues/Problems

Aspen dynamics over the past several centuries are difficult to characterize due to relatively short lifespan, rapid decay of tree ring records and the lack of clear patterns of broad-scale establishment of tree-sized stands as occurred in the late 1800s. Range of variation in the recruitment of tree-sized stems may be substantially wider than currently considered. Disturbance regimes, particularly with regard to measures of central tendency surrounding fire size, appear highly variable, and are dependent on information obtained from different but adjacent vegetation types. Nonetheless, the ecological importance

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of aspen may still justify management for vigorous tree-sized aspen stands.
This BpS can be rare in some portions of MZ21, although ecologically significant, and likely difficult to map in areas of high conifer encroachment. In the southern portion of MZ21, aspen is not rare, but occurs at low levels and was much more prevalent on the landscape historically.

Comments

This model for MZ29 was adopted as-is from the same BpS from MZ20.

This model for MZ20 was adapted from the same BpS in MZ21, which was created by Roy Renkin, Nathan Korb and Jodie Canfield and reviewed by Liz Davy, Tim Belton, Dave Barron, Spencer Johnston, Candi Eighme, Lisa Heiser and Heidi Whitlatch. For MZ20, descriptive changes and minor quantitative changes were made to better represent the composition and thinking within MZ20 area.

The model for MZ21 is based on the models from MZs 12, 17, 10 and 19. Models from MZs 12 and 17 were created by Louis Provencher and Julia Richardson. Models from MZs 10 and 19 were created by Krista Waid-Gollnick and Sarah Heide.

BpS 1011 for MZs 17 and 12 is intended to represent stable aspen as found on many ranges of NV. BpS 1011 for MZs 12 and 17 is different from BpS 1011 for MZ16. BpS 1011 for MZ16 was modeled by Linda Chappell, Robert Campbell, Stanley Kitchen (skitchen@fs.fed.us), Beth Corbin (ecorbin@fs.fed.us) and Charles Kay. R2ASPN was modeled by Linda Chappell (lchappell@fs.fed.us), Robert Campbell (rbcampbell@fs.fed.us) and Bill Dragt (William_Dragt@nv.blm.gov). R2ASPN was reviewed by Cheri Howell (chowell02@fs.fed.us), Wayne Shepperd (wshepperd@fs.fed.us) and Charles Kay (ckay@hass.usu.edu).

Vegetation Classes

Class A **15 %**

Early Development 1 All Structure

Indicator Species* and Canopy Position

POTR5 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Tree 0m	Tree 5m
Tree Size Class	Seedling <4.5ft	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 2

Description

Aspen suckers less than two meters tall. Understory species include a wide variety of shrubs, forbs and grasses. Under moderate to intense browsing, this condition could persist for long periods. Under light browse intensities, succession to class B after 15yrs. (For MZ21, this class ended at 10yrs; however, for MZ20, it was changed to 15yrs in order to accommodate for more class A on the historical landscape - 15% vs 10%.)

This structure is an established, persistent, shrub-type aspen clone that is maintained in this state either because of continual browsing or suboptimal site conditions. As such, it was the starting point in which to model asexual regeneration in the face of disturbance. This condition does not represent the uncommon site establishment via sexual reproduction that would revert to grass three years after seedling establishment. This is in comment to reviewers' suggestion that this class would be eliminated and returned to grass in three years under intense browsing; however, that scenario is not an accurate depiction of this class. Also - although

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aspen suppression by herbivores is important in the Greater Yellowstone Ecosystem, (which would more likely be a current condition, not a reference condition scenario being described) there seems to be insufficient evidence that this process can extirpate a patch in three years. Aspen appears relatively persisting and certainly can be extirpated, but it is believed that this occurs far less frequently.

Native grazing occurs with a probability of 0.04, which returns the class to the beginning of the state.

Class B **20 %**

Mid Development 1 All Structures

Indicator Species* and Canopy Position

POTR5 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 9

Description

Aspen over two meters up to 10m tall dominate. Canopy cover usually closed representing dense sapling stand. Fire frequency is highly variable because of site conditions and adjacent vegetation. Original modelers chose a 60yr interval for an average; however, reviewers recommended a 100yr interval; that 100yr interval was chosen for the model based on several reviews.

Insect/disease outbreaks are rare, but were not modeled to result in successional pathway changes. Because herbivory was insufficient to prevent succession, it was not modeled. Class B therefore represents a transitional stage toward a mature aspen stand. Succession to class C occurs after approx 30yrs resulting in a mature closed-canopy stand.

This class originally was considered a closed, mid-development stage with between 41-100% cover; however, it was changed to 21-100% cover and an all structures stage to account for the possibility that the cover might be lower at times.

Class C **25 %**

Late Development 1 Closed

Indicator Species* and Canopy Position

POTR5 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 9

Description

Closed-canopy, relatively pure aspen stand (>10m) with large overstory trees. Fire frequency highly variable depending upon site location and adjacent vegetation. A 60yr MFRI was originally used for the model and results generally in overstory mortality. Reviewers recommended a 100yr MFRI, and that value was incorporated into the model.

Aspen always suckers. Suckering and recruitment might be impeded because of overstory auzin transport, but is infrequently eliminated, unless there are other root problems with the clone. Existing data suggest that aspen can persist in the understory of conifers as a shrub for relatively long periods of time (Dan Kashian,

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personal communication).

Browsing more than likely occurred on suckers in the pre-disturbance state and will likely again occur post disturbance. Further, herbivory is ubiquitous across the range of this BpS (Romme et al. 1995). Browsing is therefore consistently incorporated into the model.

Without herbivory, this condition can persist indefinitely with continued regeneration and overstory recruitment. The cumulative effect of sustained herbivory will eventually result in an open canopy mature stand (class D) due to canopy die-off and a lack of recruitment. Herbivory occurs with a probability of 0.01.

Any reduction of canopy auxin transport because of mixed or replacement fire will stimulate the suckering response.

Reviewers for MZ21 also recommended adding mixed severity fire at 100yrs and replacement fire at 100yrs. For MZ20, this mixed severity fire was included at 150yr interval, since conifers of varying fire susceptibility also can be present, and it is thought that perhaps 20% of the entire BpS would be affected by mixed severity fire, versus replacement.

Subalpine fir might be coming in in the understory, as per reviewers of this model.

Insect/diseases outbreaks are believed to occur every 200yrs on average causing stand thinning (transition to class D).

Succession maintains vegetation in this class, however without disturbance and under certain site conditions a small percentage of this class may transition to mixed conifer forest (class E). This occurs every 200yrs.

Structure overlaps between C and E. However, the classes are distinguished by aspen versus mixed conifer.

Class D **25 %**

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 2

Indicator Species* and Canopy Position

POTR5	Upper
ARTR2	Lower
GRASS	Lower
PSME	Low-Mid

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	0 %	40 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Aspen (>10m) widely spaced, open canopy existing until the over-story succumbs to mortality. This is a transitional state caused by insects, disease, herbivory or interactions among these factors. Continued moderate to high herbivory, which originally takes the site from class C, prevents the recruitment of overstory trees. Native herbivory was added to the model at a 0.01 probability but keeps the class in D.

Mean FRIs for fire are highly variable but a MFRI of 60yrs was originally used for the model, but changed to 100yrs as per reviews.

In the absence of fire this state transitions to conifer, sagebrush or grassland dominated (class E). This was modeled as a main successional pathway that occurs after approximately 100yrs.

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Reviewers state that in the southern portion of this map zone, this would transition to ABLA instead of PSME. PICO and ABLA would occur in the lower, mid and upper canopies. Fire would create suckers in the holes causing aspen to persist in this stage. Fires might also remove some of the conifers.

Reviewers recommended adding in insects/disease disturbance at 0.005 probability; this was input into the model with little impact. There is thus far no data to support the impact of insects/disease.

Class E **15 %**

Late Development 2 Closed

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PSME	Upper
PICO	Upper
PIEN	Upper
ARTR2	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Very Large >33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E is a catch-all category that represents aspen replaced by other vegetation types or a mixed aspen-conifer overstory that is changing to a conifer dominated forest. If aspen persists in the understory, parent root material remaining on site allows aspen regeneration after fire. Replacement fire was originally modeled at every 60yrs but was changed to a 100yr frequency based on review.

Reviewers stated that an occasional aspen tree will be present in the overstory. If stand-replacing fire occurs, aspen will sucker. ABLA would be present in high amounts in the upper canopy as well.

Structure overlaps between C and E. However, the classes are distinguished by aspen versus mixed conifer.

Disturbances

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 100
Min 1
Max 1000

Sources of Fire Regime Data

☑ Literature
☑ Local Data
☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	120	4	200	0.00833	84
Mixed	625			0.0016	16
Surface					
All Fires	101			0.00994	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2910480** **Northwestern Great Plains Highland White Spruce Woodland**

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

General Information

Contributors (also see the Comments field **Date** 6/13/2006

Modeler 1	Cody Wienk	cody_wienk@nps.gov	**Reviewer**	Deanna Reyher	dreyher@fs.fed.us
Modeler 2	Bob Paulson	bpaulson@tnc.org	**Reviewer**	Todd Pechota	tpechota@fs.fed.us
Modeler 3	Deanna Reyher	dreyher@fs.fed.us	**Reviewer**	Peter Brown	pmb@rmtrr.org

Vegetation Type
Forest and Woodland

Dominant Species*
PIPO
PIGL

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Map Zone
29

Model Zone
☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Geographic Range

The only place that this type occurs is within the Black Hills of SD and WY. M334Ab is currently the identified subsection code assigned to the upper elevations of the Black Hills.

Biophysical Site Description

This group is most common at the higher elevations in the Central Granitic Core and Upper Limestone Plateau of the Black Hills. This type generally occurs on gentle to steep slopes. Several montane grasslands (many that are not associated with water) are intermingled throughout this area and influence burn patterns.

The approximate elevation range is 5700ft+ (Mariott et al 2000) in Northern Hills to approximately 6000ft in the Central Limestone Plateau area. This is higher than BpS 1054. Geology is generally dominated by limestone, granite, slate and schist.

This system is limited to relatively high-elevation outliers of montane environments in the northwestern Great Plains. Best known areas including this system are small portions of the Black Hills of WY and SD. These highland areas generally have a cooler climate than the surrounding mixed-grass prairie. This woodland system is generally limited to sideslopes and depressions, sometimes adjoining riparian zones, where snow is generally retained longer than on adjacent BpS in the Black Hills. The depth of the soils of the area vary widely from deep to quite shallow.

Vegetation Description

Ponderosa pine, white spruce, paper birch and aspen are dominant overstory species. Other woody species found in various areas of this type includes various woody species such as bearberry, hazelnut, ninebark,

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grouseberry, snowberry, rose and ironwood. Spruce and paper birch generally occur on northern aspects and higher elevations of this area. Numerous forb species dominate the herbaceous layer and include species such as twinflower, violets and orchids.

Disturbance Description

It is generally believed based on discussions that this type best fits in Fire Regime Group I. Ponderosa pine makes up the greatest proportion of conifers and has a greater influence on the FRG. There is a tendency towards FGR III in the areas where white spruce becomes more prevalent. Stand replacing disturbances are primarily associated with climatic fluctuations and include fire and insect (in late-development classes only, mountain pine beetle creates larger patch sizes; Ips beetles creates smaller patches). Snowbreak and windthrow events may occur, but are not modeled. The majority of the insect outbreaks are generally occuring in late-development types but in periods of drought (such as that which the forest is currently experiencing), tree mortality is occuring in ponderosa pine that are less than seven inch DBH.

Surface and stand replacing fire events occurred in this BpS. Stand replacing fires were likely most common in higher elevation and northern slopes that were primarily dominated by spruce, with surface fires occurring most often in the moist ponderosa pine.

Brown indicates approximately 35yrs for a FRI in the ponderosa pine component of this high elevation system. A great deal of discussion took place among MZs 29 and 30 reviewers, and it was felt that was the best choice to use for the model. Although spruce is a component of this BpS, ponderosa pine is still the major component, so the frequency is going to be a "combination". It is likely that the FRI for the spruce portion (a smaller component of the system) is longer, but the group reviewing felt it would be a better representation to go with the data that was available for the pine component of that BpS.

There is some debate about whether mixed severity fire would have occurred in this type based on tree-ring and historical evidence. It is included in this model at a 100-year return interval.

The Rapid Assessment peer review process raised questions about the role of mixed severity fire versus surface fire in this BpS and the overall fire frequency. The BpS was originally modeled with a 25yr MFRI; 62% of fires were surface (45yr MFRI), 25% were mixed (100yr MFRI) and 12% (200yr MFRI) were replacement severity. Based on peer review, the overall fire frequency was reduced to 35yrs, the amount of mixed severity fire was cut in half to a 200yr return interval (although some comments indicated eliminating mixed severity fire completely), the amount of replacement fire was reduced to a 300yr return interval and the amount of surface fire was decreased slightly to a 50yr return interval.

Adjacency or Identification Concerns

This type occurs at elevations above Southern Rocky Mountain Ponderosa Pine Woodland. This type differs from Southern Rocky Mountain Ponderosa Pine Woodland because it has less frequent surface fires, more frequent replacement fires and more closed canopy forest.

The white spruce vegetative component distinguishes this BpS from the SRM Ponderosa Pine Woodland. The moister environment generally supports a higher site index than that of ponderosa pine.

Longer fire return intervals associated with the spruce are also different than the PIPO BpSs.

More mosses and lichens are present in association with the moister, cooler conditions.

There is generally a greater component of aspen compared to Southern Rocky Mountain Ponderosa Pine

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BpS.

One reviewer commented that this BpS appears to have many questions about it, and is not sure it should be a separate type. Essentially the difference is the presence of spruce, and these stands occur mainly on north-facing slopes in contrast to adjacent more dominant pure ponderosa stands which are well described by the Southern Rocky Mountain Ponderosa Pine model. It is thought that perhaps the area covered by this type is small enough that it should not be a separate model and these stands should be included in the mid or late closed classes of the southern Rockies ponderosa pine model. However, due to consensus from the other modelers/reviewers regarding this type, this model/description was retained. Perhaps it can be distinguished from the others also by elevation/aspect.

The most similar type could be the Southern Rocky Mountain Ponderosa Pine Woodland (1054) or the Black Hills versions 11791, 11792.

This BpS is different currently versus historically due to what has occurred throughout the Black Hills in general. There have been varying amounts of timber that have been removed since the Custer Expedition in 1874 as well as 100yrs+ of fire suppression. There are many private inholdings, with the majority located in the montane grasslands and riparian meandows included within this group. Some of those inholdings are being developed, which include the construction of access roads. Several exotic plant species, including noxious weeds are present. As noted in Parrish et al. 1996, riparian habitats have been altered by a wide array of contributing factors (roads, private land draining of wetlands, reduction or removal of beaver, grazing, haying, etc.). Livestock grazing occurs in many areas currently. Bison are no longer a wildlife component of the area (unless they are brought in to graze private land parcels).

Based on the data that has been gathered, the same general basal area of ponderosa pine generally exists today as historically, but occurs in a smaller diameter class (Brown in press 2006).

It is likely that the extent of this type may be greater today as compared to historical conditions, with a primary contributing factor leading being that of fire suppression.

Historically, without fire suppression, it is expected that there would have been much less spruce than currently exists on the landscape today. It is also expected that there is a greater canopy cover of conifer species (ponderosa pine and spruce) and less canopy cover of hardwoods (sucha as aspen and birch) and grassland openings (refer to historical photos from 1874 to current photos of the same areas). With denser canopies of conifers it is generally expected that there is less herbaceous understory growth than occurred historically with a less dense canopy.

Native Uncharacteristic Conditions

Historically, without fire suppression, it is expected that there would have been much less spruce than what currently exists on the landscape today. It is also expected that there is a greater canopy cover of conifer species (ponderosa pine and spruce) and less canopy cover of hardwoods (such as aspen and birch) and grassland openings (refer to historical photos from 1874 to current photos of the same areas). With denser canopies of conifers it is generally expected that there is less herbaceous understory growth than occurred historically with a less dense canopy.

Scale Description

Scale varies widely. Includes gap phase dynamics (single to few tree mortality events) to watershed scale events (mixed severity fire or insect events in ponderosa pine to stand replacing fire in spruce).

Issues/Problems

There is considerable debate over the role of mixed severity and surface fires in the historical range of variability in this and other ponderosa pine forests in the northern and central Rockies (Baker and Ehle 2001, 2003, Barrett 2004, Veblen et al. 2000). However, actual data has been and continues to be gathered in order to learn more about the role of fires and climate in portions of the Black Hills (Brown 2006, Brown 2003, Brown and Sieg 1996).

Comments

This model for MZ29 was adapted from the RA model R0PIPObh - high elevation, created by Deanna Reyher and reviewed by Dennis Knight, Cathy Stewart and Bill Baker. It was modified descriptively and quantitatively. Reviewers for MZs 29 and 30 were Gwen Sanchez-Lipp, Dave Thom and Blaine Cook.

Rapid Assessment workshop code was PPIN9. Rapid Assessment code became Ponderosa Pine-Black Hills-High Elevation (R0PIPObh)

Additional authors and in-workshop (Rapid Assessment) review from: Cody Wienk, Carolyn Sieg, Peter Brown, Blaine Cook and Breck Hudson.

Vegetation Classes

Class A **10 %**

Early Development 1 All Structure

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

POTR5	Mid-Upper
BEPA	Mid-Upper
ARUV	Lower
AMAL	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Aspen and birch shrublands with dense herbaceous cover of a variety of forbs. It is expected that this class generally lasts for approximately 20yrs then succeeds to B (with timing potentially affected by climatic conditions, fire, etc.).

Replacement fire is estimated to generally occur every 250yrs. Low severity fire is estimated to generally occur every 45yrs for this model.

Class A can generally be expected to have a dense herbaceous layer with a large diversity of forb species.

The upper layer lifeform in this class could be either herbs or trees, but for the model, it is trees.

The estimate for this class is approximately 10-15% based on literature (Parrish et al. 1996). Fire suppression has reduced fire frequency and altered extent of conifers (Brown in press 2006).

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Class B **10 %**

Early Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

POTR5	Upper
BEPA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Closed-canopy deciduous forest dominated by quaking aspen and paper birch. Birch tends to dominate on north aspects and moist slopes, while aspen will dominate on the remaining sites.

This class lasts for 20yrs then succeeds to a mid-development open stage. It succeeds to that class (a mid-open stage) because of the change in indicator species versus the next class - conifers are expected to be encroaching on hardwoods.

Replacement fire is estimated to generally occur at approximately 250yrs. Low severity fire may generally be expected to occur at approximately 45yrs (primariily based on climatic factors, etc.) but generally is not expected to cause a transition.

It is generally expected that this class would have made up approximately 10-15% of the landscape.

Class C **25 %**

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

POTR5	Upper
BEPA	Upper
PIPO	Mid-Upper
PIGL	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Conifers likely begin invading and constitute about 20% of the overstory.

This class is estimated to last approximately 40yrs (depends on climatic conidtions and other factors) then it is expected to generally succeed to class D, another mid-development generally open stage. Stand is in transition from decidous to conifer. Class C is mixed hardwood early conifer development.

This may not be mid-open but could be thought of as more of a mid-development stage (still existing hardwood canopy but it being encroached upon by conifers, either/both spruce or ponderosa pine).

The canopy cover of the conifers only would be 10-25% at this stage and they are 0-25m in height. This class overlaps in cover/height with class E. However, the indicator species for class C in the upper layer lifeform are POTR5 and BEPA still, whereas the indicator species for class E in the upper layer lifeform have transitioned to PIPO and PIGL. They are therefore distinguished by species upper layer.

Replacement fire may be modeled to generally occur every 250yrs, mixed fire every 100yrs not causing a transition, and low severity 35-45yrs, also not causing a transition. However, all of this is affected by a

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variety of factors including changes in climatic conditions (such as drought).

It is generally expected that the extent of this class would likely be less today based on the hardwood component being less today.

Class D **30 %**

Mid Development 2 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PIGL	Upper
POTR5	Mid-Upper
BEPA	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	50 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

In this class, it is expected that conifers continue to expand, and would generally constitute about 50% of the tree overstory.

This class is expected to last approximately 50yrs (depending on climatic conditions and other influences) then would generally be expected to succeed to class E, which is generally described as a late development closed conifer stage.

In this class it is expected that the extent and number of conifer individuals (spruce and/or ponderosa pine) continue to expand. The dominate species for class C is birch and aspen. The dominate species for class D has changed to ponderosa pine and spruce.

This class is generally considered to be a mid-development stage where the hardwoods are being replaced by a more dominant conifer component. The conifers are generally expected to become more mature with a greater portion of the area covered by a larger dominant number of conifers and where more hardwood individuals are becoming decadent or dying.

The canopy cover of the conifers is approximately 25-50% cover and they are 10-25m in height. However, the canopy cover of all of the species combined, could be 51-100%. However, so that there isn't overlap with class E, this class was modeled with a 21-50% canopy cover - of the conifers.

Replacment fire is generally thought to occur at approximately 250yr intervals. It is generally thought that mixed fire may have generally occurred at about every 200yrs, and may not have resulted in a transition. Generally, it is estimated for the model that low severity fire may have occurred approximately every 45yrs, which generally did not cause a transition to another class.

Insect/disease is expected to generally occur with a probability of 0.002 and likely causing a transition back to class C or A, split equally among the probabilities (0.001 for each transition).

We would expect to see about 30% of this class on the landscape historically.

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Class E 25 %

Late Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PIGL	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Dominated by dense stands of white spruce on north-facing slopes at higher elevations, and pine-dominated stands on lower elevation level areas and south-facing slopes at higher elevations. Pockets of deciduous trees and shrubs occur throughout.

See dominate species listed and canopy position. Class E loses the hardwood component and is entirely described as a conifer type.

Replacement fire is generally modeled to occur at about every 300yrs. Low severity fire is not generally expected to cause a transition and is modeled to occur at about every 45yrs. Mixed severity fire can be expected to result in potential transitions to classes C, D or no transition to class E - all modeled with probability of 0.005 (200yrs), for an overall probability of 0.015 (65yrs).

Insect/disease can contribute to a set of conditions that may result in a transition back to class A with an assigned probability of 0.002. Disturbances and mortality associated with insects and disease can also contribute to a transition to classes C or D, both with assigned modeling probabilities of 0.001 (overall 0.002). Differences in transitions to different classes primarily dependent on conifer canopy cover density. Assuming 100% cover, landscapes are documented to have a generally high insect hazard and currently entire landscapes are being subjected to changes by the mortality associated with insects. Changes to the various classes are generally associated with the amount of mortality that occurs at each site (please refer to recent high levels of tree mortality associated with increases in mountain pine beetle levels in the Black Hills in this stage).

It is expected that this generally closed canopy class of this BpS is generally higher in proportional extent for the present day (primarily associated with forest management practices and fire suppression). However, current climatic conditions and insect activity are currently "unraveling" the ponderosa pine component of the closed late development class (becoming much more open through ponderosa pine mortality) and may be adjusting the spatial extent back to what may have been expected more during historical conditions for this type. Because of the ongoing ponderosa pine mortality that is currently being experienced in the Black Hills and in this type (USDA Forest Service 2006), the proportion of live spruce to ponderosa pine is expected to be increasing. However, as ponderosa pine remnants continue to deteriorate, spruce individuals may also be lost due to their susceptibility to windthrow.

Disturbances

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Fire Regime Group:** I

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

- [ ] Literature
- [x] Local Data
- [x] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	250			0.004	11
Mixed	100			0.01	28
Surface	45			0.02222	61
All Fires	28			0.03622	

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.

Additional Disturbances Modeled

- [x] Insects/Disease
- [ ] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2910490** **Rocky Mountain Foothill Limber Pine-Juniper Woodland**

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

General Information

Contributors (also see the Comments field **Date** 1/20/2006

Modeler 1	Don Despain	don_despain@usgs.gov	**Reviewer**	Chris Thomas	cthomas@fs.fed.us
Modeler 2	LaWen Hollingsworth	lhollingsworth@fs.fed.us	**Reviewer**	Dennis Sandbak	dsandbak@fs.fed.us
Modeler 3			**Reviewer**	Paul Mock	pmock@fs.fed.us

Vegetation Type

Forest and Woodland

Dominant Species*

PIFL2 JUSC2
PSEUD7
PIPO
JUCO6

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Geographic Range

Northern MT to central CO east of the Continental Divide, on escarpments across WY into the Black Hills and extending out into the western Great Plains. In MZ29, it occurs at elevations below lodgepole pine type in Laramie Peak Range and in the Bighorns. For MZ29, this occurs in M331I and probably M331B. Rocky Mountain juniper occurs in the western Dakotas. Pinus flexilis occurs in Slope County, ND. There is only one stand of limber pine in SD - 6-10ac in size at 6600-6800ft elevation in the granitic core (Cathedral Spires) of the Black Hills where it is a subdominant species.

Biophysical Site Description

Occurs in foothill and lower montane zones into the western Great Plains. Elevation ranges from 1000-2400m (3300-7900ft). In MZ29, it occurs at elevations below lodgepole pine type in the Laramie Peak Range. It occurs in shallow, sandy soils with high rock component, often gravelly and calcareous. Slopes are moderately steep to steep, typically on steep, rocky, well-drained, windswept, and nutrient-poor sites on exposed ridges and summits. This type is often found in locations too dry for other coniferous species, such as Douglas-fir, juniper, ponderosa pine.

There is only one stand of limber pine in South Dakota - 6-10ac in size at 6600-6800ft elevation in the granitic core (Cathedral Spires) of the Black Hills where it is a subdominant species; on the lower half of the slope with ponderosa pine and on the upper half of the slope with Picea glauca. Juniperus communis is present on the lower slope but there is no Juniperus scopulorum anywhere nearby.

Vegetation Description

Open canopy dominated by mixed conifer or Pinus flexilis, Pseudotsuga menziesii, Pinus ponderosa and

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Juniperus spp. Also - Cercocarpus ledifolius or Arctostaphylos uva-ursi, or by grasses such as Festuca idahoensis or Leucopoa kingii.

Pinus flexilis vegetation is considered both climax and seral. It is the climax on the extremely harsh sites occurring on windswept ridges and steep slopes, but in slightly more mesic areas it can be seral to Abies or Picea as well as Pseudotsuga menziesii. At the arid forest margins, climax stands of Pinus flexilis vegetation can include some cover of Pseudotsuga menziesii (Steele et al. 1983).

For this vegetation, one association is considered uncommon based on the conservation rank of the National Vegetation Classification. That association is Pinus flexilis/Festuca idahoensis with a G3 conservation rank. Pinus flexilis/Cercocarpus ledifolius woodland plant association has a G3G4 conservation rank, meaning it could be uncommon or abundant. More information is needed to better clarify its rank. All other associations have G4 or G5 conservation ranks, meaning they are abundant (Anderson et al. 1998) (from Jones and Ogle 2000).

Disturbance Description

Limber pine bark at the base of older trees may be 2in (5cm) thick, therefore these trees can withstand stem scorch from low-severity fires. Terminal buds are somewhat protected from the heat associated with crown scorch by the tight clusters of needles around them. Wildfires are less frequent in limber pine communities than in other conifer habitats because of low fuel accumulation associated with poor soil development and limited grass and forb productivity. Locations where limber pine grows may have a much lower fire frequency than surrounding communities. Surrounding community fire regime may have impact on limber pine (Johnson 2001).

Johnson (2001) states that Keeley and Zedler (1998) include limber pine among those pines growing in areas with very low site productivity and therefore low fuel loads and an unpredictable FRI of up to 1000yrs. A reviewer noted that these woodlands have the fuel structure of juniper woodlands with all fire intervals of several centuries (Anonymous).

Some reviewers felt that small surface fires occurred every 30-40yrs and the mean fire interval could be between 100-300yrs, as per Bradley et al (1992); however, that could not be verified, and original modelers disagreed. Therefore, the longer interval was chosen. Also - the data from Yellowstone show that approximately 80% of fires go out at less than one acre therefore it is very difficult to justify the short fire return intervals in the earlier fire history studies. The longer fire return interval should be used, as this is a woodland with widely scattered trees, not a limber pine stand (Despain, personal correspondence).

Replacement fires have been modeled at approximately every 400yrs, and surface fires between 300-400yrs in some of the successional stages. Estimates are based only on logical inference that fire would be uncommon, as no scientific studies have been done (Anonymous contributor, personal correspondence).

Pinus flexilis trees are adapted to surface fires because they have a thick layer of bark at the base of the trunk protecting the cambium. This species also produces a tight cluster of needles around terminal buds for protection against high temperatures (Fischer and Clayton 1983). Fischer and Clayton (1983) place this vegetation in fire group one of their classification which has a long fire return interval of 50-100yrs. Stands are not subjected to more frequent fires because of low productivity and subsequent fuel accumulation (Steele et al. 1983). However, Fischer and Clayton (1983) concede that fires may be more frequent if grasses dominate the understory. Of course, such fires would be of low intensity and probably not destroy the tree vegetation. This type grows on such harsh sites that other species are not able to

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displace it, even after disturbance (Reid et al. 1999). Fischer and Clayton (1983) mention that recovery of this type can be slow following stand-replacing fires, but fortunately high severity burns are uncommon in this vegetation. (from Jones and Ogle 2000).

As for other disturbances, Pinus flexilis is susceptible to white pine blister rust which has destroyed many stands in the Northern Rockies (Kendall 1998). High mortality is expected from white pine blister rust in the future for the regions that include the three forests (Kendall 1998). (from Jones and Ogle 2000).

Adjacency or Identification Concerns

Where limber pine grows in association with other trees, the fire regimes of those species are relevant and affect fire return interval (Johnson 2001).

This species can be susceptible to white pine blister rust which can cause mortality. White Pine Blister Rust is removing Limber pine from this landscape, expect 70-90 % mortality in 20-50yrs.

It is also susceptible to mountain pine beetle outbreaks.

This BpS was adapted to include the transitions between Douglas-fir, Ponderosa and Limber and Juniper.

This BpS is adjacent to ponderosa pine, limber pine, doug fir, grasses and mountain shrubs.

Clark's nutcracker and other small mammals disperse the seed of Pinus flexilis and are thought to influence the local distribution of stands. At the dry forest boundaries, the mosaic pattern of Pseudotsuga menziesii and Pinus flexilis vegetaion may be the result of past seed caching (Steele et al. 1983) (from Jones and Ogle 2000).

This vegetation is considered both climax and seral. It is the climax on the extremely harsh sites occurring on windswept ridges and steep slopes, but in slightly more mesic areas it can be seral to Abies or Picea as well as Pseudotsuga menziesii. At the arid forest margins, climax stands of Pinus flexilis vegetation can include some cover of Pseudotsuga menziesii (Steele et al. 1983). (from Jones and Ogle 2000).

For this vegetation, one association is considered uncommon based on the conservation rank of the National Vegetation Classification. That association is Pinus flexilis / Festuca idahoensis with a G3 conservation rank. Pinus flexilis / Cercocarpus ledifolius woodland plant association has a G3G4 conservation rank, meaning it could be uncommon or abundant. More information is needed to better clarify its rank. All other associations have G4 or G5 conservation ranks, meaning they are abundant (Anderson et al. 1998). See the section entitled "Representations on the Three Forests" for a complete list associations and ranks.

In the Northern Rockies, white pine blister rust has killed virtually all of the Pinus flexilis in many stands. Heavy mortality is expected to south at some point in the future, which will make this type less common on the three forests (Kendall 1998). (from Jones and Ogle 2000).

Fire suppression has resulted today in more of the late successional classes and higher amounts of shrubs for MZ29.

1057 RM Subalpine-Montane Limber-Bristlecone Pine Woodland might be difficult to distinguish from 1049 RM Foothill Limber Pine-Juniper Woodland. The difference is mainly in the elevation break in that

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

1057 is higher, subalpine elevation. All of the other limber pine should probably be classified to 1049.

Native Uncharacteristic Conditions

Cover >70% can be considered uncharacteristic in this woodland community.

Scale Description

Tens to 100s of acres, generally smaller islands of trees.

Issues/Problems

Fire history is lacking with a wide range of estimates available. As a whole, fire is rare in this BpS due to limited fine fuel. Review raises concern about the percent of replacement fire.

Comments

This model for MZ29 was adapted from the model from the same BpS from MZ21 created by Don Despain and LaWen Hollingsworth and reviewed by Bill Romme, Liz Davy and Tim Belton. Descriptive changes only were made to cover the Bighorn and Pryor Mountains. Other reviewers for MZ29 were David Overcast and Kathy Roche. For MZ30, Dave Ode also provided comments.

This model for MZ21 is based on the LANDFIRE model for 191049 created by Mike Babler (mbabler@tnc.org) and reviewed by Dennis Knight (dknight@wyo.edu), Vic Ecklund (vecklund@csu.org) and Paul Langowski (plangowski@fs.fed.us), but was adapted for MZ21 to better reflect local conditions. Descriptive and quantitative changes were made. Other reviewers for MZ21 included an anonymous reviewer in February 2006, and Lisa Heiser, Candi Eighme, Dennis Barron, Spencer Johnston and Heidi Whitlatch in March 2006.

For MZs 10 and 19, this model was adopted as-is from mapping MZ28 with minor modifications to the description. Original model developed for MZs 23 and 24 by Mike Babler, (mbabler@tnc.org), 4/10/2005. Reviewed by D. Knight (dhknight@wyo.edu). Further modified for mapping MZ28, 4/19/2005. Was also reviewed in workshop by Chuck Kostecka (Colo State Forest Service, ret.).

Vegetation Classes

Class A 11 %

Early Development 1 All Structure

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 2

Indicator Species* and Canopy Position

PIFL2	Upper
PSEUD7	Upper
PIPO	Mid-Upper
JUSC2	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	60 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Seedlings can be slow to establish. Competition from grasses and shrubs is variable depending on moisture availability. Adjacent grasslands, shrublands and mixed conifer ecosystems can influence the fire regime. Trees <70yrs in this class; succession to an open late-development state occurs after 70yrs, although an alternative successional pathway can occur bringing the class to a closed state with a probability of 0.01, under the right conditions. The trees occur on very low productivity sites and results in very slow growth.

Replacement fire occurs every 400yrs. Surface fire does not occur in this class.

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**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 sev

The data from Yellowstone shows that ca 80% of fires go out at less than one acre therefore it is very difficult to justify the short fire return intervals in the earlier fire history studies. The longer fire interval should be used, as this is a woodland with widely scattered trees, not a limber pine stand.

Class B **11 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 8

Indicator Species* and Canopy Position

PIFL2	Upper
PSEUD7	Upper
PIPO	Upper
JUSC2	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	30 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Trees are established. Grasses and herbs can be sparse due to limited moisture. This class includes mid to late seral classes with an open canopy. Low to mixed severity fire can often enter this system from adjacent grasslands, shrublands and Douglas-fir ecosystems.

Both juniper and limber pine seeds are transported by birds. Clarks Nutcracker distributes limber pine and robins distribute juniper – also foxes.

This class can persist, although in the absence of fire for 200yrs, this class might succeed to a closed state.

Replacement fire occurs every 400yrs, and surface fire occurs every 300yrs.

The data from Yellowstone shows that ca 80% of fires go out at less than one acre therefore it is very difficult to justify the short fire return intervals in the earlier fire history studies. The longer fire interval should be used, as this is a woodland with widely scattered trees, not a limber pine stand.

Class C **78 %**

Late Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 8

Indicator Species* and Canopy Position

PIFL2	Upper
PSEUD7	Upper
PIPO	Upper
JUSC2	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	70 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Trees are established. Grasses and herbs can be sparse due to limited moisture. This class includes mid to late seral classes with a denser canopy. Low to mixed severity fire can often enter this system from adjacent grasslands, shrublands and Douglas-fir ecosystems. Stand-replacing fire tends to occur under dry, windy conditions and may be impacted from fire brands from adjacent vegetation types.

Stands typically would be <50% cover, but >70% would be uncharacteristic.

Replacement fire occurs every 400yrs and surface every 300yrs.

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The data from Yellowstone shows that ca 80% of fires go out at less than one acre therefore it is very difficult to justify the short fire return intervals in the earlier fire history studies. The longer fire interval should be used, as this is a woodland with widely scattered trees, not a limber pine stand.

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg 25
Min 1
Max 200

Sources of Fire Regime Data

- ☐ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	400	100	500	0.0025	49
Mixed					
Surface	385	50	400	0.0026	51
All Fires	196			0.00511	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting 2910500 Rocky Mountain Lodgepole Pine Forest

☑ *This BPS is lumped with: 1055, 1167*

☐ *This BPS is split into multiple models: This model incorporates some facets of 1050, 1055 and poor site Lodgepole 1167. Development of this type is thought to be different from the others in structure and pre-European fire regime.*

General Information

Contributors (also see the Comments field **Date** 6/13/2006

Modeler 1 Chris Thomas	cthomas@fs.fed.us	**Reviewer** Elena Contreras	econtreras@tnc.org
Modeler 2 Dennis Sandbak	dsandbak@fs.fed.us	**Reviewer**	
Modeler 3 Paul Mock	pmock@fs.fed.us	**Reviewer**	

Vegetation Type

Forest and Woodland

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

PICO
PIEN
ABLA
VASC

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Common in the mountains of WY and minor portion of the Pryor Mountains in the upper montane and lower subalpine zones. This would occur in ECOMAP sections M331B and M331I. This type occurs in the Bighorn Mountains of WY as well as the Laramie Peak Range.

Biophysical Site Description

This BpS occurs between approximately 7000ft (above foothill forests dominated by ponderosa pine and Douglas-fir) to 9500ft. This type is restricted to north slopes at lower elevations. Slopes may be gentle to moderately steep (eg, 0-60% slope).

Vegetation Description

Lodgepole pine, Engelmann spruce and subalpine fir are the dominants of this BpS. Lodgepole pine is more common on drier sites and spruce and fir are more common on more mesic sites (such as north-facing slopes). Common associated species include aspen, grouse whortleberry, common juniper, heartleaf arnica, russet buffaloberry, elk sedge and various grasses.

Because of its relative intolerance for the forest understory environment, lodgepole pine traditionally has been considered a pioneer or seral species to forests dominated by Engelmann spruce and subalpine fir. However, some of the Bighorn National Forest (MZ29) is too dry to support spruce-fir forests and lodgepole pine perpetuates itself in some areas (Despain 1973 in Meyer et al. 2005).

Disturbance Description

Fire Regime Group V or IV, but primarily moderately long to long-interval stand replacement fires. Mixed-severity and surface fires may occur rarely in small patch sizes (ie, <1000s of acres) for this group,

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but are not modeled here.

Insects (mountain pine beetle) affect approximately 0.1% of the landscape every year and will either open the canopy (maintaining or causing a transition to classes C and D) or replace the vegetation, causing a transition to early-development conditions (class A). Stand replacing insect outbreaks typically only occur in closed-canopy forests (classes B and E).

Blister rust might have occured during the HRV period - at relatively low levels during cool periods and a thigher levels during warm, moist periods such as the early 1500s early 1700s (Meyer et al. 2005).

Blowdown events occur rarely (once every 500-1000yrs), and are replacement events, causing a transition to early-development conditions (class A).

For MZ29, changed replacement fire - higher and more frequent to get correct percentages in classes.

The HRV for succession and processes during the reference period for both individual stands and the landscape in the Bighorn Mtns would have been broad. Different sites on any specific burn can experience different successional trajectories, resulting in doghair stands of lodgepole in some areas, stands of average or below average tree density elsewhere, and a full variety of combinations of invading aspen, spruce, fir and lodgepole pine across the landscape (in Meyer et al 2005).

Meyer et al. (2005) suggest that the MFRI of stand-replacing fires in the last 100yrs in high elevation types within the Bighorns is still within the range of means during the HRV period, despite fire suppression efforts. Recent fire records for the Bighorn National Forest suggest that fires still play an important role on the Bighorn National Forest, but fire suppression efforts have lengthened the MFRI during the last 50yrs (Meyer et al. 2005).

Surface fires in lodgepole pine have been observed in the Bighorns, and because of the thin bark, some trees are killed. Surface fires may have burned through lodgepole pine forests in the Bighorn National Forest at intervals as short as 40-80yrs (Meyer et al. 2005). They were not modeled here.

Adjacency or Identification Concerns

In WY, this group is adjacent to lodgepole pine and upper subalpine groups, and will be found above Douglas-fir and ponderosa types in elevation. Vegetation classes may vary significantly.

Secondary succession initiated today could have quite different trajectories than 200-300yrs ago because of the warmer and wetter climatic conditions of the last century (in Meyer et al. 2005).

This type might be confused with the Subalpine Spruce Fir Forests, 1056. This system, however, incorporates more of the lodgepole and is at somewhat lower elevations and might be drier. Note that some of the Englemann spruce/subalpine fir should be keyed to 1056 as well as 1050/1055 in MZ29.

Blister rust ncreased in 1900s. At present time, dwarf mistletoe occurs at higher levels than in the HRV (Meyer et al. 2005).

In the Bighorns, a full range of size and age class structures probably existed during the HRV period, ranging from young to older even-aged stands of lodgepole, many having developed after fires in the 1600s and 1700s to uneven-aged stands that hadn't burned for centruies and were dominated primarily by

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Engelmann spruce and subalpine fir. The fires would have killed many of the big trees from time to time, and they probably burned over large areas. Consequently, tree size would have ranged from uniformly small trees after the stand was recently burned to very large trees with small trees when the stand hadn't been disturbed for long periods. Since the late 1800s, both human-caused fire and timber harvest have converted areas with large, old trees to stands of younger, smaller trees, with the exception that timber harvesting could extend into areas that hadn't burned for centuries, such as on leeward slopes or in ravines. When timber harvesting in those areas doesn't proivide sufficient time to allow regrowth of old trees, age and size class structure is outside of the HRV. Across the rest of the landscape where disturbances were more common historically, the variety of age and size class structures with and without clearcutting is probably within the HRV - -as both clearcutting and intense fires would create the kind of size class structure characteristic of even-aged stands, and currently, the forest stands have not been cut more frequently than the rate at which fires have burned stands. However, because planned rotation times are shorter than natural FRIs, the average harvested stand won't be able to achieve old-growth characteristics and thus stand age and size structure may eventually exceed the HRV (Meyer et al. 2005).

In the Bighorns, due to thinning and selective harvesting, percent canopy cover is probably lower than that of the HRV (Meyer et al. 2005).

In the Bighorns, under existing conditions, tree densities might still fall within the moderately broad HRV, because even though trees have been partially or completely removed on about 20% of the landscape, fires may have removed half of that anyway if fire suppression had not been practiced. Canopy gap density and cover may be slightly below the HRV, but after 20yrs, these variables return to more natural conditions (Meyer et al. 2005). Stand variables averaged at the landscape scale could go beyond the HRV because of the abundance of older forests, mineral soil disruption or compaction, snag density and abundance of coarse woody debris (Meyer et al. 2005).

Native Uncharacteristic Conditions

There might be lower canopy cover and less old-growth today in parts of the Bighorns.

Scale Description

Patch sizes are generally 1000s to 10000s of acres in variable mosaics, including forest land and meadows. Landscapes are never in equilibrium, except possibly considering very large scales that exceed 300000ac.

Issues/Problems

This system will be highly heterogeneous and dynamic; this system has a very wide range of variability.

Comments

This model for MZ29 was adapted from the RA model R0LPSFcr Lower Subalpine, Wyoming and Central Rockies, created by Chris Thomas, Dennis Knight, Kathy Roche, and reviewed by Bill Romme and Bill Baker. Other modeler for MZ29 was David Overcast. Model changed descriptively, structurally, and quantitatively.

Laramie RA workshop code was LSAL2.

Additional edits from Dennis Knight and peer review incorporated on 4/11/2005. Peer review resulted in no changes to the model.

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Vegetation Classes

Class A 15 %

Early Development 1 All Structure

Indicator Species* and Canopy Position

PICO Upper
PIEN Upper

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Tree 0m	Tree 5m
Tree Size Class	Seedling <4.5ft	

☐ Upper layer lifeform differs from dominant lifeform.

Description

These are seedling/sapling trees less than one inch DBH and generally less than six feet in height

Range of 3-50% of a landscape, depending on climatic conditions and size of landscape. Early succession after moderately long to long-interval replacement fires. Buttery and Gillam's (1987) HSS 1, 2. Time in class is dependent on scale and intensity of disturbance, but generally moves out within 20yrs and goes to a mid-closed stage, class B. Alternatively, succession, under the right conditions, can move to a closed stage. This was modeled as alternate succession with a probability of 0.002.

Replacement fire occurs every 300yrs.

Class B 35 %

Mid Development 1 Closed

Indicator Species* and Canopy Position

PICO Upper
PIEN Lower

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Sapling >4.5ft; <5"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

This is dog hair lodgepole less than five inches DBH and 25ft tall.

Range of 5-50% of a landscape, depending on climatic conditions and size of landscape. Saplings to poles in size. Buttery and Gillam's (1987) HSS 3B, 3C. Includes classic "dog hair" stands. Ages run from 20-80yrs, then succeeds to a late closed stage, class E.

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) (0.0015 probability) and blowdowns (0.001 probability), cause a transition to a mid-open stage. Insects can also cause a transition very rarely (0.0001 probability) to the early stage, class A.

There is probably more of this class in current versus historical conditions, at least in the Bighorns (Meyer et al. 2005).

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Class C **10 %**

Mid Development 1 Open

Indicator Species* and Canopy Position

PICO	Upper
PIEN	Mid-Upper
ABLA	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Description

This is open grown pole sized lodgepole less than nine inches DBH and 35ft in height.

Range of 3-50% of a landscape, depending on climatic conditions and size of landscape. Saplings to poles. Buttery and Gillam's (1987) HSS 3A. Ages run from 20-80yrs, then succeed to a late open stage. Alternately, under the right conditions, succession can also occur toward a late closed stage - with a probability of 0.001.

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) (0.0015 probability) and blowdowns (0.001 probability), cause a transition to a mid-open stage.

There is probably more of this class in current versus historical conditions, at least in the Bighorns (Meyer et al. 2005).

Class D **10 %**

Late Development 1 Open

Indicator Species* and Canopy Position

PICO	Upper
PIEN	Upper
ABLA	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Description

Range of 2-15% of a landscape, depending on climatic conditions and size of landscape. Edaphic conditions control the density of this class. Moderate to large-diameter mixed conifer, generally on south aspects and shallow, intermittent rocky soils. Ages run from 80-300yrs, then succeeds to the late closed stage.

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) and blowdowns (0.001 probability for both), can cause a transition to a mid-open stage or can maintain this late open stage. Competition/maintenance can also maintain this stage with a probability of 0.001.

There is probably less old growth in current versus historical conditions (Meyer et al. 2005).

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Class E **30 %**

Late Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PICO	Upper
PIEN	Mid-Upper
ABLA	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Range of 15-50% of a landscape, depending on climatic conditions and size of landscape. Moderate to large-diameter trees largely on mesic sites (eg, north slopes). This is closed lodgepole stands less than nine inches DBH and <50ft tall. Ages run from 80-300yrs (LANDSUM requires that this class lasts through 999yrs).

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) (0.0015 probability) can cause a transition to a mid-open stage or an early stage (0.0001 probability). Blowdowns (0.001 probability), cause a transition to a late-open stage.

There is probably less old growth in current versus historical conditions (Meyer et al. 2005).

Disturbances

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 1000
Min 1
Max 100000

Sources of Fire Regime Data

- [x] Literature
- [x] Local Data
- [x] Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	120	30	300	0.00833	100
Mixed					
Surface					
All Fires	120			0.00835	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- [x] Insects/Disease
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [x] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2910510** **Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland**

☑ *This BPS is lumped with: 1052*

☐ *This BPS is split into multiple models: 1052 is thought to be very infrequent in MZ29 and only occurs on north-facing slopes, toe slopes and wetter sites within montane conifer forests and is defined as having Picea pungens (usually) as a component; 1052 is fairly difficult to recognize as occurring except in very small patches in the Laramie range; therefore, it was just lumped with 1051 for MZ29.*

General Information

Contributors (also see the Comments field **Date** 3/2/2005

Modeler 1	Mark Loewen	mloewen@fs.fed.us	**Reviewer**	Elena Contreras	econtreras@tnc.org
Modeler 2	Doug Page	doug_page@blm.gov	**Reviewer**		
Modeler 3	Linda Chappell	lchappell@fs.fed.us	**Reviewer**		

Vegetation Type

Forest and Woodland

Dominant Species*

PSEUD7 CARU
ABCO CAGA3
PIPO
PICO

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Geographic Range

As per NatureServe, this system occurs only in the Laramie Range of southern WY in MZ29. This might also occur in the Bighorns. Occurs throughout the southern Rockies, north and west into UT, NV, western WY and ID.

Biophysical Site Description

This is a highly variable ecological system of the montane zone of the Rocky Mountains. These are mixed-conifer forests occurring on all aspects at elevations ranging from 1200-3300m. Rainfall averages <75cm per year (40-60cm) with summer "monsoons" during the growing season contributing substantial moisture. The composition and structure of overstory is dependent upon the temperature and moisture relationships of the site, and the successional status of the occurrence.

Abies concolor dominates at higher, colder locations; Picea pungens represents mesic conditions; and Pseudotsuga menziesii dominates intermediate zones.

In the Bighorn Mountains, Douglas-fir and ponderosa pine are the dominants of late-successional forests at low elevations.

This type is generally located just above sagebrush ecosystems and adjacent to ponderosa pine woodlands.

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Vegetation Description

Pseudotsuga menziesii and Abies concolor are most frequent, but Pinus ponderosa may be present to codominant. Pseudotsuga menziesii forests occupy drier sites, and Pinus ponderosa is a common codominant. Abies concolor-dominated forests occupy cooler sites, such as upper slopes at higher elevations, canyon side slopes, ridge tops and north and east-facing slopes which burn somewhat infrequently. Picea pungens is most often found in cool, moist locations, often occurring as smaller patches within a matrix of other associations. As many as seven conifers can be found growing in the same occurrence.

In the Bighorns, Douglas-fir and ponderosa pine are the dominants of late-successional forests at low elevations. Sometimes Douglas-fir replaces ponderosa pine as the stand matures, but most ponderosa pine stands are dominated by ponderosa pine saplings in the understory. Lodgepole in the Bighorns is generally not seral to Douglas-fir (in Meyer et al. 2005).

There are a number of cold-deciduous shrub and graminoid species common, including Arctostaphylos uva-ursi, Mahonia repens, Paxistima myrsinites, Symphoricarpos oreophilus, Jamesia americana, Quercus gambelii and Festuca arizonica.

Populus tremuloides is often present as intermingled individuals in remnant aspen clones or in adjacent patches. The composition and structure of overstory are dependent upon the temperature and moisture relationships of the site and the successional status of the occurrence (DeVelice et al. 1986, Muldavin et al. 1996).

Other important species include Acer glabrum, Acer grandidentatum, Amelanchier alnifolia, Arctostaphylos patula, Holodiscus dumosus, Jamesia americana, Juniperus communis, Physocarpus monogynus, Quercus arizonica, Quercus rugosa, Quercus X pauciloba, Quercus hypoleucoides, Robinia neomexicana, Rubus parviflorus and Vaccinium myrtillus. Where soil moisture is favorable, the herbaceous layer may be quite diverse, including graminoids Bromus ciliatus (=Bromus canadensis), Calamagrostis rubescens, Carex geyeri, Carex rossii, Carex siccata (=Carex foenea), Festuca occidentalis, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia virescens, Poa fendleriana and Pseudoroegneria spicata, and forbs Achillea millefolium, Arnica cordifolia, Erigeron eximius, Fragaria virginiana, Linnaea borealis, Luzula parviflora, Osmorhiza berteroi, Packera cardamine (=Senecio cardamine), Thalictrum occidentale, Thalictrum fendleri, Thermopsis rhombifolia, Viola adunca and species of many other genera, including Lathyrus, Penstemon, Lupinus, Vicia, Arenaria, Galium and others.

Disturbance Description

Areas dominated by Douglas-fir are Fire Regime Group I. Some portions of these sites are transition zones to Fire Regime Groups II and III. Frequent surface and mixed severity fires were the common fire regime characteristics. Surface fires intervals ranged from 10-50yrs, and replacement severity occurred at intervals of 150-400yrs+ (Crane 1986, Barrett 1988, Bradley 1992a,b, Brown 1994, Morgan et al. 1996). Mixed severity fires were assumed to have an intermediate FRI of 45-75yrs on average. Stand replacement fires were generally restricted to the closed canopy forest and the stand initiation conditions.

The Fire Regime Group I characteristics are facilitated by understory vegetation dominated by fine fuel (grasses, sedges and forbs), landscape position and adjacency to other frequent fire BpSs. Much of the forest structure was open canopy overstory that resulted in an understory dominated by healthy and vigorous plants (grasses, sedges and forbs) and generally continuous fine fuel layer. These fine fuel

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facilitated fire spread and thinning of the conifer or aspen seedlings (thus promoting aspen suckering).

Other disturbances included insects and disease (return interval of 100yrs), including Douglas-fir beetle and mountain pine beetle; and drought, wind, and ice damage (every 1000yrs in closed stands; every 250yrs in open stands). Competition among trees was also a factor that increasingly slowed succession dynamics in more closed stands. Fire was by far the dominant disturbance agent.

Pseudotsuga menziesii forests are the only true 'fire-tolerant' occurrences in this ecological system. Pseudotsuga menziesii forests were probably subject to a moderate-severity fire regime in presettlement times, with fire-return intervals of 30-100yrs. Many of the important tree species in these forests are fire-adapted (Populus tremuloides, Pinus ponderosa and Pinus contorta) (Pfister et al. 1977), and fire-induced reproduction of Pinus ponderosa can result in its continued codominance in Pseudotsuga menziesii forests (Steele et al. 1981). Seeds of the shrub Ceanothus velutinus can remain dormant in forest occurrences for 200yrs (Steele et al. 1981) and germinate abundantly after fire, competitively suppressing conifer seedlings. Successional relationships in this system are complex.

Pseudotsuga menziesii is less shade-tolerant than many northern or montane trees such as Tsuga heterophylla, Abies concolor and Picea engelmannii, and seedlings compete poorly in deep shade. At drier locales, seedlings may be favored by moderate shading, such as by a canopy of Pinus ponderosa, which helps to minimize drought stress.

Fire suppression has probably led to a longer FRI than in the HRV (Meyer et al. 2005).

Adjacency or Identification Concerns

Aspen patches occurred at smaller scales than in more mesic mixed conifer forests. These more mesic sites would have had grass understories that did not dry as early in the year as surrounding areas, especially under a closed forest canopy, and these mesic areas often experience quicker humidity recovery in the evenings. These circumstances tended to lessen the fire severity in the aspen stands which acted as fire-safe sites compared to the surrounding landscape. This was important because aspen is much less resistant to fire than Douglas-fir.

If aspen is present in large patches or if conifers are not coming in after ~30yrs, the BpS is probably misclassified and one of the pure aspen types should be examined (Rocky Mountain Aspen Forest and Woodland (1011) or Intermountain Basins Aspen-Mixed Conifer Forest and Woodland (1061)).

BpS is often transitional between non-forested areas or between Pinus ponderosa (at lower elevations) and spruce-fir at higher elevations. It may, thus, grade into Southern Rocky Mountain Ponderosa Pine Woodland (1054) at lower elevations and Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland (1055).

With fire suppression, Abies concolor has vigorously colonized many sites formerly occupied by open Pinus ponderosa woodlands. These invasions have dramatically changed the fuel load and potential behavior of fire in these forests. In particular, the potential for high-intensity crown fires on drier sites now codominated by Pinus ponderosa and Abies concolor has increased. Increased landscape connectivity, in terms of fuel loadings and crown closure, has also increased the potential size of crown fire.

In some locations, many of these forests have been logged or burned during European settlement, and present-day occurrences are second-growth forests dating from fire, logging or other occurrence-replacing

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disturbances (Mauk and Henderson 1984, Chappell et al. 1997).

In general, fire suppression has lead to the encroachment of more shade-tolerant, less fire-tolerant species (eg, climax) into occurrences, and an attendant increase in landscape homogeneity and connectivity (from a fuel perspective). This has increased the lethality and potential size of fires.

The warmer and sometimes drier conditions in recent years can lead to changes in the successional trajectory at lower elevations and high, particularly due to changes in stand structure. Large conflagrations due to warming and fuel loading could set back some stands to earlier successional stages than would have occurred during the HRV (Meyer et al. 2005).

Native Uncharacteristic Conditions

Scale Description

This BpS occurs in patches ranging from 1000s to 10'000s of acres.

Issues/Problems

Comments

This model for MZ29 was adopted from the same BpS from MZs 22, 23 and 24, created by Loewen, Page and Chappell and reviewed by Dan Binkley for MZ22. NatureServe descriptors added in. Also - originally, MZ29 modelers modeled this system, but it was later decided that they were describing 1166.

This model for MZ22 was adopted as-is from the same BpS from MZ23, created by Mark Loewen, Doug Page, Linda Chappell and reviewed by Tim Christiansen (tchristiansen@tnc.org) and an anonymous reviewer. No significant changes were made for MZ22, as no one felt it occurred frequently enough to conduct a thorough review.

This model for MZ23 is identical to the model for the same BpS in MZ16 (Utah High Plateaus), with descriptive adjustments based on peer-review for MZs 23 and 24. This model was developed from the Rapid Assessment model R2PSMEdy (original modeler Lynn Bennett, lmbennett@fs.fed.us, and modified by Louis Provencher). Hugh Safford (hughsafford@fs.fed.us) and Steve Barrett (sbarrett@mtdig.net) were reviewers of R2PSMEdy.

Vegetation Classes

Class A **20 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 5

Indicator Species* and Canopy Position

CARU	Low-Mid
CAGA3	Low-Mid
PSEUD7	Upper
PIPO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Grass/forb/shrub/tree seedlings. Replacement fire is frequent (FRI of 25yrs) and causes top-kill of most vegetation. Mixed severity fire (FRI of 100yrs) does not cause an ecological setback. Vegetation will succeed to the mid-development closed (class B) condition in 35yrs.

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Class B **5 %**

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 9

Indicator Species* and Canopy Position

PSEUD7 Upper
ABCO Upper
PIPO Upper
PICO Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	80 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Forest canopy closure is >35%. Closed stand with trees, poles, saplings, grass and scattered shrub; 75-100% Douglas-fir and/or white fir. This class was originally modeled with a 100% canopy cover; however a reviewer noted that that was too high; cover max was changed to 80%.

In the absence of fire, vegetation will succeed to class E (closed, late-development) after 70yrs. Replacement fire (average FRI of 150yrs) and infrequent weather-related stress (return interval of 250yrs) return vegetation to class A. Mixed severity fire (FRI of 45yrs) and insect/diseases every 100yrs on average will cause a transition to an open mid-development forest (class C). Competition (probability/year = 0.01) maintains the stand in its closed condition.

Class C **15 %**

Mid Development 1 Open

Indicator Species* and Canopy Position

PSEUD7 Upper
PIPO Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	40 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 9

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Forest canopy closure is 10-35%. Open trees, (poles and saplings) of Douglas-fir and occasional ponderosa pine with grass and scattered shrubs.

With surface fire (FRI of 10yrs), mixed severity fire (FRI of 75yrs), weak adult tree competition (not modeled) and insect/diseases (every 100yrs), primary succession is to class D, the open late-development condition. Infrequent stand-replacing fire (FRI of 400yrs - changed to 500yrs for MZ29, so as to match class D and to better correspond to Disturbance Description) and infrequent weather-related stress (return interval of 1000yrs) will cause transitions to A. The stand will succeed on an alternative path to a closed late-development condition if it goes 68yrs without fire.

Class D **55 %**

Late Development 1 Open

Indicator Species* and Canopy Position

PSEUD7 Upper
PIPO Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	40 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Large 21-33"DBH	

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 9

- [ ] Upper layer lifeform differs from dominant lifeform.

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**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 sev

Description

Forest canopy closure is 10-35%. Open large tree/grass and scattered shrubs; Douglas-fir with occasional ponderosa pine.

Low severity fire (FRI of 10yrs) and mixed severity fire (FRI of 75yrs) maintain the stand in the open condition. This open condition, however, will close after 70yrs without fire (alternative path to class E). Mortality from adult tree competition (prob/yr of 0.001) and insect/diseases (100yrs return interval) also disturb this class, but do not affect the succession age. Replacement fire every 500yrs on average and weather-related stress (1000yrs return interval) will cause a transition to A.

Class E **5 %**

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

PSEUD7	Upper
ABCO	Upper
PICO	Upper
PIPO	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Forest canopy closure is >35%. Closed large trees of Douglas-fir, white fir and occasional lodgepole pine, scattered shrubs. Replacement fire (FRI of 150yrs) and infrequent weather/wind-related stress (return interval of 250yrs) cause a transition to class A. Mixed severity fire (FRI of 45yrs) open the structure of the stand (transition to class D), whereas surface fire (FRI of 50yrs) and competition (100yrs) , although present, do not cause transitions to other classes. Insect/diseases occur every 40yrs on average, however different insects cause 50% of the times a transition to class C, whereas others cause a transition to class D 50% of the time.

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg 100
Min 10
Max 1000

Sources of Fire Regime Data

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	100	90	600	0.01	11
Mixed	80	45	80	0.0125	14
Surface	15	10	50	0.06667	75
All Fires	11			0.08917	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

***Biophysical Setting* 2910520** **Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland**

☑ *This BPS is lumped with: 1051*

☐ *This BPS is split into multiple models: 1052 is thought to be very infrequent in MZ29 and only occurs on north-facing slopes, toe slopes and wetter sites within montane conifer forests and is defined as having Picea pungens (usually) as a component; 1052 is fairly difficult to recognize as occuring except in very small patches in the Laramie range; therefore, it was just lumped with 1051 for MZ29.*

General Information

Contributors (also see the Comments field **Date** 3/2/2005

Modeler 1	Mark Loewen	mloewen@fs.fed.us	**Reviewer**	Elena Contreras	econtreras@tnc.org
Modeler 2	Doug Page	doug_page@blm.gov	**Reviewer**		
Modeler 3	Linda Chappell	lchappell@fs.fed.us	**Reviewer**		

Vegetation Type

Forest and Woodland

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

PSEUD7 CARU
ABCO CAGA3
PIPO
PICO

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

As per NatureServe, this system occurs only in the Laramie Range of southern WY in MZ29. This might also occur in the Bighorns. Occurs throughout the southern Rockies, north and west into UT, NV, western WY and ID.

Biophysical Site Description

This is a highly variable ecological system of the montane zone of the Rocky Mountains. These are mixed-conifer forests occurring on all aspects at elevations ranging from 1200-3300m. Rainfall averages <75cm per year (40-60cm) with summer "monsoons" during the growing season contributing substantial moisture. The composition and structure of overstory is dependent upon the temperature and moisture relationships of the site, and the successional status of the occurrence.

Abies concolor dominates at higher, colder locations; Picea pungens represents mesic conditions; and Pseudotsuga menziesii dominates intermediate zones.

In the Bighorn Mountains, Douglas-fir and ponderosa pine are the dominants of late-successional forests at low elevations.

This type is generally located just above sagebrush ecosystems and adjacent to ponderosa pine woodlands.

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Vegetation Description

Pseudotsuga menziesii and Abies concolor are most frequent, but Pinus ponderosa may be present to codominant. Pseudotsuga menziesii forests occupy drier sites, and Pinus ponderosa is a common codominant. Abies concolor-dominated forests occupy cooler sites, such as upper slopes at higher elevations, canyon side slopes, ridge tops, and north- and east-facing slopes which burn somewhat infrequently. Picea pungens is most often found in cool, moist locations, often occurring as smaller patches within a matrix of other associations. As many as seven conifers can be found growing in the same occurrence.

In the Bighorns, Douglas-fir and ponderosa pine are the dominants of late-successional forests at low elevations. Sometimes Douglas-fir replaces ponderosa pine as the stand matures, but most ponderosa pine stands are dominated by ponderosa pine saplings in the understory. Lodgepole in the Bighorns is generally not seral to Douglas-fir (in Meyer et al. 2005).

There are a number of cold-deciduous shrub and graminoid species common, including Arctostaphylos uva-ursi, Mahonia repens, Paxistima myrsinites, Symphoricarpos oreophilus, Jamesia americana, Quercus gambelii and Festuca arizonica.

Populus tremuloides is often present as intermingled individuals in remnant aspen clones or in adjacent patches. The composition and structure of overstory are dependent upon the temperature and moisture relationships of the site and the successional status of the occurrence (DeVelice et al. 1986, Muldavin et al. 1996).

Other important species include Acer glabrum, Acer grandidentatum, Amelanchier alnifolia, Arctostaphylos patula, Holodiscus dumosus, Jamesia americana, Juniperus communis, Physocarpus monogynus, Quercus arizonica, Quercus rugosa, Quercus X pauciloba, Quercus hypoleucoides, Robinia neomexicana, Rubus parviflorus and Vaccinium myrtillus. Where soil moisture is favorable, the herbaceous layer may be quite diverse, including graminoids Bromus ciliatus (=Bromus canadensis), Calamagrostis rubescens, Carex geyeri, Carex rossii, Carex siccata (=Carex foenea), Festuca occidentalis, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia virescens, Poa fendleriana and Pseudoroegneria spicata and forbs Achillea millefolium, Arnica cordifolia, Erigeron eximius, Fragaria virginiana, Linnaea borealis, Luzula parviflora, Osmorhiza berteroi, Packera cardamine (=Senecio cardamine), Thalictrum occidentale, Thalictrum fendleri, Thermopsis rhombifolia, Viola adunca, and species of many other genera, including Lathyrus, Penstemon, Lupinus, Vicia, Arenaria, Galium and others.

Disturbance Description

Areas dominated by Douglas-fir are Fire Regime Group I. Some portions of these sites are transition zones to Fire Regime Groups II and III. Frequent surface and mixed severity fires were the common fire regime characteristics. Surface fires intervals ranged from 10-50yrs, and replacement severity occurred at intervals of 150-400yrs+ (Crane 1986, Barrett 1988, Bradley 1992a,b, Brown 1994, Morgan et al. 1996). Mixed severity fires were assumed to have an intermediate FRI of 45-75yrs on average. Stand replacement fires were generally restricted to the closed canopy forest and the stand initiation conditions.

The Fire Regime Group I characteristics are facilitated by understory vegetation dominated by fine fuel (grasses, sedges and forbs), landscape position and adjacency to other frequent fire BpSs. Much of the forest structure was open canopy overstory that resulted in an understory dominated by healthy and vigorous plants (grasses, sedges, and forbs) and generally continuous fine fuel layer. These fine fuel

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facilitated fire spread and thinning of the conifer or aspen seedlings (thus promoting aspen suckering).

Other disturbances included insects and disease (return interval of 100yrs), including Douglas-fir beetle and mountain pine beetle; and drought, wind and ice damage (every 1000yrs in closed stands; every 250yrs in open stands). Competition among trees was also a factor that increasingly slowed succession dynamics in more closed stands. Fire was by far the dominant disturbance agent.

Pseudotsuga menziesii forests are the only true 'fire-tolerant' occurrences in this ecological system. Pseudotsuga menziesii forests were probably subject to a moderate-severity fire regime in presettlement times, with fire-return intervals of 30-100yrs. Many of the important tree species in these forests are fire-adapted (Populus tremuloides, Pinus ponderosa and Pinus contorta) (Pfister et al. 1977), and fire-induced reproduction of Pinus ponderosa can result in its continued codominance in Pseudotsuga menziesii forests (Steele et al. 1981). Seeds of the shrub Ceanothus velutinus can remain dormant in forest occurrences for 200yrs (Steele et al. 1981) and germinate abundantly after fire, competitively suppressing conifer seedlings. Successional relationships in this system are complex.

Pseudotsuga menziesii is less shade-tolerant than many northern or montane trees such as Tsuga heterophylla, Abies concolor and Picea engelmannii, and seedlings compete poorly in deep shade. At drier locales, seedlings may be favored by moderate shading, such as by a canopy of Pinus ponderosa, which helps to minimize drought stress.

Fire suppression has probably led to a longer FRI than in the HRV (Meyer et al. 2005).

Adjacency or Identification Concerns

Aspen patches occurred at smaller scales than in more mesic mixed conifer forests. These more mesic sites would have had grass understories that did not dry as early in the year as surrounding areas, especially under a closed forest canopy, and these mesic areas often experience quicker humidity recovery in the evenings. These circumstances tended to lessen the fire severity in the aspen stands which acted as fire-safe sites compared to the surrounding landscape. This was important because aspen is much less resistant to fire than Douglas-fir.

If aspen is present in large patches or if conifers are not coming in after ~30yrs, the BpS is probably misclassified and one of the pure aspen types should be examined (Rocky Mountain Aspen Forest and Woodland (1011) or Intermountain Basins Aspen-Mixed Conifer Forest and Woodland (1061)).

BpS is often transitional between non-forested areas or between Pinus ponderosa (at lower elevations) and spruce-fir at higher elevations. It may, thus, grade into Southern Rocky Mountain Ponderosa Pine Woodland (1054) at lower elevations and Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland (1055).

With fire suppression, Abies concolor has vigorously colonized many sites formerly occupied by open Pinus ponderosa woodlands. These invasions have dramatically changed the fuel load and potential behavior of fire in these forests. In particular, the potential for high-intensity crown fires on drier sites now codominated by Pinus ponderosa and Abies concolor has increased. Increased landscape connectivity, in terms of fuel loadings and crown closure, has also increased the potential size of crown fire.

In some locations, much of these forests have been logged or burned during European settlement, and present-day occurrences are second-growth forests dating from fire, logging or other occurrence-replacing

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disturbances (Mauk and Henderson 1984, Chappell et al. 1997).

In general, fire suppression has lead to the encroachment of more shade-tolerant, less fire-tolerant species (eg, climax) into occurrences and an attendant increase in landscape homogeneity and connectivity (from a fuel perspective). This has increased the lethality and potential size of fires.

The warmer and sometimes drier conditions in recent years can lead to changes in the successional tranjectory at lower elevations and high, particularly due to changes in stand structure. Large conflagrations due to warming and fuel loading could set back some stands to earlier successional stages than would have occurred during the HRV (Meyer et al. 2005).

Native Uncharacteristic Conditions

Scale Description

This BpS occurs in patches ranging from 1000s to 10000s of acres.

Issues/Problems

Comments

This model for MZ29 was adopted from the same BpS from MZs 22, 23 and 24, created by Loewen, Page and Chappell and reviewed by Dan Binkley for MZ22. NatureServe descriptors added in. Also - originally, MZ29 modelers modeled this system, but it was later decided that they were describing 1166.

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Vegetation Classes

Class A **20 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 5

Indicator Species* and Canopy Position

CARU	Low-Mid
CAGA3	Low-Mid
PSEUD7	Upper
PIPO	Upper

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	0 %	20 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Grass/forb/shrub/tree seedlings. Replacement fire is frequent (FRI of 25yrs) and causes top-kill of most vegetation. Mixed severity fire (FRI of 100yrs) does not cause an ecological setback. Vegetation will succeed to the mid-development closed (class B) condition in 35yrs.

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**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 seve

Class B 5 %

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 9

Indicator Species* and Canopy Position

PSEUD7	Upper
ABCO	Upper
PIPO	Upper
PICO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	80 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Forest canopy closure is >35%. Closed stand with trees, poles, saplings, grass and scattered shrub; 75-100% Douglas-fir and/or white fir. This class was originally modeled with a 100% canopy cover; however a reviewer noted that that was too high; cover max was changed to 80%.

In the absence of fire, vegetation will succeed to class E (closed, late-development) after 70yrs. Replacement fire (average FRI of 150yrs) and infrequent weather-related stress (return interval of 250yrs) return vegetation to class A. Mixed severity fire (FRI of 45yrs) and insect/diseases every 100yrs on average will cause a transition to an open mid-development forest (class C). Competition (probability/year = 0.01) maintains the stand in its closed condition.

Class C 15 %

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 9

Indicator Species* and Canopy Position

PSEUD7	Upper
PIPO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	40 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Forest canopy closure is 10-35%. Open trees, (poles and saplings) of Douglas-fir and occasional ponderosa pine with grass and scattered shrubs.

With surface fire (FRI of 10yrs), mixed severity fire (FRI of 75yrs), weak adult tree competition (not modeled) and insect/diseases (every 100yrs), primary succession is to D, the open late-development condition. Infrequent stand-replacing fire (FRI of 400yrs - changed to 500yrs for MZ29, so as to match class D and to better correspond to Disturbance Description) and infrequent weather-related stress (return interval of 1000yrs) will cause transitions to class A. The stand will succeed on an alternative path to a closed late-development condition if it goes 68yrs without fire.

Class D 55 %

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 9

Indicator Species* and Canopy Position

PSEUD7	Upper
PIPO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	40 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Large 21-33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

Description

Forest canopy closure is 10-35%. Open large tree/ grass and scattered shrubs; Douglas-fir with occasional ponderosa pine.

Low severity fire (FRI of 10yrs) and mixed severity fire (FRI of 75yrs) maintain the stand in the open condition. This open condition, however, will close after 70yrs without fire (alternative path to class E). Mortality from adult tree competition (prob/yr of 0.001) and insect/diseases (100yrs return interval) also disturb this class, but do not affect the succession age. Replacement fire every 500yrs on average and weather-related stress (1000yrs return interval) will cause a transition to A.

Class E **5 %**

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

PSEUD7	Upper
ABCO	Upper
PICO	Upper
PIPO	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Forest canopy closure is >35%. Closed large trees of Douglas-fir, white fir and occasional lodgepole pine, scattered shrubs. Replacement fire (FRI of 150yrs) and infrequent weather/wind-related stress (return interval of 250yrs) cause a transition to class A. Mixed severity fire (FRI of 45yrs) open the structure of the stand (transition to class D), whereas surface fire (FRI of 50yrs) and competition (100yrs), although present, do not cause transitions to other classes. Insect/diseases occur every 40yrs on average, however different insects cause 50% of the times a transition to class C, whereas others cause a transition to class D 50% of the time.

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg 100
Min 10
Max 1000

Sources of Fire Regime Data

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	100	90	600	0.01	11
Mixed	80	45	80	0.0125	14
Surface	15	10	50	0.06667	75
All Fires	11			0.08917	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

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**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 seve

LANDFIRE Biophysical Setting Model

Biophysical Setting **2910540** **Southern Rocky Mountain Ponderosa Pine Woodland**

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

General Information

Contributors (also see the Comments field **Date** 6/13/2006

Modeler 1	Cody Wienk	cody_wienk@nps.gov	**Reviewer**	Peter Brown	pmb@rmtrr.org
Modeler 2	Jeff DiBenedetto	jdibenedetto@fs.fed.us	**Reviewer**	Deanna Reyher	dreyher@fs.fed.us
Modeler 3	Chris Thomas	cthomas@fs.fed.us	**Reviewer**	Bill Schaupp	bschaupp@fs.fed.us

Vegetation Type

Forest and Woodland

Dominant Species*

PIPO JUCO6
PRVI MARE11
ROWO TORY
ORAS ARUV

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Geographic Range

This type would be in MZ 29, 30 and 20. In MZ29, sections M331I, M331B and 342A; subection 342Fb. . It also occurs in Bighorns in WY. This is the ponderosa pine woodland that is in the Rocky Mountain range. In WY, it is basically found in the Laramie and Bighorn Ranges and west.

Biophysical Site Description

North and northeast aspect slopes outside of Laramie Peak (section M331). Soils range from sandy loams to loams (Hansen and Hoffman 1988). The underlying substrate would be predominantly sedimentary. Elevation would be at approximately 3000-4000ft.

This BpS is found on all aspects of Laramie Peak above ponderosa pine savanna (BpS 1117) (generally 4000-6000ft), predominately on the lower limestone plateau and material weathered from metamorphic rocks. This type is generally on sites with sandy loam to clayey loam soils.

Vegetation Description

Ponderosa pine, chokecherry, Saskatoon serviceberry, aspen, Ribes species, rose species, hawthorn, Oregon grape, raspberry, littleseed ricegrass, Canada wildrye, needlegrasses, sideoats grama, sedges, common juniper and poison ivy are common.

Plant communities for Laramie Peak:
1) Pinus ponderosa/Arctostaphylos uva-ursi with Mahonia repens, Rosa woodsii and Symphoricarpos albus; 2) Pinus ponderosa/Carex rossii with Purshia tridentata; and 3) Pinus ponderosa/Carex geyeri with Arctostaphylos uva-ursi, Mahonia repens and Juniperus communis.

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Disturbance Description

Generally frequent fire return interval with surface fire. The presence of abundant fire-scarred trees in multi-aged stands supports a prevailing historical model for ponderosa pine forests in which recurrent surface fires affected heterogeneous forest structure (Brown 2006). Mixed severity fire occurs if fire return intervals are missed, and stand replacement fire is infrequent. Some speculate that stand replacing fire in the Black Hills is less frequent than outside. The Black Hills stand replacement frequency is thought to be approximately 300yrs+. Some speculate that the stand replacement frequency outside the Black Hills is thought to be approximately 150-200yrs (and is thought to be as such for the Laramie Peak area). With the Native American influence outside of the Black Hills, the replacement fire interval could be even more frequent than the 300yr interval. However, due to lack of evidence for a different interval outside of the Black Hills, the 300yr interval was chosen for this model and supported by review.

Laramie Peak area is subject several different weather patterns maybe tied to the El Niño/Southern Oscillation (ENSO). Sometimes it gets its weather from the southwest –eg, like AZ monsoons, other years it gets its weather from the Northern Great Plains –colder dryer, then some years it gets its weather from the Southern Great Plains influenced by the Gulf of Mexico. Also Laramie Peak area has more elevation differences and topographic effects because of its steepness. Forest Service Region 2 considers ponderosa pine on Laramie Peak area to be more similar to Colorado Front Range ponderosa pine which doesn't prune branches as readily nor get as big as fast as Black Hills ponderosa pine.

There is considerable debate over the role of mixed severity and surface fires in the historical range of variability in this and other ponderosa pine forests in the northern and central Rockies (Baker and Ehle 2001, 2003, Barrett 2004, Veblen et al. 2000).

Brown (in press) argues that surface fire was dominant mode of disturbance.

Snead (2005) reported a MFRI of 4-42yrs on northern side of Ashland Ranger District; on southern 4-63.

Precipitation is concentrated in April through June, but occurs throughout the growing season, resulting in good pine regeneration and dense patches of saplings. Elk, and to a lesser extent, bison, were important ungulates. Windthrow, storm damage and mountain pine beetles were important disturbances in this type, especially when stands reached high densities, as evidenced in mountain pine beetle outbreaks occuring from 2000 through present and still increasing. USDA Forest Service 2006 map.

The Laramie Peak had a mountain pine beetle outbreak in ponderosa pine in the early 90s followed by some large fires that were stand replacing in areas - now there is not much activity.

Insect/disease disturbance occurs, but unsure of frequency. It was modeled at a very infrequent rate. Frequency could be related to density; therefore, modeled in the late closed and open stages. For additional information on insects in the Black Hills see the Phase II Amendment (USDA Forest Service 2005).

Disturbance from mountain pine beetles was frequent locally and rare area-wide. Current research indicates highest probability of infestation occurs in areas with trees denser than 120 sq ft per acre (possibly 100) and averaging seven inches DBH or greater.

The occurrence of area wide mountain pine beetles epidemics is dependent on favorable weather and abundant food supplies in the form of adjacent susceptible areas.

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Adjacency or Identification Concerns

This type occurs at elevations above ponderosa pine savanna. This type differs from Northwestern Great Plains Highland Spruce Woodland and Ponderosa Pine- Black Hills (BpS 2910480) because it has been documented to have more frequent surface fires, less frequent replacement fires and less closed canopy forest. (Brown 2003)

This system could be difficult to distinguish from 1117, Ponderosa Pine Savanna. They will be adjacent to each other. It could also be adjacent to grassland and shrubland systems/associated with prairie systems. It might also be adjacent to and intermingled with green ash/woody draw systems. And at the lowest margins grassland invasion has occurred. Distinguishing features can be found by aspect (see Biophysical Site Description).

This system will be difficult to distinguish from Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna - Low Elevation Woodland (1179); it is only distinguished by geography.

Currently, there have probably been at least five fire cycles that have been missed due to suppression, grazing, etc. (In the Laramie Peak area, however, there have been numerous wildfires since the 1990s, so this claim cannot be made for that area.) Therefore, the system today would look much more like the late closed stage with approximately 70-90% canopy closure. Increased ladder fuel as a result of missed fire cycles increases the probability of a stand replacement fire.

Expansion into grasslands both at prairie margins and into interior meadows; timber harvest and removal of larger size classes from all areas; stand infilling and thickening due to fire exclusion.

The absence of dwarf mistletoe also distinguishes this ponderosa pine system from most others in the country.

This model for 1054 for MZ29 seems to differ slightly from 1054 in MZ20 (adjacent mapzone), due to distinctness of Black Hills ponderosa pine (which was originally modeled for 291054). However, in general, overall FRI similar with mostly low severity fires. And general amounts in the successional classes are similar, with similar cover/height distinctions. Some of the other disturbance probabilities differ, due to more information provided in literature for MZ29.

In this system, as in many others, non-native grass species may be providing different surface fire effects. For example, litter produced by Kentucky bluegrass, Japanese brome, and downy brome is much finer and has different characteristics for burning, insulation and moisture retention. This would change the effects of fires, even if they occurred at historic frequencies. The most likely change is in composition of surface vegetation, although longer term effects to the soil may also occur.

Native Uncharacteristic Conditions

The Laramie Peak area has numerous areas where canopy closure will never get above 40% and other areas where canopy closure will never get above 60%. There is so much rock that ponderosa pine grows in “flower pots” between the rocks.

Scale Description

Disturbance patch size probably ranged from 10s-10,000s of acres.

Outside of the Black Hills and Missouri Breaks, this BpS would have been 10s-1000ac.

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**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 seve

Issues/Problems

Comments

This BpS was originally modeled for MZs 29 and 30 including the Black Hills. However, post-model-review-and-delivery, the new BpS, Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna - Low Elevation Woodland (1179) was created by NatureServe. Therefore, this model 1054 was retained as-is for a portion of MZs 29 and 30, based on geography, and this model 1054 was also copied as-is for a different portion of MZs 29 and 30, based on geography, and used for the Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna - Low Elevation Woodland (1179) split.

This model for MZs 29 and 30 was adapted from the model from the Rapid Assessment R0PIPObl Ponderosa Pine Woodlands and BH Low Elevation developed by Kelly Pohl, Cody Wienk and Carolyn Sieg. Other modelers for MZs 29 and 30 were Paul Mock, Dave Overcast and Kim Reid. Other reviewers for MZs 29 and 30 were Carolyn Sieg, Gwen Sanchez-Lipp, Kathy Roche and Mary Lata.

RA quantitative model was developed post-workshop by Kelly Pohl with input from Cody Wienk and Carolyn Sieg. Additional input was provided during the workshop by Deanna Reyher, Blaine Cook and Bill Baker and factored into the model development. Because of the model's late development it received no peer review.

Vegetation Classes

Class A **5 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

PRVI	Mid-Upper
AMAL	Mid-Upper
PIPO	Middle
	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	60 %
Height	Shrub 0m	Shrub 3.0m
Tree Size Class	Seedling <4.5ft	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Herbaceous/shrubby post-replacement class, persists 0-15yrs.

Outside of the Black Hills, associated with grass/forb, chokecherry, serviceberry, leadplant, raspberry, rose, Oregon grape, snowberry and currant.

Shrubs are typically greater than one meter but chokecherry can reach heights of over three meters.

This class is generally expected to succeed to a mid-open stage in approximately 15yrs, although without fire for 13yrs or other distubances, it may succeed to a mid-closed stage.

Replacement fire occurs every 300yrs, and low severity fire every 20yrs. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30yrs; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.)

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**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 sev

Class B **15 %**

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Pole ponderosa pine (dog hair), generally persists 15-50yrs. (Because Laramie Peak area is so rocky, it rarely gets dog hair ponderosa pine.) Very few understory species present due to canopy closure. This class may succeed to a late closed stage if not affected by fire or insect outbreaks.

Replacement fire occurs every 300yrs, and low severity fire every 20yrs, but causes no transition. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30yrs; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.)

Class C **15 %**

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO Upper
PRVI Middle
AMAL Middle
Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class persists 15-50yrs. Surrounding this class are other trees/stands that are over 100yrs old.

Understory species would be similar to those in class A. Snowberry will also become more prevalent.

This class succeeds to a late open stage, although without fire for 25yrs, this class can move to a mid-closed stage.

Replacement fire occurs every 300yrs, low severity fire every 20yrs and mixed fire every 200yrs, but low and mixed do not cause a transition. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30yrs; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.)

Class D **55 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO Upper
PRVI Middle
AMAL Middle
Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

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**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 sev

Description

Open canopy stand; persists 50yrs+. Patches of dense doghair and 200yrs+ trees persist. Common juniper and rough leaf ricegrass common in Black Hills.

Other understory species same as in class C and A.

In the absence of fire, drought or insect outbreaks for 60yrs, this class may be expected to succeed to a late development closed stage.

Insect/disease outbreaks functioning as minor mortality incidents not causing a transition to another class, can occur every 20yrs (reviewers speculated between 15-25yrs and 30-50yrs). Moderate mortality incidents can cause a transition to a mid-open stage every 100-200yrs (modeled every 250yrs), and catastrophic mortality which causes a change back to an early stage occurs every 200-300yrs (modeled as every 333yrs).

It is thought that class D should occupy approximately 60% of the historical landscape (see figure 3 in Brown and Cook (2006) for some rough numbers, which found that ~60% of the reconstructed historical stands had approximately <20m^2/ha basal area which would probably be late open.)

Replacement fire occurs every 300yrs. Low severity fire occurs every 20yrs but does not cause a transition. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30yrs; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.). Mixed severity fire occurs approximately every 200yrs overall, half the time causing a transition to a mid stage and half the time causing no transition. Mixed severity fires are patchy.

Class E **10 %**

Late Development 1 Closed

Indicator Species* and Canopy Position

PIPO	Upper
JUCO	Low-Mid

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	51 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Closed canopy, multi-layer stand, persists 50yrs+. At >70% canopy closure, mountain pine beetle outbreaks occur, opening up the canopy. Insect/disease outbreaks functioning as minor mortality incidents not causing a transition to another class, can occur every 40yrs (reviewers speculated between 15-25yrs and 30-50yrs). Moderate mortality incidents can cause a transition to a late-open stage every 100-200yrs (modeled every 100yrs), and catastrophic mortality which causes a change back to an early stage occurs every 200-300yrs (modeled as every 333yrs).

Understory species the same but fewer numbers. Common or Rocky Mountain juniper might be present with lack of disturbance. Outside of Black Hills, sun sedge and littleseed ricegrass may be present.

Mixed fire occurs approximately every 200yrs, half the time causing a transition to a mid development stage (75% open, 25% closed), and half the time staying within the late development stage (75% open, 25% closed).

Replacement fire occurs every 300yrs, and low severity fire every 20yrs and brings this class to a late open

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**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 seve

stage. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.)

See figure 5 in Brown (2006); closed canopy conditions were probably transient due to regional synchronous recruitment forced by climate (i.e., the distinction between fire history and fire regime).

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg
Min 1
Max 100000

Sources of Fire Regime Data

- [x] Literature
- [ ] Local Data
- [ ] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	300	100	400	0.00333	6
Mixed	270	50	400	0.00370	6
Surface	20	5	50	0.05	88
All Fires	18			0.05704	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- [x] Insects/Disease
- [ ] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

References

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2910550** **Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland**

☑ *This BPS is lumped with: 1055, 1050*

☐ *This BPS is split into multiple models:* *This model incorporates some facets of 1050, 1055 and poor site Lodgepole 1167. Development of this type is thought to be different from the others in structure and pre-European fire regime.*

General Information

Contributors (also see the Comments field **Date** 6/13/2006

Modeler 1	Chris Thomas	cthomas@fs.fed.us	**Reviewer**	Elena Contreras econtreras@tnc.org
Modeler 2	Dennis Sandbak	dsandbak@fs.fed.us	**Reviewer**	
Modeler 3	Paul Mock	pmock@fs.fed.us	**Reviewer**	

Vegetation Type

Forest and Woodland

Dominant Species*

PICO
PIEN
ABLA
VASC

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Geographic Range

Common in the mountains of WY and minor portion of the Pryor Mountains in the upper montane and lower subalpine zones. This would occur in ECOMAP sections M331B and M331I. This type occurs in the Bighorn Mountains of WY as well as the Laramie Peak Range.

Biophysical Site Description

This BpS occurs between approximately 7000ft (above foothill forests dominated by ponderosa pine and Douglas-fir) to 9500ft. This type is restricted to north slopes at lower elevations. Slopes may be gentle to moderately steep (eg, 0-60% slope).

Vegetation Description

Lodgepole pine, Engelmann spruce and subalpine fir are the dominants of this BpS. Lodgepole pine is more common on drier sites and spruce and fir are more common on more mesic sites (such as north-facing slopes). Common associated species include aspen, grouse whortleberry, common juniper, heartleaf arnica, russet buffaloberry, elk sedge and various grasses.

Because of its relative intolerance for the forest understory environment, lodgepole pine traditionally has been considered a pioneer or seral species to forests dominated by Engelmann spruce and subalpine fir. However, some of the Bighorn National Forest (MZ29) is too dry to support spruce-fir forests and lodgepole pine perpetuates itself in some areas (Despain 1973 in Meyer et al. 2005).

Disturbance Description

Fire Regime Group V or IV, but primarily moderately long to long-interval stand replacement fires.

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Mixed-severity and surface fires may occur rarely in small patch sizes (ie, <1000s of acres) for this group, but are not modeled here.

Insects (mountain pine beetle) affect approximately 0.1% of the landscape every year and will either open the canopy, (maintaining or causing a transition to classes C and D), or replace the vegetation, causing a transition to early-development conditions (class A). Stand replacing insect outbreaks typically only occur in closed-canopy forests (classes B and E).

Blister rust might have occured during the HRV period - at relatively low levels during cool periods and a thigher levels during warm, moist periods such as the early 1500s early 1700s (Meyer et al. 2005).

Blowdown events occur rarely (once every 500-1000yrs), and are replacement events, causing a transition to early-development conditions (class A).

For MZ29, changed replacement fire - higher and more frequent to get correct percentages in classes.

The HRV for succession and processes during the reference period for both individual stands and the landscape in the Bighorn Mtns would have been broad. Different sites on any specific burn can experience different successional trajectories, resulting in doghair stands of lodgepole in some areas, stands of average or below average tree density elsewhere, and a full variety of combinations of invading aspen, spruce, fir and lodgepole pine across the landscape (in Meyer et al 2005).

Meyer et al. (2005) suggest that the MFRI of stand-replacing fires in the last 100yrs in high elevation types within the Bighorns is still within the range of means during the HRV period, despite fire suppression efforts. Recent fire records for the Bighorn National Forest suggest that fires still play an important role on the Bighorn National Forest, but fire suppression efforts have lengthened the MFRI during the last 50yrs (Meyer et al. 2005).

Surface fires in lodgepole pine have been observed in the Bighorns, and because of the thin bark, some trees are killed. Surface fires may have burned through lodgepole pine forests in the Bighorn National Forest at intervals as short as 40-80yrs (Meyer et al. 2005). They were not modeled here.

Adjacency or Identification Concerns

In WY, this group is adjacent to lodgepole pine and upper subalpine groups, and will be found above Douglas-fir and ponderosa types in elevation. Vegetation classes may vary significantly.

Secondary succession initiated today could have quite different trajectories than 200-300yrs ago because of the warmer and wetter climatic conditions of the last century (in Meyer et al. 2005).

This type might be confused with the Subalpine Spruce Fir Forests 1056. This system, however, incorporates more of the lodgepole and is at somewhat lower elevations and might be drier. Note that some of the Englemann spruce/subalpine fir should be keyed to 1056 as well as 1050/1055 in MZ29.

Blister rust increased in 1900s. At present time, dwarf mistletoe occurs at higher levels than in the HRV (Meyer et al. 2005).

In the Bighorns, a full range of size and age class structures probably existed during the HRV period, ranging from young to older even-aged stands of lodgepole, many having developed after fires in the

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1600s and 1700s to uneven-aged stands that hadn't burned for centruies and were dominated primarily by Engelmann spruce and subalpine fir. The fires would have killed many of the big trees from time to time, and they probably burned over large areas. Consequently, tree size would have ranged from uniformly small trees after the stand was recently burned to very large trees with small trees when the stand hadn't been disturbed for long periods. Since the late 1800s, both human-caused fire and timber harvest have converted areas with large, old trees to stands of younger, smaller trees, with the exception that timber harvesting could extend into areas that hadn't burned for centuries, such as on leeward slopes or in ravines. When timber harvesting in those areas doesn't provide sufficient time to allow regrowth of old trees, age and size class structure is outside of the HRV. Across the rest of the landscape where disturbances were more common historically, the variety of age and size class structures with and without clearcutting is probably within the HRV - -as both clearcutting and intense fires would create the kind of size class structure characteristic of even-aged stands, and currently, the forest stands have not been cut more frequently than the rate at which fires have burned stands. However, becasue planned rotation times are shorter than natural FRIs, the average harvested stand won't be able to achieve old-growth characteristics and thus stand age and size structure may eventually exceed the HRV (Meyer et al. 2005).

In the Bighorns, due to thinning and selective harvesting, percent canopy cover is probably lower than that of the HRV (Meyer et al. 2005).

In the Bighorns, under existing conditions, tree densities might still fall within the moderately broad HRV, because even though trees have been partially or completely removed on about 20% of the landscape, fires may have removed half of that anyway if fire suppression had not been practiced. Canopy gap density and cover may be slightly below the HRV, but after 20yrs, these variables return to more natural conditions (Meyer et al. 2005). Stand variables averaged at the landscape scale could go beyond the HRV because of the abundance of older forests, mineral soil disruption or compaction, snag density and abundance of coarse woody debris (Meyer et al. 2005).

Native Uncharacteristic Conditions

There might be lower canopy cover and less old-growth today in parts of the Bighorns.

Scale Description

Patch sizes are generally 1000s-10000s of acres in variable mosaics, including forest land and meadows. Landscape are never in equilibrium, except possibly considering very large scales that exceed 300000ac.

Issues/Problems

This system will be highly heterogeneous and dynamic; this system has a very wide range of variability.

Comments

This model for MZ29 was adapted from the RA model R0LPSFcr Lower Subalpine, Wyoming and Central Rockies, created by Chris Thomas, Dennis Knight and Kathy Roche, and reviewed by Bill Romme and Bill Baker. Other modeler for MZ29 was David Overcast. Model changed descriptively, structurally and quantitatively.

Laramie RA workshop code was LSAL2.

Additional edits from Dennis Knight and peer review incorporated on 4/11/2005. Peer review resulted in no changes to the model.

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Vegetation Classes

Class A **15 %**

Early Development 1 All Structure

Indicator Species* and Canopy Position

PICO Upper
PIEN Upper

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Tree 0m	Tree 5m
Tree Size Class	Seedling <4.5ft	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

These are seedling/sapling trees less than one inch DBH, and genrally less than six feet in height

Range of 3-50% of a landscape, depending on climatic conditions and size of landscape. Early succession after moderately long to long interval replacement fires. Buttery and Gillam's (1987) HSS 1, 2. Time in class is dependent on scale and intensity of disturbance, but generally moves out within 20yrs and goes to a mid-closed stage, B. Alternatively, succession, under the right conditions, can move to a closed stage. This was modeled as alternate succession with a probability of 0.002.

Replacement fire occurs every 300yrs.

Class B **35 %**

Mid Development 1 Closed

Indicator Species* and Canopy Position

PICO Upper
PIEN Lower

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This is dog hair lodgepole less than five inches DBH and 25ft tall.

Range of 5-50% of a landscape, depending on climatic conditions and size of landscape. Saplings to poles in size. Buttery and Gillam's (1987) HSS 3B, 3C. Includes classic "dog hair" stands. Ages run from 20-80yrs, then succeeds to a late closed stage, class E.

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) (0.0015 probability) and blowdowns (0.001 probability), cause a transition to a mid-open stage. Insects can also cause a transition very rarely (0.0001 probability) to the early stage, A.

There is probably more of this class in current vs historical conditions, at least in the Bighorns (Meyer et al. 2005).

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Class C **10 %**

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PICO Upper
PIEN Mid-Upper
ABLA Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This is open grown pole sized lodgepole less than nine inches DBH and 35ft in height.

Range of 3-50% of a landscape, depending on climatic conditions and size of landscape. Saplings to poles. Buttery and Gillam's (1987) HSS 3A. Ages run from 20-80yrs, then succeed to a late open stage. Alternately, under the right conditions, succession can also occur toward a late closed stage - with a probability of 0.001.

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) (.0015 probability) and blowdowns (.001 probability), cause a transition to a mid-open stage.

There is probably more of this class in current vs historical conditions, at least in the Bighorns (Meyer et al. 2005).

Class D **10 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PICO Upper
PIEN Upper
ABLA Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Range of 2-15% of a landscape, depending on climatic conditions and size of landscape. Edaphic conditions control the density of this class. Moderate to large-diameter mixed conifer, generally on south aspects and shallow, intermittent rocky soils. Ages run from 80-300yrs, then succeeds to the late closed stage.

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) and blowdowns (0.001 probability for both), can cause a transition to a mid-open stage or can maintain this late open stage. Competition/maintenance can also maintain this stage with a probability of 0.001.

There is probably less old growth in current vs historical conditions (Meyer et al. 2005).

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Class E **30 %**

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PICO	Upper
PIEN	Mid-Upper
ABLA	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Range of 15-50% of a landscape, depending on climatic conditions and size of landscape. Moderate to large-diameter trees largely on mesic sites (eg, north slopes). This is closed lodgepole stands less than nine inches DBH and <50ft tall. Ages run from 80-300yrs (LANDSUM requires that this class lasts through 999yrs).

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) (0.0015 probability) can cause a transition to a mid-open stage or an early stage (0.0001 probability). Blowdowns (0.001 probability), cause a transition to a late-open stage.

There is probably less old growth in current vs historical conditions (Meyer et al. 2005).

Disturbances

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 1000
Min 1
Max 100000

Sources of Fire Regime Data

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	120	30	300	0.00833	100
Mixed					
Surface					
All Fires	120			0.00835	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2910560** **Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland**

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

General Information

Contributors (also see the Comments field **Date** 6/13/2006

Modeler 1	Chris Thomas	cthomas@fs.fed.us	**Reviewer**	Elena Contreras	econtreras@tnc.org
Modeler 2	Dennis Sandbak	dsandbak@fs.fed.us	**Reviewer**		
Modeler 3	Paul Mock	pmock@fs.fed.us	**Reviewer**		

Vegetation Type

Forest and Woodland

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

PIEN
ABLA
PICO

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

Northern Rockies, including MT, ID and WY. This BpS is thought to be very limited in extent in MZ20, since almost all of MZ20 forest is BpS 1045.

In MZ29, this occurs in the Bighorn Mountains, and there is some spruce/fir in the Laramie Peak Range. Sections M331B and M331I

Biophysical Site Description

Upper subalpine zone and mesic sites. Occurrences are typically found in locations with cold-air drainage or ponding, or where snowpacks linger late into the summer, such as north-facing slopes and high-elevation ravines. They can extend down in elevation below the subalpine zone in places where cold-air ponding occurs; northerly and easterly aspects predominate. These forests are found on gentle to very steep mountain slopes, high-elevation ridgetops and upper slopes, plateau-like surfaces, basins, alluvial terraces, well-drained benches, and inactive stream terraces. Reviewers for MZ20 felt that the preceding sentence does not align with this BpSs shrub understory component, as this BpS has moist-driven shrubs and may occur near riparian areas.

Vegetation Description

Engelmann spruce and subalpine fir dominate on most aspects with lodgepole pine comprising a greater component on dryer sites or earlier successional stages. Early succesional vegetation contains Eurybia conspicua and Carex geyeri. Vaccinium scoparium is a common understory associate in later successional stages.

Mesic understory shrubs include Menziesia ferruginea, Vaccinium membranaceum, Rubus parviflorus

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and Ledum glandulosum. Herbaceous species include Actaea rubra, Maianthemum stellatum, Cornus canadensis, Erigeron engelmannii, Saxifraga bronchialis, Lupinus argenteus ssp. subalpinus and Valeriana sitchensis, and graminoids such as Carex generii and Calamagrostis canadensis.

Disturbance Description

Fire Regime Group V or IV; primarily long-interval stand replacement fires. In some areas, spruce beetle can influence successional stage, species composition and stand density. Spruce beetle may act to accelerate succession.

It has been suggested that this system is not outside of its HRV for fire frequency and severity. Fire interval could be greater than 400yrs at times (Romme, personal correspondence; Veblen et al. 1991, 1994), or between 335-400yrs (Bradley et al. 1992), and there is no equilibrium achieved in this system, as it fluctuates widely normally in each class.

For MZ21, all modelers and reviewers agreed that this fire return interval should be greater than 300yrs. Most of the fire is modeled as replacement fire. There might be some mixed severity fire in this system, and it is modeled in the late closed state, as per modelers and reviewers.

Adjacency or Identification Concerns

Adjacent to drier, lower subalpine forests (lodgepole-spruce-fir) and to krummholz and alpine vegetation. This system typically has more precipitation and longer winters than lower subalpine types.

This BpS 1056 will be difficult to distinguish from the 1050/1055 system in MZ29. Note that some of the Englemann spruce/subalpine fir should be keyed to 1056 as well in MZ29.

Climate (severely dry conditions) is the primary driver of fire regimes in this system. Long-term changes in climate as well as interannual climate variability will affect the frequency of fire in this system.

This BpS corresponds to the following habitat types (Pfister et al. 1977): ABLA/ALSI, ABLA/CAGE, ABLA/VASC, TSME/XETE, TSME/MEFE, TSME/CLUN, PICEA/GART, PICEA/LIBO and PICEA/PHMA.

It has been suggested that this system is not outside of its historic range of variability for proportions of seral stages (Romme, personal correspondence; Veblen et al. 1991, 1994), and there is no equilibrium achieved in this system, as it fluctuates widely normally in each class.

Native Uncharacteristic Conditions

Scale Description

Fires could range from 1000s-10000s of acres. Variability of climate, topography and other site factors can result in a wide range of representation of successional stages on the landscape. Equilibrium landscapes are not likely to develop in areas <500000ac, or perhaps not in areas greater than that either (Romme, personal correspondence). Reviewers state that typical fires in this system are small clumps of stand replacing fires with spots to adjacent clumps.

Issues/Problems

Currently, balsam bark beetle is killing subalpine fir trees throughout the Rocky Mountain subalpine mesic spruce fir region.

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Reviewers state that since 1990, subalpine fir mortality complex has increased.

Comments

This model for MZ29 was adapted from the model from the same BpS in MZ20 reviewed by Cathy Stewart. Other modeler for MZ29 was David Overcast. Small quantitative changes were made in model.

This model for MZ20 was adopted as-is from the model from the same BpS from MZ21, created by Vicky Edwards, Tim Brickell and Don Despain and reviewed by Liz Davy, Tim Belton and Bill Romme. Only minor descriptive changes were made.

This model for MZ21 was adapted from LANDFIRE models for the same BpS 1056 in MZs 10 and 19 created by Kathy Roche (kroche@fs.fed.us) and reviewed by Steve Barrett and Cathy Stewart. Descriptive changes to model for MZ21 were made by Vicky Edwards, Don Despain and Tim Brickell. Model was reviewed then by Bill Romme on 1/30/06 and an anonymous reviewer in February 06. Quantitative changes were implemented during the review process in March 06 by Liz Davy, Tim Belton, Heidi Whitlatch, David Barron, Spencer Johnston, Candi Eighme and Lisa Heiser.

The model for MZs 10 and 19 was adapted from the Rapid Assessment model R0SPFI, which was reviewed by Bill Baker (bakerwl@uwyo.edu), Dennis Knight (dhknight@uwyo.edu) and Bill Romme (romme@cnr.colostate.edu). Based on input for MZs 10 and 19 (Steve Barrett, sbarrett@mtdig.net; and Cathy Stewart, cstewart@fs.fed.us), minor modifications were made to the description and a reduction in the overall mean fire return interval (from 300yrs to 175yrs). For MZ21, however, all modelers and reviewers agreed that this fire return interval should be greater than 300yrs.

Vegetation Classes

Class A **10 %**

Early Development 1 All Structure

Indicator Species* and Canopy Position

PIEN	Upper
PICO	Upper
ABLA	Mid-Upper

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 5

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

This is an early succession stage after long interval replacement fires. There can be extended periods (as long as 300yrs) of grass/seedling stage after fire replacement events.

This stage may occupy 3-50% of the landscape depending upon climatic conditions and variability of fire return intervals.

This class succeeds to a mid-development closed state after 30yrs. This class might also succeed to class C, a mid-development open state with a probability of 0.001, under the right conditions.

Replacement fire occurs every 500yrs.

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Class B **15 %**

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 8

Indicator Species* and Canopy Position

PIEN	Upper
PICO	Upper
ABLA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Shade tolerant and mixed conifer saplings to poles (>60% canopy cover).

High density saplings to poles. May occupy 5-50% of the landscape.

This class succeeds to a late-development closed state, class E, after 70yrs.

Replacement fire occurs every 500yrs.

Wind/weather/stress occurs with a probability of 0.001 and can take the class to a mid-open state, class C.

Class C **5 %**

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIEN	Upper
PICO	Upper
ABLA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Low density saplings to poles. Primarily occurs after weather stress thins denser stands, and also from succession from A. It might be possible that this could occur from insects and disease.

This class succeeds to a late-development, open state, class D, after 70yrs.

Replacement fire occurs every 500yrs.

Class D **25 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 10

Indicator Species* and Canopy Position

PIEN	Upper
ABLA	Upper
PICO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	50 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Very Large >33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Poles (five inches DBH+) and larger diameter moderately shade tolerant conifer species (<50% canopy cover) in small to moderate size patches. Patches would include subalpine fir seedlings.

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This stage occupies 15-50% of the landscape.

Replacement fire occurs every 200-300yrs.

Endemic spruce beetle occurs at 200-300yr intervals, setting back succession to C, epidemic subalpine fir mortality complex. Another reviewer stated that areas affected by spruce beetle were included in the original field-based fire rotation estimates, simply because beetle-affected areas are commonly also burned. Thus, the rotation estimate for fire is really a combination of fire and beetles; therefore, the disturbance was partitioned between these two disturbance types. Insect/disease was modeled at 0.001 probability, and replacement fire at 0.0025 probability.

Succession to E, late closed state might occur with a probability of 0.004. Otherwise, this class will persist.

Class E **45 %**

Late Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 10

Indicator Species* and Canopy Position

PIEN	Upper
ABLA	Upper
PICO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	90 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Very Large >33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Pole and larger diameter moderately to shade tolerant conifer species (>50% canopy cover), in moderate to large size patches, all aspects.

Replacement fire occurs every 200-300yrs, setting the system back to class A. Mixed severity fires occur every 500yrs.

Endemic spruce beetle occurs at 200-300yr intervals, setting back succession to D. Another reviewer stated that areas affected by spruce beetle were included in the original field-based fire rotation estimates, simply because beetle-affected areas are commonly also burned. Thus, the rotation estimate for fire is really a combination of fire and beetles; therefore, the disturbance was partitioned between these two disturbance types. Insect/disease was modeled at 0.001 probability, and replacement fire at 0.0035 probability.

Disturbances

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- [x] Literature
- [ ] Local Data
- [x] Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	350	100	600	0.00286	74
Mixed	1000			0.001	26
Surface					
All Fires	259			0.00387	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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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Additional Disturbances Modeled

- [x] Insects/Disease
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting 2910570 Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland

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

General Information

Contributors (also see the Comments field **Date** 11/20/2006

Modeler 1	Kathy Roche	kroche@fs.fed.us	**Reviewer**	Kathy Roche (re-rvw'd)	kroche@fs.fed.us
Modeler 2	Elena Contreras	econtreras@tnc.org	**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type

Forest and Woodland

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

PIAR ARUV
PIFL2 CELE3
FEID JUCO6
MARE11

General Model Sources

☐ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

CO south of I-70, into NM. Bristlecone component drops out north of I-70. In CO above South Park, San Luis Valley floors. Extends onto southerly slopes of Mt. Evans and Pikes Peak and along spine of Sangre de Cristos and east mid-slopes of San Juans into NM.

This system is not common for MZ29. It might only be found in the higher elevations of the Bighorns, and possibly some of the isolated ranges in central WY (the Ferris Mtns). In MZ29, it would occur on few locations around Laramie Peak (10274ft) and maybe in the Bighorns. This would a very small number of acres within the map zone.

Biophysical Site Description

Elevation ranges from 2475-3050m (7500-10000ft), mid to upper slopes. The areas are typically in rain shadows, and can often be considered dry, cold extents of tree cover. May also occur where soils are extremely rocky and on windswept ridges where the snow is blown away.

In MZ29, in the Bighorns, limber pine is located almost exclusively on sedimentary substrates. In the Laramie Peak area, it occurs on Sherman Granite. It is at high elevations - approx 10000ft.

Vegetation Description

Usually a mixed PIAR (not in MZ29) and PIFL type, with PIEN and PSME and occasionally PIPO as sites moderate. Sparse understories, with grass (FEAR and FETH) or short shrubs (Ribes spp and Juniperus spp). Arizona fescue doesn't occur in MZ29. Festuca idahoensis does. Thurber's fescue also doesn't occur in MZ29.

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Disturbance Description

This group contains some of the oldest trees in the region, with PIAR 1000yrs old or more and PIFL ages of 500-1000yrs+. Understories are often sparse, with little to carry fires across the surface. Fire occurrence is low frequency and mixed severity. Fire frequency, in fact, can be low enough to be almost non-existent as PIFL has no fire resistance and somehow it gets to be very old on many of these sites. In the absence of wind, fires are likely limited in extent (two acres or less). Stand replacement fires are usually wind-driven, especially in class C.

Peer review of R3BCLP disagreeed with the fire frequency of the original Rapid Assessment (RA) R3BCLPsw model (83yr MFRI) and thought a longer MFRI should be used, putting the BpS into Fire Regime Group IV or V. Surface fires were reduced from a 200yr MFRI to a 1000yr MFRI. The MZ28 model had a replacement interval of 500yrs (as did the RA model), and a mixed severity interval of 200yrs, for an overall FRI of 143yrs, which was shorter than the FRI of the lower elevation BpS 1049 and was in contrast to the description above. Therefore, the regional lead decided to change the model for MZ29 to match the RA model's FRI of 1000yrs for low severity/surface fire, instead of 200yr mixed severity fire interval.

Susceptible to bark beetles (esp. PIFL), but generally drought-tolerant. Affected by whitepine blister rust – uncharacteristic condition that results in more dead trees and fuel than would be characteristic in MZ29. This was not modeled, however.

Adjacency or Identification Concerns

Probably synonymous with PIAR/FETH and PIAR/FEAR habitat types described by DeVelice, et al (1986). Also similar to Great Basin Pine group present in UT, NV and ID.

1057 Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland might be difficult to distinguish from 1049 Rocky Mountain Foothill Limber Pine-Juniper Woodland. The difference is mainly that 1057 is higher, subalpine elevation. All of the other limber pine should probably be classified to 1049.

Adjacent to lodgepole pine and spruce-fir types in MZ29. Can also be adjacent to alpine/subalpine grass types.

Native Uncharacteristic Conditions

Canopy cover >60% can be considered uncharacteristic for this woodland BpS, although that cover occurs occassionally in MZ29.

Scale Description

Large patch. 50-2000ha. Stand replacement fires of 100s of acres have been experienced. Continuous bands of the group of 1000s of acres are present around large intermountain valleys (eg, South Park in CO).

Issues/Problems

Comments

Model for MZ29 was adapted from the same model from MZ28 created by Bruce Short and reviewed by Vic Ecklund and Chuck Kostecka. Descriptive and model changes were made to better reflect MZ29 and to match the RA model FRIs.

Model for MZ28 was based on the Rapid Assessment model R3BCLPsw created by Bruce Short,

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bshort@fs.fed.us. and reviewed by B. Johnston (bcjohnston@fs.fed.us), B. Wilmore (bwilmore@fs.fed.us) and B. Baker (bakerwl@wyo.edu).

Quality control for the RA found one rule violation of a disturbance advancing the age of a class (surface fire caused a transition from class A to class B, advancing age by disturbance).

Vegetation Classes

Class A 15 %

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 1

Indicator Species* and Canopy Position

	All
PIFL2	All
FEID	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	60 %
Height	Tree 0m	Tree 5m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Bare ground and talus with sparse ground cover of forbs, grasses and low shrubs. Occasional old survivors may be present.

PIAR was listed as an indicator for MZ28 and RA; however, PIAR is not present in MZ29, so it was removed from the list. FEAR2 was replaced with FEID.

This class lasts approximately 100yrs then succeeds to B.

Replacement fire occurs every 500yrs, and surface fire every 1000yrs.

Wind/weather stress occurs every 100yrs.

Class B 30 %

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 8

Indicator Species* and Canopy Position

	Upper
PIFL2	Upper
FEID	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	60 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Open woodland, generally with <40% crown closure of seedlings, saplings and survivors. Not seen as a closed stand.

PIAR was listed as an indicator for MZ28 and RA; however, PIAR is not present in MZ29, so it was removed from the list. FEAR2 was replaced with FEID.

This class was modeled for MZ28 as succeeding to C after 100yrs, at age 200yrs; however, regional lead changed MZ29 model to match RA model of succession to C after 150yrs, at age 250yrs so that class percentages would be the same as that for the RA and more similar to that from MZ28, since FRI was also changed for MZ29.

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Replacement fire occurs every 500yrs, and surface fire every 1000yrs.

Class C **55 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 8

Indicator Species* and Canopy Position

	Upper
PIFL2	Upper
FEID	Lower
RIBES	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	60 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Open woodland, generally with <40% crown cover of mixed diameters - 20in DBH to seedling. Sparse ground cover of grasses and low shrubs.

PIAR was listed as an indicator for MZ28 and RA; however, PIAR is not present in MZ29, so it was removed from the list. FEAR2 was replaced with FEID. RIMO was also listed for MZ28. This was replaced with generic RIBES for MZ29, to encompass Ribes cireum and Ribes inerme.

Replacement fire occurs every 500yrs, and surface fire every 1000yrs.

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

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Fire Regime Group:** V

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- [ ] Literature
- [ ] Local Data
- [x] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	500			0.002	66
Mixed					
Surface	1000			0.001	33
All Fires	333			0.00301	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- [ ] Insects/Disease
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2910610** **Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland**

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

General Information

Contributors (also see the Comments field **Date** 6/16/2006

Modeler 1	Steve Barrett	sbarrett@mtdig.net	**Reviewer**	Kathy Roche	kroche@fs.fed.us
Modeler 2			**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type

Forest and Woodland

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

POTR5 PIFL2
PIEN PICO
ABLA
PSME

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This ecological system occurs on montane slopes and plateaus in UT, western CO, northern AZ, eastern NV, southern ID and western WY. Elevations range from 1700-2800m (5600-9200ft).

This BpS is thought to be limited to very limited in extent in MZ20 - less even than pure aspen.

For MZ29, this BpS is thought to occur in the Bighorns and a few places in central and southern MZ29, and the Laramie Range.

Biophysical Site Description

Description taken from MZ18: Occurrences are typically on gentle to steep slopes on any aspect but are often found on clay-rich soils in intermontane valleys. Soils are derived from alluvium, colluvium and residuum from a variety of parent materials but most typically occur on sedimentary rocks. In the northern portion of MZ18, this system occurs throughout the area on north, northeast and southwest aspects with shallow soils.

Vegetation Description

The tree canopy is composed of a mix of deciduous and coniferous species. The BpS is a matrix of even-aged Populus tremuloides patches interspersed among conifer stands including Abies lasiocarpa, Picea engelmannii, Pinus flexilis, Juniperus occidentalis (southwestern ID) and Pseudotsuga menziesii. As the occurrences age, Populus tremuloides is slowly reduced until the conifer species become dominant. Then, after fire, the aspen again becomes dominant for 60-120yrs.

Common shrubs include Amelanchier alnifolia, Prunus virginiana, Symphoricarpos oreophilus, Juniperus

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communis, Paxistima myrsinites, Rosa woodsii, Spiraea betulifolia, Symphoricarpos albus or Mahonia repens.

Herbaceous species include Bromus carinatus, Calamagrostis rubescens, Carex geyeri, Elymus glaucus, Poa spp, Achnatherum nelsonii, Melica bulbosa, and Achnatherum, Hesperostipa, Nassella, and/or Piptochaetium spp (=Stipa spp.), Achillea millefolium, Arnica cordifolia, Asteraceae spp, Erigeron spp, Galium boreale, Geranium viscosissimum, Lathyrus spp, Lupinus argenteus, Mertensia arizonica, Mertensia lanceolata, Maianthemum stellatum, Osmorhiza berteroi (=Osmorhiza chilensis) and Thalictrum fendleri.

Disturbance Description

This is a strongly fire adapted community, more so than BpS 1011 (Rocky Mountains Aspen Woodland and Forest), with FRIs varying for mixed severity fire with the encroachment of conifers. BpS 1061 has elements of Fire Regime Groups II, III and IV. Mean FRI for replacement fire is every 60yrs on average. Replacement fire is absent during early development (as for stable aspen, BpS 1011) and has a mean FRI of 100yrs between 80-100yrs in the open condition. The FRI of mixed severity fire could increase from stands <100yrs to stands >100yrs with conifer encroachment. Episodic drought and fire could maintain the MFRI of 60-100yrs. Fire was modeled with an overall FRI of 50yrs, split between mixed and replacement fire 50/50. However, for class D, the late open stage, fire was split 40/60 mixed/replacement, respectively.

As this type has a fairly short fire return interval compared to other aspen types, it should be noted that aspen can act as a tall shrub. Bradley, et al. (1992) state that Loope and Gruell estimated a fire frequency of 25-100yrs for a Douglas-fir forest with seral aspen in Grand Teton National Park (p39). In the Fontenelle Creek, WY drainage, the mean fire-free interval was estimated to be 40yrs. Fires in this area burned in a mosaic pattern of severities, from stand-replacement to low fires that scarred but did not kill the relatively thin-barked lodgepole pine on the site (p46).

Aspen stands tend to remain dense througout most of their life-span, hence the open stand description was not used unless it described conifer coverage during initial encroachment. While not dependent upon disturbance to regenerate, aspen was adapted to a diverse array of disturbances.

Under presettlement conditions, disease and insect mortality did not appear to have major effects, however older aspen stands would be susceptible to outbreaks every 200yrs on average. We assumed that 20% of outbreaks resulted in heavy insect/disease stand-replacing events (average return interval 1000yrs), whereas 80% of outbreaks would thin older trees >40yrs (average return interval 250yrs). Older conifers (>100yrs) would experience insect/disease outbreaks every 300yrs on average.

Some sites are prone to snowslides, mudslides and rotational slumping. Flooding may also operate in these systems. Bracken fern (Pteridium aquilinum) can indicate unstable slopes.

Adjacency or Identification Concerns

If conifers are not present in the landscape, or represent <25% relative cover, the stable aspen model (BpS 1011; Rocky Mountain Aspen Woodland and Forest) should be considered. The aspen-mixed conifer in the Black Hills probably doesn't belong in this BpS. If aspen is absent, refer to 1051 or 1052.

This type is more highly threatened by conifer replacement than stable aspen. Most occurrences at present represent a late-seral stage of aspen changing to a pure conifer occurrence. Nearly a hundred years of fire suppression and livestock grazing have converted much of the pure aspen occurrences to the present-day

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aspen-conifer forest and woodland ecological system.

Fire suppression has resulted in more conifers and later successional stages as uncharacteristic conditions.

Under current conditions, herbivory can significantly effect stand succession. Kay (1997, 2001a, b, c) found the impacts of burning on aspen stands were overshadowed by the impacts of herbivory.

Native Uncharacteristic Conditions

Scale Description

This type occurs in a landscape mosaic from moderate (10ac) to large sized patches (1000ac).

Issues/Problems

In the western Rocky Mountains, Baker (1925) studied closely the presettlement period for aspen and noted fire scars on older trees. Bartos and Campbell (1998) support these findings. We interpreted ground fires that scarred trees, as mixed severity fire that also promoted abundant suckering. In the presence of conifer fuel, these would be killed and aspen suckering promoted.

In previous models from the Rapid Assessment (eg, R2ASMClw), experts and modelers expressed different views about the frequency of all fires, citing FRIs longer than those noted by Baker (1925). The FRIs used here were a compromise between longer FRIs proposed by reviewers and the maximum FRI of Baker (1925).

Comments

This model for MZ29 was adopted from the model for the same BpS in MZ20 modified by Steve Barrett.

The model for MZ20 was adapted from the model from the same BpS in MZ18 created by Krista Waid-Gollnick (krista_waid@blm.gov) and Sarah Heide (sarah_heide@blm.gov) and reviewed by Jon Bates (jon.bates@oregonstate.edu). Descriptive and quantitative changes were made for MZ20 to better match the disturbance description and to abide by mapping rules. The model for MZ18 violated some rules and was not consistent in its output versus description. Descriptive changes were made to better reflect MZ20.

For MZ18, D. Major made changes to vegetation class structural values in response to MTDB v3.1 updates (K Pohl 7/18/05 request). BpS 1061 for MZs 12 and 17 was accepted with model and database revisions for MZ18 by K. Waid and S. Heide. Comments by Jon Bates (reviewer) were minor.

BpS 1061 for MZs 12 and 17 was developed by Julia Richardson (jhrichardson@fs.fed.us) and Louis Provencher (lprovencher@tnc.org) and is a compromise among R2ASMClw (aspen-mixed conifers low-mid elevation) from the Rapid Assessment, BpS 1011 for MZs 12 and 17, and BpS 1061 for MZ16. BpS 1061 for MZs 12 and 17 is approximately split into the age classes of R2ASMClw. R2ASMClw was developed by Linda Chappell (lchappell@fs.fed.us), Bob Campbell (rbcampbell@fs.fed.us) and Cheri Howell (chowell02@fs.fed.us), and reviewed by Krista Gollnick-Wade/Sarah Heidi (Krista_Waid@blm.gov), Charles E. Kay (ckay@hass.usu.edu) and Wayne D. Shepperd (wshepperd@fs.fed.us). BpS 1061 for MZ16 was developed by Linda Chappell, Robert Campbell, Stanley Kitchen (skitchen@fs.fed.us), Beth Corbin (ecorbin@fs.fed.us) and Charles Kay.

Vegetation Classes

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Class A **10 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 5

Indicator Species* and Canopy Position

POTR5	Upper
SYOR2	Middle
RIBES	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	100 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Grass/forb and aspen suckers <12ft tall. Generally, this is expected to occur 1-3yrs post-disturbance. Fire is absent. Succession to class B after 10yrs.

Class B **45 %**

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 9

Indicator Species* and Canopy Position

POTR5	Upper
SYOR2	Low-Mid
RIBES	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Aspen saplings over 12ft tall dominate during the first 30yrs. Aspen trees 5-16in DBH later in the stage, for the last 40yrs. Canopy cover is highly variable. Conifer saplings and seedlings are coming in during the last 40yrs.

This class was originally modeled as two mid-development closed classes; however, in order to abide by mapping/modeling rules, the two mid-closed classes were combined into one. Height was also changed to abide by mapping rules so that it did not overlap with A. So although this class might have trees that are less than five meters, the height chosen for this class is 5.1-10m.

Fire was modeled with an overall FRI of 50yrs, split between mixed and replacement fire; mixed severity fire does not change the successional age of these stands, although this fire consumes litter and woody debris and may stimulate suckering. Mixed severity fire, while thinning some trees, promotes suckering and maintains vegetation in this class.

Insect/diseases outbreaks occur every 200yrs on average with 80% of times causing stand thinning (maintaining this stage - probably bringing it to the earlier years of this stage) and 20% of times causing stand replacement (transition to class A).

Conifer encroachment causes a succession to class C after 70yrs.

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Class C **35 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 9

Indicator Species* and Canopy Position

POTR5 Upper
ABLA Mid-Upper
PSME Mid-Upper
PICO Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Aspen and conifer co-dominate. 60% aspen overstory. Trees can conceivably range in height from 5-25m; however, so as not to have overlap with class B, height was changed to start at 10.1 meters. Conifers which escape fire, or are the more fire resistant species, will likely cause the progressive suppression of aspen.

Douglas-fir occurs sporadically in MZ29. MZ29 can also have lodgepole pine.

Mixed severity fire keeps this stand open, kills young conifers and maintains aspen. Replacement fire is every 100yrs on average. However, fire was modeled with an overall FRI of 50yrs, split between mixed and replacement fire, with 60% mixed fire and 40% replacement fire.

In the absence of any fire for 100yrs, the stand will become closed with conifers (transition to class D).

Class D **10 %**

Late Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 8

Indicator Species* and Canopy Position

PSME Upper
ABLA Upper
POTR5 Mid-Upper
PICO Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	80 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Large 21-33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Conifers dominate at 100yrs+. Aspen over 16in DBH, uneven sizes of mixed conifer and main overstory is conifers. Greater than 50% conifer in the overstory. Trees can conceivably range in height beginning at 5m; however, so as not to have overlap with class B, height was changed to start at 10.1 meters.

Douglas-fir occurs sporadically in MZ29.

Fire was modeled with an overall FRI of 50yrs, split between mixed and replacement fire. Mixed severity fire causes a transition to class C.

Insect/disease outbreaks will thin older conifers (transition to class C) every 300yrs on average.

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Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg 50
Min 1
Max 100

Sources of Fire Regime Data

- [x] Literature
- [x] Local Data
- [x] Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	115	50	300	0.0087	46
Mixed	100	10	125	0.01	53
Surface					
All Fires	53			0.01871	

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.

Additional Disturbances Modeled

- [x] Insects/Disease
- [ ] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2910620** **Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland**

☐ *This BPS is lumped with:*

☐ *This BPS is split into multiple models:* *We initially considered lumping 1062 and 1086. However, in order to account for the CEMO component, we decided to make 1086 the CEMO portion. 1086 accommodates the mountain mahogany portion of 1086 only, which does function differently than the rest of the shrub component of 1062.*
True mountain mahogany is being split from 1086 due to different fire intervals, range and effects. It can be distinguished from 1062 and other aspects of other mapzones' 1086 by aspect - more exposed aspects and shallower, rocky soils for true mountain mahogany.

General Information

Contributors (also see the Comments field **Date** 11/18/2005

Modeler 1	Sarah Heide	sarah_heide@blm.gov	**Reviewer**	Steve Cooper	scooper@mt.gov
Modeler 2			**Reviewer**	Kathy Roche	kroche@fs.fed.us
Modeler 3			**Reviewer**		

Vegetation Type

Upland Shrubland

Map Zone

29

Model Zone

- ☐ Alaska
- ☐ California
- ☐ Great Basin
- ☐ Great Lakes
- ☐ Northeast
- ☐ Northern Plains
- ☑ N-Cent.Rockies
- ☐ Pacific Northwest
- ☐ South Central
- ☐ Southeast
- ☐ S. Appalachians
- ☐ Southwest

Dominant Species*

CELE3
ARTRV
PUTR2
SYMPH

General Model Sources

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Geographic Range

The curlleaf mountain mahogany (Cercocarpus ledifolius var. intermontanus or intercedens) community type occurs in the Sierra Nevada and Cascade Range to Rocky Mountains from MT to northern AZ, and in Baja California, and Mexico (Marshall 1995). In MZ29, curlleaf mountain mahogany occurs around the Black Hills, east of the Bighorns. On the north side of the Bighorns there is CELE. But not much in MZ29. Maybe in foothills of Bighorn Mtns in MZ29.

Biophysical Site Description

Curlleaf mountain mahogany (Cercocarpus ledifolius var. intermontanus) communities are usually found on upper slopes and ridges between 5000-10500ft elevations (USDA-NRCS 2003), although northern stands may occur as low as 2000ft (Marshall 1995). In western NV and southern ID, curlleaf mountain mahogany may occur down to 5000ft or lower. Most stands occur on rocky shallow soils and outcrops, with mature stand cover between 10-55%. In the absence of fire, old stands may occur with more than 55% cover on somewhat productive sites with moderately deep soils or, at least, fractured below ground bedrock. In southern ID, curlleaf mountain mahogany is most often associated with a limestone bedrock.

Curlleaf mountain mahogany (Cercocarpus ledifolius): Found throughout the foothill country of the

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Bighorn and other WY mountains on limestone outcrops, this broad-leaf deciduous shrub is as rugged and long living as almost any plant in the world. Specimens found on the southern slopes of the Bighorns are estimated to be at least 2000yrs old or older (Heald 2006).

Stands of Cercopcarpus ledifolius occur in the basins and foothills of the Bighorn NF below 7800ft on landforms such as escarpments and rock outcrops. It can be found on very steep slopes. Soils are rocky and shallow – mostly in areas with limestone bedrock. Precipitation falls in winter and spring (Welp et al. 2000).

As a symbiotic nitrogen fixer, this shrub is able to grow on nutrient poor sites and gain a competitive advantage over other plants. The very rocky soils are very low in productivity and very little fuel accumulates, so fire risk is low and fire occurrence rare (Welp et al. 2000).

Vegetation Description

Mountain big sagebrush is the most common codominant with curlleaf mountain mahogany. Curlleaf mountain mahogany is both a primary early succssesional colonizer rapidly invading bare mineral soils after disturbance and the dominant long-lived species. Where curlleaf mountain mahogany has reestablished quickly after fire, rabbitbrush (Chrysothamnus nauseosus) may co-dominate. Litter and shading by woody plants inhibits establishment of curlleaf mountain mahogany. Invasion of Utah and Rocky Mountain juniper or Douglas-fir can occur and will eventually shade-out the curlleaf mountain mahogany. Reproduction often appears dependent upon geographic variables (slope, aspect and elevation) more than biotic factors. Seed is wind-dispersed. Mountain big sagebrush, black sagebrush and antelope bitterbrush are often associated. Snowberry, Utah serviceberry and currant are present on cooler sites, with more moisture. Utah juniper, western juniper, Douglas-fir, red fir, white fir, Rocky Mountain juniper, Jeffrey pine (not in MZ29 - perhaps instead PIPO or PSME occurs in MZ29), singleleaf pinyon and limber pine may be present, in small (10% of total cover) to large (>30% total cover) amounts. In old, closed canopy stands, understory may consist largely of prickly phlox (Leptodactylon pungens).

Other vegetation present is Artemisia tridentata ssp. wyomingensis, Artemisia nova, Chrysothamnus nauseosus, Rhus trilobata, Ribes cereum, Ribes setosum, Amelanchier alnifolia, Prunus virginiana, Symphoricarpos oreophilus, Physocarpus malvaceus, occasional trees (Juniperus scopulorum, Pinus ponderosa, Pinus flexilis and Pseudotsuga menziesii) and some grasses (Elymus spicatus, Stipa comata, Oryzopsis hymenoides and Koeleria macrantha) (Welp et al. 2000).

Disturbance Description

Curlleaf mountain mahogany does not resprout, and is easily killed by fire (Marshall 1995). Curlleaf mountain mahogany is a primary early successional colonizer rapidly invading bare mineral soils after disturbance. Fires are not common in early seral stages, when there is little fuel, except in chaparral. Replacement fires (mean FRI of 150-500yrs) become more common in mid-seral stands, where herbs and smaller shrubs provide ladder fuel. By late succession, two classes and fire regimes are possible depending on the history of mixed severity and surface fires. In the presence of surface fire (FRI of 50yrs) and past mixed severity fires in younger classes, the stand will adopt a savanna-like woodland structure with a grassy understory, spiny phlox and currant. Trees can become very old and will rarely show fire scars. In late, closed stands, the absence of herbs and small forbs makes replacement fires uncommon (FRI of 500yrs), requiring extreme winds and drought, In such cases, thick duff provides fuel for more intense fires. Mixed severity fires (mean FRI of 50-200yrs) are present in all classes, except the late closed one, and more frequent in the mid-development classes.

Several fire regimes affect this community type. It is clear that being very sensitive to fire and very long-

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lived would suggest FRG V and development in fire-safe sites (Gruell et al. 1985). This is true of late development classes, but younger classes can resemble more the surrounding chaparral or sagebrush communities in their fire behavior and exhibit a FRG IV or III. Finally, on more productive sites in MZ18 or sites associated with ponderosa pine (FRI of 13-22yr; Arno and Wilson 1986), FRG I may be appropriate (very open, grassy stands), although this was not modeled. Experts had divergent opinions on this issue; some emphasized infrequent and only stand replacing fires whereas others suggested more frequent replacement fires, mixed severity fires and surface fires. The current model is a compromise reflecting more frequent fire in early development classes, surface fire in the late-open class and infrequent fire in the late-closed class.

Increases in curlleaf mountain-mahogany abundance are often attributed to decreased fire frequency. Curlleaf mountain-mahogany recolonization can be quick if seed in the soil is unharmed, but postfire establishment can take several decades following severe fires that destroy the seed bank and kill parent plants. Ross (1999) presents state and transition successional models for curlleaf mountain-mahogany stands studies in the Petersen and Bald mountain ranges on the CA-NV border. Disturbances highlighted in the models are those that have been most influential on the area in the past 55yrs. The successional model for the Bald Mountain range incorporates fire, red-breasted sapsucker damage, woodcutting practices and conifer canopy development, while the model of successional change in the Petersen Mountains is driven by fire as the chief disturbance process.

Curlleaf mountain-mahogany has thick bark and may survive "light" fires. Sprouts following fire are rare and short lived. Most often curlleaf mountain-mahogany is killed by fire, and regeneration is by seedling establishment. Seed may come from curlleaf mountain-mahogany trees avoiding fire in low fuel areas or by seed surviving in soil.

The very rocky soils are very low productivity and very little fuel accumulates, so fire risk is low and fire occurrence rare (Welp et al. 2000).

Ungulate herbivory: Heavy browsing by native medium-sized and large mammals reduces mountain mahogany productivity and reproduction (USDA-NRCS 2003). This is an important disturbance in early, especially, and mid-seral stages, when mountain mahogany seedlings are becoming established. Browsing by small mammals has been documented (Marshall 1995), but is relatively unimportant and was incorporated as a minor component of native herbivory mortality.

Windthrow and snow creep on steep slopes are also sources of mortality.

Adjacency or Identification Concerns

Some existing curlleaf mountain mahogany stands may be in the big sagebrush (BpS 1125, Inter-Mountain Basins Big Sagebrush Steppe and BpS 1126, Inter-Mountain Basins Montane Sagebrush Steppe), now uncharacteristic because of fire exclusion.

In MT, very hedged by deer browsing. Very short today in MZ29.

Curlleaf mountain-mahogany functions as a late-seral or a mid-seral species in most communities. Site conditions likely dictate curlleaf mountain-mahogany's place in succession. Curlleaf mountain-mahogany's shade tolerance is low, so if sites can support coniferous species, curlleaf mountain-mahogany may be replaced as conifers dominate the canopy. However, succession proceeds at an "extremely slow" rate in many curlleaf mountain-mahogany communities and long-term studies of successional change in curlleaf

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mountain-mahogany communities are lacking (Gucker 2006, Chumley et al 1998, Holmgren 1987).

Native Uncharacteristic Conditions

Scale Description

Because these communities are restricted to rock outcrops and thin soils, stands usually occur on a small scale, and are spatially separated from each other by other communities that occur on different aspects or soil types. A few curlleaf mountain mahogany stands may be much larger than 100ac, especially in southern ID.

Issues/Problems

Data about the setback in succession caused by native grazing are lacking, but consistently observed by experts; in the model, only class A exhibited a reversal of succession (mountain mahogany establishment) with native grazing, whereas no successional reversal was specified for classes B and C, which do not support many seedlings.

Comments

This BpS for MZ29 was adopted from the same BpS 1062 from MZ19 created by Sarah Heide and reviewed by Jon Bates. Descriptive additions and elaborations were made for MZ29.

MZ19 additional comments added on 3/29/06 by K. Buford to reflect structure changes as a result of s-class rectification and further review from Sarah Heide.

This model is identical to the model from mapping MZ18. D. Major made changes to vegetation class structural values in response to MTD v3.1 updates (K. Pohl 7/18/05 request). These changes have not been reviewed and accepted by model developers as of 7/24/05.
Sarah Heide accepted as-is BpS 1062 for MZ18; the database record has minor modifications. Jon Bates (reviewer) suggested a few editorial changes and comments: 1) Western juniper was added to the list of conifers present in these stands. 2) Under biophysical setting, the occurrence of curlleaf mountain mahogany on more productive soils with deeper soils and fractured bedrock was described. 3) Under issues/problem, FRG I was introduced as a possibility for more productive sites in MZ18, which are sometimes associated with ponderosa pines or sagebrush. The model was not changed to reflect this case.

BpS 1062 for MZs 12 and 17 was developed by Chris Ross (c1ross@nv.blm.gov), Don Major (dmajor@tnc.org), Louis Provencher (lprovencher@tnc.org), Sandy Gregory (s50grego@nv.blm.gov), Julia Richardson (jhrichardson@fs.fed.us) and Cheri Howell (chowell@fs.fed.us). BpS 1062 is based on one model modifications (and associated HRV) of BpS 1062 for mapping MZ16 developed by Stanley Kitchen (skitchen@fs.fed.us) and Don Major (dmajor@tnc.org). Layout of VDDT model for BpS was corrected (switched class B and C). 1062 BpS 1062 for mapping MZ16 was based on R2MTMA with moderate revisions to the original model. Current description is close to original. Original modelers were Michele Slaton (mslaton@fs.fed.us), Gary Medlyn (gmedlyn@nv.blm.gov) and Louis Provencher (lprovencher@tnc.org). Reviewers of R2MTMA were Stanley Kitchen (skitchen@fs.fed.us), Christopher Ross (c1ross@nv.blm.gov) and Peter Weisberg (pweisberg@cabnr.unr.edu).

Data from a thesis in NV and expert observations suggests some large mountain mahogany may survive less intense fires. Therefore, surface fires were added as a disturbance to late seral stages, but this is a more recent concept in curlleaf mountain mahogany ecology. Surface fires were assumed to occur on a very small scale, perhaps caused by lightning strikes.

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Vegetation Classes

Class A 10 %

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 5

Indicator Species* and Canopy Position

CELE3	Upper
ARTR2	Upper
CHRYS	Upper
SYMPH	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Curlleaf mountain mahogany rapidly invades bare mineral soils after fire. Litter and shading by woody plants may inhibit initial establishment but provide a favorable microhabitat for seedlings to become juveniles and adults when germination in these locations occur. Bunch grasses and disturbance-tolerant forbs and resprouting shrubs, such as snowberry, may be present. Rabbitbrush and sagebrush seedlings are present. Vegetation composition will affect fire behavior, especially if chaparral (not in MZ29) species are present.

Replacement fire (average FRI of 500yrs), mixed severity (average FRI of 100yrs), and native herbivory (two out of every 100 seedlings) of seedlings all affect this class. Replacement fire and native herbivory will reset the ecological clock to zero. Mixed severity fire does not affect successional age. Succession to class C after 20yrs.

Class B 10 %

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 9

Indicator Species* and Canopy Position

CELE3	Upper
ARTR2	Mid-Upper
PUTR2	Mid-Upper
SYMPH	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	60 %
Height	Shrub 1.1m	Shrub >3.1m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

Various shrub species typically dominate. However, under mixed severity fire disturbance, various grass species may dominate.

Description

Young curlleaf mountain mahogany are common, although shrub diversity is very high. One out of every 1000 mountain mahogany are taken by herbivores but this has no effect on model dynamics.

Replacement fire (mean FRI of 150yrs) causes a transition to class A. Mixed severity fire can result in either maintenance (mean FRI of 80yrs) in the class or a transition to class D (mean FRI of 200yrs).

Succession to class E after 90yrs.

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Class C 15 %

Mid Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model 5

Indicator Species* and Canopy Position

CELE3	Upper
ARTR2	Low-Mid
CHRYS	Low-Mid
SYMPH	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	30 %
Height	Shrub 1.1m	Shrub 3.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Curlleaf mountain mahogany may co-dominate with mature sagebrush, bitterbrush, snowberry and rabbitbrush. Few mountain mahogany seedlings are present.

Replacement fire (mean FRI is 150yrs) will cause a transition to class A, whereas mixed severity fire (mean FRI of 50yrs) will thin this class but not cause a transition to another class. Native herbivory of seedlings and young saplings occurs at a rate of 1/100 seedlings but does not cause an ecological setback or transition.

Succession to class B after 40yrs.

Curlleaf mountain-mahogany functions as a late-seral or a mid-seral species in most communities. Site conditions likely dictate curlleaf mountain-mahogany's place in succession. Curlleaf mountain-mahogany's shade tolerance is low, so if sites can support coniferous species, curlleaf mountain-mahogany may be replaced as conifers dominate the canopy. However, succession proceeds at an "extremely slow" rate in many curlleaf mountain-mahogany communities and long-term studies of successional change in curlleaf mountain-mahogany communities are lacking.

Class D 20 %

Late Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 9

Indicator Species* and Canopy Position

CELE3	Upper
ARTR2	Low-Mid
PUTR2	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	30 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☑ Upper layer lifeform differs from dominant lifeform.

Various shrub species typically dominate. However, under mixed severity fire disturbance, various grass species may dominate.

Description

Moderate cover of mountain mahogany. This class represents a combined Mid2-Open and Late1-Open cover and structure combination resulting from mixed severity fire in class C (note: the combined class results in a slightly inflated representation in the landscape). Further, this class describes one of two late-successional endpoints for curlleaf mountain mahogany that is maintained by surface fire (mean FRI of 50yrs). Evidence of infrequent fire scars on older trees and presence of open savanna-like woodlands with herbaceous-dominated understory are evidence for this condition. Other shrub species may be abundant, but decadent. In the absence of fire for 150yrs (2-3 FRIs for mixed severity and surface fires), the stand will become closed (transition to class E) and not support much of a herbaceous understory. Stand replacement fire every 300yrs on average will cause a transition to class A. Class D maintains itself with infrequent surface fire and trees reaching very

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old age.

Curlleaf mountain-mahogany functions as a late-seral or a mid-seral species in most communities. Site conditions likely dictate curlleaf mountain-mahogany's place in succession. Curlleaf mountain-mahogany's shade tolerance is low, so if sites can support coniferous species, curlleaf mountain-mahogany may be replaced as conifers dominate the canopy. However, succession proceeds at an "extremely slow" rate in many curlleaf mountain-mahogany communities and long-term studies of successional change in curlleaf mountain-mahogany communities are lacking (Gucker 2006).

Class E 45 %

Late Development 1 Closed

Indicator Species* and Canopy Position

CELE3 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	60 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 6

Description

High cover of large shrub or tree-like mountain mahogany. Very few other shrubs are present, and herb cover is low. Duff may be very deep. Scattered trees may occur in this class. This class describes one of two late-successional endpoints for curlleaf mountain mahogany.

Replacement fire every 500yrs on average is the only disturbance and causes a transition to class A. Class will become old-growth with trees reported to reach 1000yrs+.

Curlleaf mountain-mahogany functions as a late-seral or a mid-seral species in most communities. Site conditions likely dictate curlleaf mountain-mahogany's place in succession. Curlleaf mountain-mahogany's shade tolerance is low, so if sites can support coniferous species, curlleaf mountain-mahogany may be replaced as conifers dominate the canopy. However, succession proceeds at an "extremely slow" rate in many curlleaf mountain-mahogany communities and long-term studies of successional change in curlleaf mountain-mahogany communities are lacking.

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg 50
Min 1
Max 100

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	285	100	500	0.00351	24
Mixed	149	50	150	0.00671	47
Surface	238	50	200	0.00420	29
All Fires	69			0.01442	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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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Additional Disturbances Modeled

- [ ] Insects/Disease
- [ ] Wind/Weather/Stress
- [x] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2910660** **Inter-Mountain Basins Mat Saltbush Shrubland**

☑ *This BPS is lumped with: 1081*

☐ *This BPS is split into multiple models: MZ22 lumped 1081 with 1127. MZ29 didn't have occurrences of 1127. MZ29 lumped 1081 with 1066.*

General Information

Contributors (also see the Comments field **Date** 5/5/2006

Modeler 1	George Soehn	george_soehn@blm.gov	**Reviewer**	Steve Cooper	scooper@mt.gov
Modeler 2	George Jones	gpjones@uwyo.edu	**Reviewer**		
Modeler 3	Dennis Knight	dhknight@uwyo.edu	**Reviewer**		

Vegetation Type

Upland Shrubland

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

ATCO	TETRA3
PIDE4	CHVI8
KRLA2	ACHY
ATCA2	GRSP

General Model Sources

☐ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

Occurs throughout MZ22 in areas with <10in precipitation (none of the subsections that are part of M331.)

In MZ29, 1081/1066 would occur around 331Nb, c, and very southern portion of 331Kf near WY border. Also along MT and WY border around 331Gf. In the Pryor Mtns and Red Desert.

Biophysical Site Description

This type occurs from lower slopes to valley bottoms ranging in elevation from 4300-6500ft. Soils are often alkaline or calcareous. Soil permeability ranges from high to low, with more impermeable soils occurring in valley bottoms. Soil texture is variable becoming finer toward valley bottoms. Many soils are derived from colluvium on slopes and residual soils elsewhere. There may be water ponds on alkaline bottoms. Average annual precipitation ranges from 5-10in. Summers are hot and dry. Spring is the only dependable growing season with moisture both from winter and spring precipitation. Cool springs can delay the onset of plant growth and drought can curtail the length of active spring growth. Freezing temperatures are common between October and April.

This group generally lies above playas and lakes. It tends to be the lowest vegetation group in elevation. Upslope it is bordered by and can intergade with low elevation big sagebrush groups, commonly Wyoming big sagebrush, low sagebrush, black sagebrush communities and sometimes juniper woodland.

Vegetation Description

This ecological system includes low (less than three feet) and medium-sized shrubs found widely

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scattered (often 20-30ft apart), to high density (3-4 plants per sq. m) shrubs interspersed with low to mid-height bunch grasses. Common shrubs are shadscale, winterfat, budsage, fourwing saltbush, Wyoming big sagebrush, spiney horsebrush, low rabbitbrush, broom snakeweed and spiny hopsage. Some of these will dominate more than others depending on the site.

(Originally in 1085 - but moved to this BpS: Minor brush components would include greasewood, salt brush and rabbitbrush. Rabbitbrush is dominant in MZs 29 and 30. In MZ30, patches of stands are dominated by one or more of these shrubs.)

Common grass species are Indian ricegrass, needle-and-thread, western wheatgrass, three-awn and Sandberg bluegrass. Prickly pear cactus, hood's phlox, scarlet globemallow, wild onion, Hooker's sandwort and Sego lily are the most common and widespread forbs. The variably abundant understory grasses and forbs are salt and drought tolerant. The relative abundance of species may vary in a patchwork pattern across the landscape in relation to subtle differences in soils and reflect variation in disturbance history.

Achnatherum hymenoides is also a dominant.

Total cover rarely exceeds 25% and annual production is closely linked to prior 12 months' precipitation.

Stand replacing disturbances (insects, extended wet periods and drought) shift dominance between shrub and grass species. Following drought, the system will tend more toward class B (more shrub prevalence). Following fire and extended wet periods, the system will tend more toward class A (greater grass prevalence).

Disturbance Description

Under reference conditions disturbances were unpredictable, but abnormally high precipitation, drought, insects and fire may all occur in these systems. Extended wet periods tended to favor perennial grass development, while extended drought tended to favor shrub development.

Documented Mormon cricket/grasshopper outbreaks since settlement were associated with drought; outbreaks cause shifts in composition amongst dominant species, but do not typically cause shifts to different seral stages. Therefore insect disturbance was not modeled. During outbreaks, Mormon crickets prefer open, low plant communities. Consequently, herbaceous communities and the herbaceous component of mixed communities were more susceptible to cricket grazing.

Fire was rare and limited to more mesic sites (and moist periods) with high grass productivity.

Reviewers for MZ16 indicated that there is no evidence for fire in salt desert shrub during presettlement. Research from the USFS Desert Experimental Range supports this and indicates that the reference condition would have been shifting mosaics of communities based on drought, flooding and insect outbreaks. Although historic fire regimes in desert shrublands are difficult to quantify, West (1983) believes that on sparsely vegetated salt-desert types, fires were historically rare except under unusual circumstances such as following high precipitation years.

Native American manipulation of salt desert shrub plant communities was minimal. Grass seed may have been one of the more important salt desert shrub crops. It is unlikely that native Americans manipulated the vegetation to encourage grass seed.

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Stand replacing disturbances (insects, extended wet periods and drought) shift dominance between shrub and grass species. Following drought, the system will tend more toward class B (more shrub prevalence). Following fire and extended wet periods, the system will tend more toward class A (greater grass prevalence).

Adjacency or Identification Concerns

This BpS contains the typical Great Basin salt desert shrub communities. Salt desert shrub is also common in the Wyoming big sagebrush community and there is some species overlap with other BpS. A wide range of salt desert shrubs can occur in this group. This could be confused with 1125, since Wyoming big sagebrush is a component. This can also be confused with 1072.

Upland salt desert shrub communities are potentially invaded by cheatgrass which could lead to more frequent fire intervals. Other nonnative problematic annuals include Japanese brome, halogeton (not necessarily in MZ29), Russian thistle (not necessarily in MZ29) and several mustards.

There are, however, still salt-desert shrublands in the western United States experiencing historic fire regimes. For example, the well-studied salt-desert communities of Raft River Valley, southwestern ID, have not experienced fire since at least the 1930s. The vegetation community changes of this area have been monitored since 1951 (see http://www.cnrhome.uidaho.edu/default.aspx?pid=81934) with the last photo-documentation done in 2002 showing a significant cheatgrass component.

In MZ29, cheatgrass might not be as significant a component.

This system would not show much, if any, departure.

Plains shrubland has more mesic shrubs, whereas the salt desert shrub is more xeric - thus found in the Badlands and salt-affected soils. The FRI of salt-shrubs would be much longer.

Native Uncharacteristic Conditions

Over 30% shrub cover would be uncharacteristic.

Scale Description

This type occurs in patches of less than one acre to hundreds of acres in size. Disturbance scale was variable during presettlement. Droughts and extended wet periods could be region-wide, or more local. A series of high precipitation years or drought could affect whole basins.
Mormon cricket disturbances could affect hundreds of acres for years to 1-2 decades. Most fires were rare and less than one acre, but may exceed hundreds of acres with a good grass crop.

Issues/Problems

Lack of references limited model development. Reviewers for MZ16 indicated that there is no evidence for fire in salt desert shrub during presettlement. Research from the USFS Desert Experimental Range supports this and indicates that the reference condition would have been shifting mosaics of communities based on drought, flooding and insect outbreaks. There was little to no information about the early successional species and their relationships in this system prior to the advent of aggressive and noxious non-natives. Because of the pervasive replacement of native, early successional species by non natives, an adequate description of the forb and grass early seral communities may be difficult to complete.

Since disturbance is rare and unpredictable, the disturbance and successional pathways were difficult to

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model.

Comments

This model for MZ29, adapted from model for same BpS for MZ22 created by George Soehn, George Jones, Dennis Knight and reviewed by Eve Warren.

This model for MZ22 was adapted from the model from the same BpS in MZ16. Descriptive and quantitative changes were made. This model was changed to a two-box model.

The model for MZ16 was based on the Rapid Assessment PNVG R2SDSH by Bill Dragt. Jolie Pollet and Annie Brown, and Stanley Kitchen simplified the model and eliminated a class dominated by greasewood. Reviewers of R2SDSH were Stanley Kitchen (skitchen@fs.fed.us), Mike Zielinski (mike_zielinski@nv.blm.gov) and Jolie Pollet (jpollet@blm.gov).

Quality control process by Pohl on 4/6/05 resulted in slightly adjusted percentages in each class to more closely match VDDT results.

Vegetation Classes

Class A 25 %

Early Development 1 All Structure

Indicator Species* and Canopy Position

ACHY Lower
ATCO Upper

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

The dominant lifeform are grasses, but shrubs are the upper level lifeform at <5% and <0.5m tall.

Description

Dominated by continuous grass with widely scattered shrubs and relatively younger shrubs than in class B. Over 10yrs, vegetation moves to class B as the primary successional pathway.

Replacement fire occurs every 300yrs on average, and will set back succession to year zero. Extended wet periods (every 35yrs) will also have a stand replacing effect.

PASM was listed as an indicator in previous mapzones, but was removed for MZ29.

Class B 75 %

Mid Development 1 Open

Indicator Species* and Canopy Position

ATCO Upper
ACHY Lower

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

Discontinous grass patches, and higher shrub canopy cover than in class A. Extended wet periods (every 35yrs on average) could cause a stand replacing transition to class A or could maintain this class with a higher component of grasses with slightly less precipitation. That second scenario was not modeled. Replacement fire is rare (mean FRI of 500yrs). Class B will be maintained in the absence of disturbance. Drought (mean return interval of 35yrs) will maintain vegetation in class B.

PASM was listed as an indicator in previous mapzones, but was removed for MZ29.

Class C 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Description

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Description

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Description

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Disturbances

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 10
Min 1
Max 1000

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	450			0.00222	99
Mixed					
Surface					
All Fires	450			0.00224	

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.

Additional Disturbances Modeled

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

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

LANDFIRE Biophysical Setting Model

Biophysical Setting **2910720** **Wyoming Basins Dwarf Sagebrush Shrubland and Steppe**

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

General Information

Contributors (also see the Comments field **Date** 2/10/2006

Modeler 1	Tim Kramer	tim_kramer@blm.gov	**Reviewer**	Jeff DiBenedetto	jdibenedetto@fs.fed.us
Modeler 2	Roger Bankert	roger_bankert@blm.gov	**Reviewer**	Jim Von Loh	jvonloh@e2m.net
Modeler 3			**Reviewer**		

Vegetation Type

Upland Shrubland

Dominant Species*

ARNO4 KOMA
ARAR8 PSSP6
ARPE6 POSE
ARTR4

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Geographic Range

In MZ22 this type occurs in all sections of the map zone.

Found in western CO, eastern UT, (north?) western WY, western MT, southcentral MT (at base of Beartooth on east side; between Beartooth and Pryor Mtns), southern ID, and southeastern OR.

In MZ29, this type occurs in the Casper Mountain area, along the slopes of the Bighorn Mountains and into the Pryor Mountains. It occurs in subsections 342Ad, 331N - just on the fringes of MZ29.

Biophysical Site Description

Very heavy, montmorillonite (smectite) clay soils with some coarse fragments, usually effectively very shallow to a hard clay pan, not deep enough to support either big sagebrush or deep-rooted grasses. Usually poorly drained. Soils may be too dense and poorly drained for Artemisia arbuscula (little sagebrush), but NOT for Artemisia nova (black sagebrush). Black sagebrush generally occupies medium to coarse-textured soils, often with a large volume of rock fragments. Those two sagebrushes do grow together sometimes, and they overlap somewhat in their habitats, but they simply are not both shrubs of fine-textured soils, or soils with impervious clay layers. What's true for A. arbuscula is untrue for A. nova.

Vegetation Description

Low-stature sagebrush shrubs, sometimes with conspicuous (though sparse) grass layer taller than the shrubs (especially with ARAR8). The two vegetation series (Artemisia nova and Artemisia arbuscula) are here combined; though they occupy different climates (ARAR8 on much colder sites), they have very similar physiognomies and responses to fire; almost never do the two species occur together or in adjacent

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sites. Total live cover usually <100%, average 60-80%.

Artemisia tripartita (threetip) ssp. rupicola is also an indicator species for 1072. It certainly is a dwarf shrub, usually shorter even than Artemisia nova and Artemisia arbuscula. A. tripartiata ssp. rupicola is probably a dominant, or co-dominant, shrub over more acres than is Artemisia nova. A. tripartita ssp. rupicola is more restricted geographically, though, limited to central and southeastern WY -- subsections M331Ad, M331Aj (and maybe M331Ai), 342Aa; section 342F; and subsection 342Gb. (It may extend slightly into subsections 342Ga and 342Gd as well, but doubtful.) These three dwarf shrubs somteimes grow together, but vegetation with only A. tripartita ssp. rupicola is quite common.

The two subspecies of A. tripartita are quite different and probably do not grow together.

A. tripartita rupicola can grow on fine-textured soils, but in parts of central WY and all of southeastern WY, it grows on coarse-textured soils derived from granite or resistant sedimentary rocks (limestones and sandstones). In fact, the shrub might be more common on coarse-textured soils than fine-textured soils. (See biophysical site description for further explanation of differences in soils.)

Threetip sagebrush is an historic indicator on sites with higher precipitation and shallow soil within MZ22. Black sagebrush as well. Low sagebrush is rare in our area of MZ22, but may be more common elsewhere. In comparison, low sagebrush is very common in other areas, with black sagebrush being rare and threetip sagebrush non-existent. Overall, black sagebrush is more common than threetip sagebrush throughout our area.

Disturbance Description

Fire has very little effect on this ecosystem, since there is little vegetation to carry a fire. Low and black sagebrush are easily killed by fire, but stands usually don't burn, apparently because of low productivity, low canopy heights and fuel too scattered. In MZ28, the majority of reviewers agreed with a 125yr average; one review suggested using a 400yr average. A slightly higher (less fire) FRI was chosen for MZ22.

Native ungulates sometimes cause erosion in these stands when they trail across them, especially in spring and fall when the sites are wet. The sites are resilient and resistant to trampling in summer and winter, when they are dry or frozen. This was not modeled here.

Fall 2005 burning of low sagebrush patches and stands in a matrix of mountain big sagebrush stands at Fossil Butte National Monument near Kemmerer, WY resulted in their removal. Fall 2006 sampling of sites for vegetation map accuracy assessment resulted in no observations of low sagebrush seedlings on burned sites. These patches and stands were mature to becoming decadent with high cover values for the type, up to 35-40% cover for some occurrences. Plot data were recorded to support classification of this vegetation type among others for production of a vegetation map (vonLoh, pers comm).

Adjacency or Identification Concerns

Often occurs interspersed or alternating with big sagebrush shrublands, sometimes in a mosaic, corresponding to the mosaic of habitats (moderately well-drained vs. excessively poorly-drained).

It is guessed that the succession classes of low sagebrush are about the same now as they used to be; the shrubs are neither denser nor taller than before so that there shouldn't be too much departure. However, this is only a guess based on expert opinion.

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This system might be departed as a function of grazing, at least around Pryor Mtns. Midgrasses such as bluebunch and needle/thread, have been replaced by shorter grass such as Sandberg, junegrass, blue grama and maybe squirreltail.

Native Uncharacteristic Conditions

Over 40% shrub cover would be uncharacteristic. Also shouldn't be taller than 0.5m.

Scale Description

The scale of polygons varies with the scale of the habitat, from small patches in the 10s of acres, up to larger sites of 100s-1000s of acres.

Issues/Problems

Little information exists about historical disturbances in this system. Patch sizes were probably <500ac and interspersed in other vegetation communities.

Comments

This model for MZ29 was adopted from the same model from MZ22 created by Tim Kramer and Roger Bankert and reviewed by George Jones. Descriptive additions made for MZ29.

The model for MZ22 was based on the LANDFIRE model for the same BpS 1072 from MZ28, created by Mike Babler and reviewed by Chuck Kostecka, Vic Ecklund and an anonymous reviewer. Descriptive and quantitative changes were made to the model for MZ22.

MZ28 model was based on the Rapid Assessment model R0SBDW. One reviewer suggests combining with 1064. Peer reviewers disagreed about the frequency of fire in this system.

Vegetation Classes

Class A **30 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

POSE4	Upper
KOMA	Upper
ELEL5	Upper
PSSP6	Upper

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.

Description

Grass and forb dominated site for approximately 125yrs. Black/low sagebrush seedlings are young and begin to establish towards the end of this seral period.

Replacement fire occurs every 300yrs.

For MZ29, at least, STCO (HECOC8) - common dominants in Mueggler's (1980) description of PNV dominants in absence of improper grazing. ELEL5 is probably more of an indicator of disturbance/improper grazing.

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**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 sev

Class B **70 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 5

Indicator Species* and Canopy Position

ARNO4	Upper
ARAR8	Upper
ELEL5	Middle
KOMA	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	40 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Black/low sagebrush with mid height late seral grasses. 150yrs+.

Replacement fire occurs every 300yrs.

For MZ29, at least, PSSP6, STCO (HECOC8), POSE - common dominants in Mueggler's description of PNV dominants in absence of improper grazing. ELEL5 is probably more of an indicator of disturbance/improper grazing.

Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Description

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Description

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

Disturbances

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	300		400	0.00333	99
Mixed					
Surface					
All Fires	300			0.00335	

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.

Additional Disturbances Modeled

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

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

LANDFIRE Biophysical Setting Model

***Biophysical Setting* 2910800** **Inter-Mountain Basins Big Sagebrush Shrubland**

☑ *This BPS is lumped with: 1125*

☐ *This BPS is split into multiple models: 1125 describes MZ29 better. 1080 has ARCA13, which doesn't apply in these mapzones. Production is somewhat different, but not enough to split out (Benkobi).*

General Information

Contributors (also see the Comments field **Date** 10/3/2006

Modeler 1	Steve Cooper	scooper@mt.gov	**Reviewer**	Lakhdar Benkobi	lbenkobi@fs.fed.us
Modeler 2			**Reviewer**	Jeff DiBenedetto	jdibenedetto@fs.fed.us
Modeler 3			**Reviewer**	George Soehn	george_soehn@blm.gov

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

ARTRW PSSP6
PASM HECO26
BOGR2 NAVI4
CHRYS9 CAFI

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This system encompasses eastern and central MT (as opposed to finding it throughout the Rocky Mountains, etc. as BpS 1125 is usually described.) 1125 is common throughout MZs 20 and 29 currently (not necessarily historically), except in western part of section 331Da. In MZ29, it is common historically.

For MZ29, it would occur in northeast WY section 331G; Thunder Basin grasslands; and northeast of 331Gg.

For MZ29, basin big sagebrush is very uncommon. Artemisia tridentata ssp. vaseyana (BpS 1126) is found at higher elevations associated with the Bighorn, Pryor and Laramie ranges. Artemisia tridentata ssp. wyomingensis is found elsewhere, where Artemisia tridentata ssp. vaseyana doesn't occur. Mountain big sagebrush occurs in sections M331 associated with Bighorn and Laramie Ranges. Artemisia tridentata ssp. wyomingensis occurs everywhere else.

In MZ29, it is found in southeast MT, this could be due to a soil anomaly. It probably occurred historically all through the subsections of southeast MT. Also through MZ30 in 331Mi in the western Dakotas and the lower portion of 331Md. As one moves north in 331Md, there is less of it. It probably does not occur in 331Mc. Canopy cover of sagebrush is probably less than 10%.

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**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 seve

Biophysical Site Description

This system is Great Plains sagebrush steppe for MZ20. For MZ29, we are describing sagebrush wheatgrass steppe, where western wheatgrass is dominant. MZs 20 and 29 are very similar for this type.

Soils are primarily dry from sedimentary processes in this system; soils are less fertile in this system, sometimes more calcareous. The Great Plains expression is found exclusively on "heavy" textured soils derived from shale and mudstones and can be strongly correlated with particular geologic formation or members thereof.

April, May and June have by far the most precipitation and this peaks in late May, early June. This pattern carries throughout the MT portion of the Great Plains though a gradient of more summer precipitation as you progress eastward but still the "spring" peak. It's not until you encounter tallgrass prairie does summer precipitation become predominant.

Wyoming big sagebrush occupies plains, foothills, terraces, slopes, plateaus, basin edges and even lower mountain slopes due to the fact that Artemisia tridentata ssp. vaseyana is not part of the mix in MZ20 nor in MZ29. Soils are shallow to moderately deep, moderate to well drained and almost exclusively fine textured soils. Wyoming big sagebrush generally occurs in the 5-15in precipitation zones. Soil depth and accumulation of snow enhances these communities in lower precipitation zones (Knight 1994).

In MZ29, Artemisia tridentata ssp. wyomingensis can occur from 2200ft up to 8000ft.

Bluebunch/Artemisia tridentata ssp. wyomingensis type is probably an inclusion in this BpS occurring on steep, south aspect slopes, typical badlands slopes/topography.

Vegetation Description

Wyoming big sagebrush is the dominant mid-to late seral species within this plant assemblage.

PASM and ELLA3 are by far the dominant grasses in MZ20 expression of this BpS. In MZ29, PASM, HECO26 and BOGR2 are by far the dominant grasses. Cool season grasses such as Indian ricegrass, bluebunch wheatgrass (Indian ricegrass and bluebunch wheatgrass occur only where coarser textured soils prevail), needle-and-thread (needle-and-thread grass has a broad environmental amplitude, but more typically abundant on coarse soils; however, under heavy grazing, it does quite well on fine-textured soils.), blue grama, Sandberg bluegrass, squirreltail, threadleaf sedge and infrequently Thurber's needlegrass. Rhizomatous wheatgrasses, such as western wheatgrass and thickspike wheatgrass, and plains reedgrass, are common species within MZs 20 and 29. Junegrass also occurs.

Common forbs are species of Astragalus, Crepis, Delphinium, Phlox and Castilleja, while associated shrubs and shrub-like species can be small green rabbitbrush, fringe sagewort, winterfat and broom snakeweed. Other dominant species of forbs include RACO3 and SPCO. Also, LIPU and PHHO occurs.

Forbs most important for MZ20 include SPHCOC, DALPUR, PHLHOO, RATCOL and OPUPOL. Other forbs in MZs 10 and 19 include hawksbeard (Crepis acuminata), bird's beak (Cordylanthus spp) , blue bell (Mertensia spp), Rocky Mountain aster (Aster scopulorum), Phlox species, lupine (Lupinus spp) and buckwheat (Eriogonum spp). In MZ29, all of the above are probably found except for lupine, which would occur in higher precipitation areas and is associated with mountain big sagebrush.

Herbaceous species usually dominate the site prior to re-establishment. Site re-establishment is by seed

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**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 seve

bank, seed production from remnant plants and seeds from adjacent (untreated) plants.

Wyoming big sagebrush in upland sites have fewer understory species relative to the mountain big sagebrush subspecies, though at higher elevations or moister areas of this vegetation community there is a higher potential for herbaceous species, relative to mountain big sagebrush sites; no definitive statement on undergrowth herbaceous diversity can be made for Wyoming big sagebrush sites. Herbaceous cover increases transitioning into the mixed-grass prairie, and in open patches.

In MZ29, Artemisia tridentata ssp. tridentata is not found. Artemisia tridentata ssp. wyomingensis is found where Artemisia tridentata ssp. vaseyana is not present. It can occur with greasewood and silver sagebrush, as well as rabbitbrushes and saltbush.

Disturbance Description

Many researchers believe fire was the primary disturbance factor within this plant assemblage. Other disturbance factors may include insects, rodents and lagomorphs, drought, wet cycles, gradual changes in climate and native grazing (Wyoming Interagency Vegetation Community 2002). Drought may have been a more significant disturbance than native grazing or insects, so was included. Native grazing by large ungulates (eg, bison), and insects were included as occurring every 10yrs but causing no transitions to another class. Heavy-impact grazing in the late closed stage occurs less frequently and causes a transition to an open state.

Following fire or other significant disturbance, herbaceous species will dominate the ecological site post-burning. Recovery to prefire canopy cover is quite variable and may generally take 50-120yrs, but occasionally occurs within a decade (Baker, in press). Site re-establishment is by seed production from remnant plants, and seeds from adjacent (untreated) plants. Discontinuity of fuel in Wyoming big sagebrush communities can result in mosaic burn patterns, leaving remnant plants for seed, but there can be large expanses of complete mortality (Bushey 1987, Baker, in press). Fire does not stimulate germination of soil-stored Wyoming big sagebrush, but neither does it inhibit its germination (Chaplin and Winward 1982). Regeneration may occur in pulses linked to high precipitation events (Maier et al. 2001).

Overall fire return intervals in Wyoming big sagebrush appear to have ranged from 100-240yrs or more (Baker, in press) for MZ22. In MZ20, some believe that intervals are shorter, with replacement fire occuring approximately every 30yrs in some of the classes (based on BLM Fire Management plans and local expert estimate, Downey). However, there was disagreement with that short interval. It is also said that we are fairly certain of the time required for sagebrush recovery (50-150yrs, mostly around 100yrs). With this slow recovery and if fires returned to the site in 30yrs, eventually the whole landscape would be only class A and maybe B (open) (Cooper, personal correspondence). Therefore, for MZ20, FRI was modeled at an overall 90yr interval, similar to other adjacent map zones and similar to the FRI of 80yrs for BpS 1080 in MZ20 to which this BpS is thought to be very similar to.

There was some disagreement among MZ20 modelers as to the FRI of 90yrs for this 1125 system. Up north, where there is a heavy grass component and much less cover of sagebrush than what is down south, relatively connected topography and a lot of wind, it would burn more frequently (Downey, pers comm). Perhaps that would be considered BpS 1085 instead of BpS 1125. And even though BpS 1085, which is also comprised mainly of Wyoming big sagebrush has an FRI of 30yrs, these two systems are different as it relates in large part to setting and precipitation patterns, and continuity of fuel. Eastern MT has few breaks, versus mountainous systems, which would be much less likely to have huge sweeping fires.

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Although the species are the same Wyoming big sagebrush - the systems are not (Martin, pers comm). The longer FRI for 1125 was therefore retained.

Benkobi (pers comm) states that in MZ29, fire frequency could range from 36-40yrs (http:/gisdata.usgs.net). However, MZ29 reviewers did not want to change the model. However, because it was also stated that recovery occurred after at least 60yrs in MZ29, and due to the discrepancy from previous map zones, the FRI from MZ20 was retained.

Discontinuity of fuel in Wyoming big sagebrush communities often result in mosaic burn patterns, but large expanses can burn with complete mortality under extreme conditions (Bushey 1987, Baker, in press). Mixed severity fire was originally modeled in this BpS but due to a new understanding of definitions of severity types, it was thought that mixed severity fire does not occur in this system and rather patchy fires do occur, with replacement severity.

In MZs 20 and 29: 29yrs after a prescribed burn, there is still zero recovery of Wyoming big sagebrush (Cooper pers comm). It is thought that Wyoming big sagebrush communities take longer than 100yrs to recover. In Bighorn battlefield, historically there was much sagebrush. Though burned in mid-80s there is still no evidence of sagebrush re-establishment 10yrs later.

Antelope, mule deer and pygmy rabbits are native herbivores that browse sagebrush. These were also not included in the model. In MZ29, probably not pygmy rabbits. Sage grouse might also have an impact. It is questionable as to the impact/frequency of antelope and mule deer in MZ29.

Adjacency or Identification Concerns

This type is difficult to distinguish from mixed-grass prairie with a high shrub component. It is possible that with severe disturbance, a state change might occur to mixed-grass prairie - which in turn changes the potential for the site to return to sagebrush. Extensive severe burns for want of an adjacent seedbank would take extensive periods before ARTTSW was again a significant component. The reference condition might have been sagebrush, but now the abiotic facotrs and biophysical gradients indicate a mixed-grass prairie.

Secondary shrub and herbaceous components may vary considerably across the range of its extent. Wyoming big sagebrush sites may be a mosaic with or abut Juniper, ponderosa pine, salt desert shrub and grassland vegetation types across its range. However, the most common accompanying vegetation is Northern Great Plains midgrass prairie.

Broom snakeweed and halogeton may dominate sites disturbed by overgrazing, oil and gas development or other disturbances. Club moss in this system increases with the intensity and duration of grazing. BROJAP can be an increaser with burning/grazing. There is also BROTEC invasion but that doesn't occur in the Northern Great Plains, except in MZ29.

Juniper increase might be occurring due to lack of fire today, but it is not developing into a true juniper woodland, especially in MZ29.

Shrub cover increases in MZs 20 and 29 with overgrazing, and herbaceous layer decreases dramatically.

Might be difficult to distinguish from BpS 1080 and BpS 1085.

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Much of 1080 has been lost due to land clearing for agriculture or converted to a cheatgrass or greasewood type. For basin big sagebrush in MZ29, this is the case. For Wyoming big sagebrush in MZ29, much has been lost due to burning for modern grazing. The understory is currently more annual bromes due to increased grazing.

Overgrazing has also been an issue in 1080. HESCOM and KOEMAC increase (MZ20) where grazing is intense and protracted. It is questionable as to whether HESCOM increases with grazing (some areas of MZ29), and might rather decrease with overgrazing. With overgrazing in some areas of MZ29, there is more bluegrasses.

Plant associations are similar between 1125 and 1080. Shrubland is perhaps further south. Herbaceous cover is the only distinguishing factor. 1125 is definitely the more prominent historically. 1080 more prevalent in central WY. These (like mixed grass prairie) are distinguished by geography. Therefore, they're being combined for MZ29.

In Bighorns battlefield (around Hardin in MT), historic photos showed a dense (up to 20%-30% cover, that is) shrub covered system, but currently it is mostly grass - due to fires that burned there (Clark et al 1995 Draft).

If adjacent to pine systems, might currently be seeing more trees. (Also found in grass systems). This was seen in historic photographs throughout the northern part of MZ29 and throughout western SD (Clark et al 1995 Draft).

Native Uncharacteristic Conditions

Over 45% shrub cover would be uncharacteristic for MZ20 and MZ29. In fact, Wyoming big sagebrush in MZ29 would not exceed 40% cover. The only reason it would be this high is in cases of extreme overgrazing or in the absence of fire or changes in fire regime - frequency.

Scale Description

Occurrences may cover between hundreds and thousands of hectares.

Disturbance patch sizes range from 10s-1000s of hectares. The patch and disturbance size gets larger as this shrub BpS intergrades with the grassland BpS, and also gets larger from MZs 19 and 20 into MZ29.

Issues/Problems

Difficult to identify where hybrids occur with other big sagebrush taxa.

Comments

This model for MZ29 was adapted from the same BpS from MZ20 created by Steve Cooper and Shannon Downey and reviewed by Steve Barrett. For MZs 29 and 30, descriptive additions and changes were made. Other reviewers for MZ29 were Bobby Baker and Jim Von Loh.

Model for MZ20 was adapted from the draft model for MZ22 for 1125b Inter-Mountain Basins Big Sagebrush Steppe-Wyoming Big Sagebrush, created by Mark Williams, Vicki Herren and an anonymous contributor and reviewed by Tim Kramer, Eve Warren and Destin Harrell. Changes were made to the description and model.

The model for MZ22 was adapted from Rapid Assessment model R0SBWYwy created by Tim Kramer (tim_kramer@blm.gov) and reviewed by Bill Baker, Don Bedunah and Dennis Knight.

For the Rapid Assessment, the workshop code was WYSB. This model was combined with another Rapid Assessment model, R0SBWA (workshop code was WSAG1), modeled by George Soehn (george_soehn@blm.gov) and reviewed by Sarah Heide (sarah_heide@blm.gov) and Krista Gollinick-Waid (krista_waid@blm.gov). The two were combined based on peer-review and the similarity of disturbance regimes and species composition.

The RA Model is based on the original FRCC PNVG (WYSB1) with modifications from Wyoming Interagency Vegetation Committee (2002) and expert estimates. Peer review for the RA model was incorporated 4/30/2005. Additional reviewers were Karen Clause (karen.clause@wy.usda.gov), Ken Stinson (ken_stinson@blm.gov) and Eve Warren (eve_warren@blm.gov).

Vegetation Classes

Class A 35 %

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

NAVI4	Upper
PASM	Upper
BOGR2	Lower
CAFI	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	80 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

Herbs dominate this class; shrubs are growing up, but do not yet dominate the class. Shrub cover less than 5% belongs in this class.

Description

Herbaceous dominated. In the presettlement condition, NAVI4 (in MZ20) and HECO26 in MZ29 would have been a major upper position component. Primarily grasses with forbs. Exact species will vary depending on location. Western wheatgrass, Sandberg bluegrass, plains reedgrass, needle-and-thread grass, bluebunch wheatgrass, threadleaf sedge, plains junegrass and blue grama would be dominant grasses. Forbs may include Astragalus, Crepis, Castelleja, Delphinium, Agoseris, Phlox and others. There may also be significant component of small green rabbitbrush.

Succession to class B, a mid-development open stage, occurs after 40yrs. This succession was originally modeled at 20yrs; however, it was later decided that that was a minimum age for succession, and it would take more like 40yrs to achieve 5-15% canopy cover of ARTTSW. There is one paper that shows no ARTTSW 15yrs post-fire and another paper for MZ19 that indicates no recovery after as much as 18yrs (Cooper, personal correspondence). In MZ29, recovery occurred after 60yrs.

Insect/disease (0.001 probability or 0.1% of the landscape each year), native grazing (0.1 probability or 10% of the landscape each year), and wind/weather stress (every 100yrs, 0.01 probability or 1% of the landscape each year) occur, but do not cause a transition.

Replacement fire was originally modeled at every 30yrs, based on expert estimate and local observations. - in BLM Fire Management Plans (Downey, personal correspondence). However, this was later changed to 90yrs based on recovery times of this type. This, and the other changes in age range, changed the class percentage from 20% to 35%.

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Class B **40 %**

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8 Upper
PASM Mid-Upper
NAVI4 Mid-Upper
HECO26 Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is greater than five percent but <15%. Understory is well represented by herbaceous species as described for class A. (Montana Academy of Sciences publication - re: in breaks, after 15yrs after fire there is no sage yet.)

ARFR4 also present in lower canopy.

Succession to class C, late development closed stage, occurs after 50yrs. (60yrs for MZ29)

Insect/disease (0.001 probability of 0.1% of the landscape each year), native grazing (0.1 probability or 10% of the landscape each year), and wind/weather stress (every 100yrs, 0.01 probability or 1% of the landscape each year) occur, but do not cause a transition to another stage.

Fire was modeled more frequently than in MZ22 based on expert estimate and data from BLM Fire Mangement Plans. Originally, mixed fire was modeled at occurring every 40yrs, maintaining the class in this stage (Downey, personal correspondence). However, this was later removed due to a new understanding of definitions of mixed versus replacement fire. This, and the other changes in age range, changed the class percentage from 55% to 35%. Replacement fire occurs every 90yrs.

Class C **25 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8 Upper
PASM Mid-Upper
NAVI4 Mid-Upper
HECO26 Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is >15 percent. Understory is well represented by herbaceous species as described for class A. This class is more common on drier sites.

Shrub cover max was 30% in MZ20. In MZ29, it was increased to 65% cover by other reviewers. However, it was decided that it could not be this amount of cover. Modal cover is 15%. The most measured was 32% cover. Some could have been higher cover but not much. Common in literature that grazing/over-grazing increases cover, not the opposite.
It is probably more common in 20% range. 40% is high, but could be a max (Cooper, diBenedetto, personal comm). Regional lead changed to 40% per comments.

ARFR4 is also present in lower canopy.

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Insect/disease (0.001 probability of 0.1% of the landscape each year), native grazing (0.002 probability or 0.2% of the landscape each year) cause a transition to the mid-open stage.

Native grazing (0.1 probability or 10% of the landscape each year) occurs, but does not cause a transition to another stage.

Drought was modeled at an overall interval of 100yrs split between maintaining this stage or taking it to the mid-development stage.

Originally, mixed fire was modeled at occurring every 40yrs, maintaining the class in this stage (Downey, personal correspondence). However, this was later removed due to a new understanding of definitions of mixed versus replacement fire. Replacement fire occurs every 100yrs. This only changed the class percentage from 25% to 30%.

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	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
Min
Max

Sources of Fire Regime Data

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	90			0.01111	100
Mixed					
Surface					
All Fires	90			0.01113	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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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Additional Disturbances Modeled

- [x] Insects/Disease
- [x] Wind/Weather/Stress
- [x] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

***Biophysical Setting* 2910810** **Inter-Mountain Basins Mixed Salt Desert Scrub**

☑ *This BPS is lumped with: 1066*

☐ *This BPS is split into multiple models: MZ22 lumped 1081 with 1127. MZ29 didn't have occurrences of 1127. MZ29 lumped 1081 with 1066.*

General Information

Contributors (also see the Comments field **Date** 5/5/2006

Modeler 1	George Soehn	george_soehn@blm.gov	**Reviewer**	Steve Cooper	scooper@mt.gov
Modeler 2	George Jones	gpjones@uwyo.edu	**Reviewer**	Jim Von Loh	jvonloh@e2m.net
Modeler 3	Dennis Knight	dhknight@uwyo.edu	**Reviewer**		

Vegetation Type

Upland Shrubland

Dominant Species*

ATCO	TETRA3
PIDE4	CHVI8
KRLA2	ACHY
ATCA2	GRSP

General Model Sources

☐ Literature
☐ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Geographic Range

Occurs throughout MZ22 in areas with <10in precipitation (none of the subsections that are part of M331.)

In MZ29, 1081/1066 would occur around 331Nb, c, and very southern portion of 331Kf near WY border. Also along MT, WY border around 331Gf, in Pryor Mtns and the Red Desert.

Biophysical Site Description

This type occurs from lower slopes to valley bottoms ranging in elevation from 4300-6500ft. Soils are often alkaline or calcareous. Soil permeability ranges from high to low, with more impermeable soils occurring in valley bottoms. Soil texture is variable becoming finer toward valley bottoms. Many soils are derived from colluvium on slopes and residual soils elsewhere. There may be water ponds on alkaline bottoms. Average annual precipitation ranges from 5-10in. Summers are hot and dry. Spring is the only dependable growing season with moisture both from winter and spring precipitation. Cool springs can delay the onset of plant growth and drought can curtail the length of active spring growth. Freezing temperatures are common between October and April.

This group generally lies above playas and lakes. It tends to be the lowest vegetation group in elevation. Upslope it is bordered by and can intergade with low elevation big sagebrush groups, commonly Wyoming big sagebrush, low sagebrush, black sagebrush communities and sometimes juniper woodland.

Vegetation Description

This ecological system includes low (less than three feet) and medium-sized shrubs found widely

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scattered (often 20-30ft apart), to high density (3-4 plants per sq. m) shrubs interspersed with low to mid-height bunch grasses. Common shrubs are shadscale, winterfat, budsage, fourwing saltbush, Wyoming big sagebrush, spiny horsebrush, low rabbitbrush, broom snakeweed, prickly pear and spiny hopsage. Some of these will dominate more than others depending on the site.

(Originally in 1085 - but moved to this BpS: Minor brush components would include greasewood, saltbush and rabbitbrush. Rabbitbrush is dominant in MZs 29 and 30. In MZ30, patches of stands are dominated by one or more of these shrubs.)

Common grass species are Indian ricegrass, needle-and-thread grass, western wheatgrass, three-awn and Sandberg bluegrass. Prickly pear cactus, Hood's phlox, scarlet globemallow, wild onion, Hooker's sandwort and Sego lily are the most common and widespread forbs. The variably abundant understory grasses and forbs are salt and drought tolerant. The relative abundance of species may vary in a patchwork pattern across the landscape in relation to subtle differences in soils and reflect variation in disturbance history.

Achnatherum hymenoides is also a dominant, and Elymus elymoides is often present.

Total cover rarely exceeds 25% and annual production is closely linked to prior 12 months' precipitation.

Stand replacing disturbances (insects, extended wet periods and drought) shift dominance between shrub and grass species. Following drought, the system will tend more toward class B (more shrub prevalence). Following fire and extended wet periods, the system will tend more toward class A (greater grass prevalence).

Disturbance Description

Under reference conditions disturbances were unpredictable, but abnormally high precipitation, drought, insects and fire may all occur in these systems. Extended wet periods tended to favor perennial grass development, while extended drought tended to favor shrub development.

Documented Mormon cricket/grasshopper outbreaks since settlement were associated with drought; outbreaks cause shifts in composition amongst dominant species, but do not typically cause shifts to different seral stages. Therefore insect disturbance was not modeled. During outbreaks, Mormon crickets prefer open, low plant communities. Consequently, herbaceous communities and the herbaceous component of mixed communities were more susceptible to cricket grazing.

Fire was rare and limited to more mesic sites (and moist periods) with high grass productivity.

Reviewers for MZ16 indicated that there is no evidence for fire in salt desert shrub during presettlement. Research from the USFS Desert Experimental Range supports this and indicates that the reference condition would have been shifting mosaics of communities based on drought, flooding and insect outbreaks. Although historic fire regimes in desert shrublands are difficult to quantify, West (1983) believes that on sparsely vegetated salt-desert types, fires were historically rare except under unusual circumstances such as following high precipitation years.

Native American manipulation of salt desert shrub plant communities was minimal. Grass seed may have been one of the more important salt desert shrub crops. It is unlikely that native Americans manipulated the vegetation to encourage grass seed.

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Stand replacing disturbances (insects, extended wet periods and drought) shift dominance between shrub and grass species. Following drought, the system will tend more toward class B (more shrub prevalence). Following fire and extended wet periods, the system will tend more toward class A (greater grass prevalence).

Drought would provide the largest effect in this system especially if coupled with grazing (Von Loh, pers comm).

Adjacency or Identification Concerns

This BpS contains the typical Great Basin salt desert shrub communities. Salt desert shrub is also common in the Wyoming big sagebrush community and there is some species overlap with other BpS. A wide range of salt desert shrubs can occur in this group. This could be confused with 1125, since Wyoming big sagebrush is a component. This can also be confused with 1072.

Upland salt desert shrub communities are potentially invaded by cheatgrass which could lead to more frequent fire intervals. Other nonnative problematic annuals include Japanese brome, halogeton (not necessarily in MZ29), Russian thistle (not necessarily in MZ29) and several mustards.

There are, however, still salt-desert shrublands in the western United States experiencing historic fire regimes. For example, the well-studied salt-desert communities of Raft River Valley, southwestern Idaho, have not experienced fire since at least the 1930s. The vegetation community changes of this area have been monitored since 1951 (see http://www.cnrhome.uidaho.edu/default.aspx?pid=81934) with the last photo-documentation done in 2002 showing a significant cheatgrass component.

In MZ29, cheatgrass might not be as significant a component.

This system would not show much, if any, departure.

Plains shrubland has more mesic shrubs, whereas the salt desert shrub is more xeric - thus found in the Badlands and salt-affected soils. The FRI of salt-shrubs would be much longer.

Native Uncharacteristic Conditions

Over 30% shrub cover would be uncharacteristic.

Scale Description

This type occurs in patches of less than one acre to hundreds of acres in size. Disturbance scale was variable during presettlement. Droughts and extended wet periods could be region-wide, or more local. A series of high precipitation years or drought could affect whole basins.
Mormon cricket disturbances could affect hundreds of acres for years to 1-2 decades. Most fires were rare and less than one acre, but may exceed hundreds of acres with a good grass crop.

Issues/Problems

Lack of references limited model development. Reviewers for MZ16 indicated that there is no evidence for fire in salt desert shrub during pre-settlement. Research from the USFS Desert Experimental Range supports this and indicates that the reference condition would have been shifting mosaics of communities based on drought, flooding and insect outbreaks. There was little to no information about the early successional species and their relationships in this system prior to the advent of aggressive and noxious non-natives. Because of the pervasive replacement of native, early successional species by nonnatives, an adequate description of the forb and grass early seral communities may be difficult to complete.

Since disturbance is rare and unpredictable, the disturbance and successional pathways were difficult to model.

Comments

This model for MZ29, adapted from model for same BpS for MZ22 created by George Soehn, George Jones and Dennis Knight and reviewed by Eve Warren.

This model for MZ22 was adapted from the model from the same BpS in MZ16. Descriptive and quantitative changes were made. This model was changed to a two-box model.

The model for MZ16 was based on the Rapid Assessment PNVG R2SDSH by Bill Dragt. Jolie Pollet and Annie Brown, and Stanley Kitchen simplified the model and eliminated a class dominated by greasewood. Reviewers of R2SDSH were Stanley Kitchen (skitchen@fs.fed.us), Mike Zielinski (mike_zielinski@nv.blm.gov) and Jolie Pollet (jpollet@blm.gov).

Quality control process by Pohl on 4/6/05 resulted in slightly adjusted percentages in each class to more closely match VDDT results.

Vegetation Classes

Class A **25 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

ACHY	Lower
ATCO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

The dominant lifeform are grasses, but shrubs are the upper level lifeform at <5% and <0.5m tall.

Description

Dominated by continuous grass with widely scattered shrubs and relatively younger shrubs than in class B. Over 10yrs, vegetation moves to class B as the primary successional pathway.

Replacement fire occurs every 300yrs on average, and will set back succession to year zero. Extended wet periods (every 35yrs) will also have a stand replacing effect.

PASM was listed as an indicator in previous mapzones, but was removed for MZ29. Sand dropseed and alkali sacaton might be indicators for MZ29.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
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Class B 75 %

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

ATCO Upper
ACHY Lower

Structure Data (for upper layer lifeform)

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

[ ] Upper layer lifeform differs from dominant lifeform.

Description

Discontinous grass patches, and higher shrub canopy cover than in class A. Extended wet periods (every 35yrs on average) could cause a stand replacing transition to class A or could maintain this class with a higher component of grasses with slightly less precip. That second scenario was not modeled. Replacement fire is rare (mean FRI of 500yrs). Class B will be maintained in the absence of disturbance. Drought (mean return interval of 35yrs) will maintain vegetation in class B.

PASM was listed as an indicator in previous mapzones, but was removed for MZ29.

Class C 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

[ ] Upper layer lifeform differs from dominant lifeform.

Description

Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

[ ] Upper layer lifeform differs from dominant lifeform.

Description

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

[ ] Upper layer lifeform differs from dominant lifeform.

Description

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Disturbances

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 10
Min 1
Max 1000

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	450			0.00222	99
Mixed					
Surface					
All Fires	450			0.00224	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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**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 sev

LANDFIRE Biophysical Setting Model

Biophysical Setting **2910850** **Northwestern Great Plains Shrubland**

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

General Information

Contributors (also see the Comments field **Date** 11/1/2006

Modeler 1	Jeff DiBenedetto	jdibenedetto@fs.fed.us	**Reviewer**	Jack Butler	jackbutler@fs.fed.us
Modeler 2			**Reviewer**	Steve Cooper	scooper@mt.gov
Modeler 3			**Reviewer**	Jim Von Loh	jvonloh@e2m.net

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

SYOC RHTR
JUHO2 SCSC
SHAR PASM
PRVI CAFI

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This type should be confined to ephemeral drainages and mesic sites and north facing slopes within mountain ranges and hillsides around the Little Rockies in MZ20. Northeastern and southeastern MT, western ND and SD, northeastern WY, western NE. This ecological system ranges from SD into southern Canada on moderately shallow to deep, fine to sandy loam soils. In MZ30, this would occur in section 331. Not much of this should be mapped; most should be mapped to 1141. This type should be very, very infrequent. This could occur in the Badlands of western ND. This type occurs in Theodore Roosevelt National Monument in ND, usually on mesic sites, benches of slopes and north-facing slopes. There are also stands at Badlands National Park and Wind Cave National Monument in SD. We mapped and described it as plant associations under the USGS-NPS National Vegetation Mapping Program and reported it in 2000 (see http://biology.usgs.gov/npsveg/).

Biophysical Site Description

Occur as small patches within northern mixedgrass prairie. Occupies microsites associated with higher available moisture or moderately steep slopes, north and south aspects. In ND, usually on mesic sites, benches of slopes and north-facing slopes. Occupy slope shoulders and drainage ways and draws; sites where moisture more available. Skunkbrush more associated with south aspect slopes. Chokecherry and serviceberry and snowberry associated with drainages and draws along the foothills of the Beartooth mountains. Horizontal juniper associated with north aspect slopes. Buffaloberry associated with north aspect slopes. Each of the shrub species associated with own habitat type and moisture gradient. Skunkbrush is dry end, and snowberry/chokecherry is wet end. This BpS is capturing a broad moisture regime from dry to mesic.

Elevations range from 1300-4000ft, and up to 4500ft east side of the Judiths, and 5000ft south side of the

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Snowies. Temperatures range between extremes of hot summers and cold winters that are typical of a continental climate. Precipitation increases from west (11in) to east (16in). Two-thirds of the precipitation occurs during the growing season (April-June).

Soils vary, but are generally entisol in the west and mollisols in the east. Soils in the northern Great Plains, west of the Missouri River in the Dakotas, northwestern NE, northeastern WY and MT are formed from sedimentry sandstone and shales, especially the badlands type topography. These soils range from clayey, fine-loamy, to fine silty soils of mixed origin on level and undulating lands with minor contributions from loess, alluvium and mountain outwash.

Many of these shrubland types occur on moderate to steep slopes (west to NW facing) at least in the badlands - grazing is not likely a factor. They occur on southwest and northwest facing slopes and moderate to steep slopes. The skunkbrush however, more associated with the southerly aspects.

Vegetation Description

This vegetation type is characterized by the dominance of snowberry, chokecherry, serviceberry, skunkbrush, buffaloberry and horizontal juniper. Ninebark may also be present on some sites. There is an understory of cool-season grasses such as western wheatgrass, needlegrasses, Sandberg bluegrass, little bluestem, threadleaf sedge and forbs.

(Silver sage was also an important component historically; however, silver sage is covered in 1162 Floodplains Systems and 1148 Western Great Plains Sand Prairie. Silver sage associated with valley bottom/terraces along streams and drainageways.)

This melds into 1141 needle-and-thread grass and western wheatgrass.

Each of the shrub species in this BpS is associated with its own habitat type and represents a broad moisture gradient from dry to mesic. Skunkbrush is dry end, and snowberry/chokecherry and buffaloberry is mesic end. All of these species don't occur together necessarily.

Disturbance Description

The northern mixed-grass prairie and shrublands are strongly influenced by wet-dry cycles. Fire, grazing by large ungulates and small mammals such as prairie dogs and soil disturbances (ie, buffalo wallows and prairie dog towns) are the major disturbances in this vegetation type. In MZ30, many of these shrubland types occur on moderate to steep slopes (west to NW facing).

From instrumental weather records, droughts are likely to occur about three in every 10yrs. Historically, there were likely close interactions between fire and grazing since large ungulates tend to be attracted to post-fire communities. Conversely, fire presumably was less likely in areas recently heavily grazed by herbivory - thus contributing to spatial and temporal variation in fire occurrence.

Average fire intervals are estimated at 8-25yrs, although in areas with very broken topography fire intervals may have been greater than 30yrs. The model for MZ20 reflects a 30yr FRI. The model for MZs 29 and 30 reflects a 15-20yr interval. This system's FRI should be very similar to 1141 mixedgrass prairie, since this system is just inclusions within 1141. It might be a little less frequent because of moisture; however, it should be similar.

Fires were most common in July and August, but probably occurred from about April to September. Seasonality of fires influences vegetation composition. Early season fires (April - May) tend to favor warm-

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season species, while late season fires (August - September) tend to favor cool-season species. Replacement fire in our model does remove 75% of the above ground cover as assumed in the literature. However, we don't think loss of the above ground cover by the replacement fire will necessarily induce a retrogression back to an earlier seral stage from the late stage because the main component of dominant grasses remains unharmed to insure the continuity of the seral stage. The shrub species, however, are sprouters. Fire would remove them, and they would re-sprout. The exception would be horizontal juniper and skunkbrush which would not resprout. It would take longer for them to become re-established.

We used different levels of native ungulate grazing intensities. We assumed that light grazing would not alter the community enough to change classes, but increasing grazing intensity would move the community back to earlier stages. Grazing return interval probably occured every 7-10yrs but grazing would only result in a class change maybe once every 80-100yrs. Overall - the grazing frequency was modeled at every 20yrs - that includes grazing just occurring with no transition resulting, as well as grazing taking the stage back to an earlier class. And - overall - the drought+grazing impact frequency was modeled as every 70yrs - that includes the no-transition + transition to early stage.

This system 1085 differs in FRI from 1125, which is composed mostly of Wyoming big sagebrush. BpS 1085 also has a higher grass component. Up north, where there is a heavy grass component and much less cover of sagebrush than what is down south, and relatively connected topography and a lot of wind, it would burn more frequently (Downey, pers comm). These two systems are different as it relates in large part to setting and precipitation patterns, and continuity of fuel. Eastern MT has few breaks, versus mountainous systems, which would be much less likely to have huge sweeping fires.

Ortmann in his review of the RA model, suggested that in addition to fire, drought and grazing and insect outbreaks (Rocky Mountain locust) would have impacted all classes.

Adjacency or Identification Concerns

Inclusions within the Mixedgrass Prairie. The Northern Great Plains Shrubland might be a subcomponent of the Northwestern Great Plains Mixedgrass Prairie BpS that was historically limited to predominantly sedimentary soil types and local microsites; resulting in a similar ecological model, but with a longer fire cycle. This 1085 might therefore be difficult to map differently from the grassland sites. Spectrally, however, this BpS will have a unique signature - esp snowberry. The sites dominated by skunkbrush might be harder to differentiate from the grasses. This melds into needle and thread/western wheatgrass 1141.

Rabbitbrush, may be better to fit with sagebrush BpS. They tend to occur together.

Small patches on landscape approximately one acre to maybe 10ac in size/ mapped by plot not imagery.

This BpS's shrub component may be increasing within the 1141 Mixedgrass prairie due to the longer current-day FRIs.

This type might be somewhat difficult to distinguish from 1106 NRM Foothill Deciduous Shrubland in terms of species, but they should be distinguished, as 1106 shrubs are adjacent to forest/woodlands or lower treeline, whereas 1085 is adjacent to ravines, more riparian and grassland 1141 system.

There should not be much mapping to this BpS. Most should be in 1141. This should be very, very infrequent for MZs 29, 30 and 20 and should encompass less than 10% of landscape historically.

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Maybe some Kentucky bluegrass in this BpS. Maybe annual bromes such as Japanese brome.

This system might appear departed currently due to increase in class C of snowberry, mostly, shrubs today due to missed FRIs. See class C comments.

This may not be a separate system from the prairie matrix. Those areas that have increased shrub cover due to fire suppression should be considered part of Northwestern Great Plains Mixedgrass Prairie (CES303.674).

Native Uncharacteristic Conditions

Scale Description

Fires would generally range from 1000s to 10000 of acres, or up to 100000ac through BpS 1141. Based on topography, wind speed, fine fuel loading and fuel arrangement, the fires would burn in a mosiac pattern. Extent of weather influences (wet-dry cycles) would have been very widespread.

Small patches on landscape approx one acre to maybe 10ac in size; mapped by plot not imagery. Patches occupy microsites associated with shoulder slopes, north aspect backslopes, depressions/swales and drainage ways/draws.

Issues/Problems

Comments

This model was adapted from the same BpS in MZ20 created by Brian Martin and reviewed by BJ Rhodes, Shannon Downey, Steve Barrett and others. Some descriptive additions/changes were made.

This model for MZ20 was originally adopted from the Rapid Assessment model R4PRMGn Northern Mixed Grass Prairie created by Cody Wienk and Lakhdar Benkobi and reviewed by David Engle (dme@mail.pss.okstate.edu) and John Ortmann (jortmann@tnc.org). Descriptive changes were first made for MZ20 by BJ Rhodes (bj_rhodes@blm.gov), John Carlson (john_carlson@blm.gov), Bill Volk (william_volk@blm.gov), Rich Adams (rich_adams@blm.gov) and Amanda Keefer (akeefer@mt.blm.gov). These reviewers, however, did not feel they had a sufficient grasp or concept of the system to change the model. Some errors were found in the original RA model that violated modeling rules and were therefore changed by Regional Lead for MZ20. Brian Martin then reviewed the model and made quantitative changes. It was changed from the original five-box model to a three-box model.

Vegetation Classes

Class A **55 %**

Early Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Description

Indicator Species* and Canopy Position

SCSC	Upper
CAFI	Upper
PASM	Upper
STIPA	Upper

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	0 %	50 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

Shrub cover would range from 0-10%.

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Graminoids such as little bluestem, western wheatgrass, stipa, bluebunch wheatgrass, side-oats grama and upland sedges dominate this class. This class is a combination of grasses and very short-stature vegetation resulting also from prairie dog disturbance (maybe only in draws - snowberry).

A variety of forb species such as fetid marigold, scarlet globemallow, scarlet gaura, skeleton weed and dotted gayfeather tend to dominate this class.

Some sprouting of snowberry, chokecherry and serviceberry.

The fuel in this class would be initially too sparse to carry fire, but then fuel increases.

This class lasts for nine years then succeeds to B, mid open state. (Although, if it were a dense stand initially and then re-sprouted, might be quicker than nine years to get to B.)

Replacement fire occurs every 15-20yrs, and sets this class back to its beginning stage.

Grazing (0.07 probability or 7% of this class each year), the combination of drought and grazing (0.02 probability or 2% of this class each year), and drought modeled as wind/weather/stress (0.05 probability or 5% of this class each year) all occur and maintain this class but don't set it back to its beginning state.

Prairie dog impact occurs with a probability of 0.0035 (0.35% of class each year) and returns this class to its beginning. The only shrub that prairie dogs might impact in this BpS would be the snowberry sites and draws/drainageways.

Class B **30 %**

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

SYOC	Upper
JUHO2	Upper
PASM	Lower
STIPA	Lower

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	0 %	20 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

[x] Upper layer lifeform differs from dominant lifeform.

Herbaceous cover is approximately 30-70% and 0.5m in height.

Description

More open community than late stage. Seedling shrubs.

Dominant shrubs coming in - snowberry, chokecherry, skunkbrush, creeping juniper and buffaloberry.

Western wheatgrass, needlegrasses, little bluestem, upland sedges, are common graminoids - same as in class A. Bluebunch wheatgrass can be locally common with skunkbrush. Common forbs include scurfpea, prairie coneflower, Rocky Mountain beeplant, scarlet globemallow and dotted gayfeather.

Herbaceous cover is approximately 30-70% and approx 0.5m in height.

This class lasts nine years and then succeeds to the late development stage.

Replacement fires occur every 15-20yrs.

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Grazing (0.02 probability or 2% of this class each year) and the combination of drought and grazing (0.01 probability), occur and cause a transition back to the early stage, A. Grazing (0.02 probability), the combination of drought and grazing (0.003 probability) and drought modeled as wind/weather stress (0.1 probability) can also occur while maintaining this class in this stage.

Prairie dog impact occurs with a probability of 0.0003, taking the class back to A.

Class C **15%**

Late Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

SYOC	Upper
JUHO2	Upper
SHAR	Upper
SCSC	Lower

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	21 %	80 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

Herbaceous cover between 50-65% and 0.5min height.

Description

Denser, higher canopy cover. Mature canopy.

Vegetation community is similar to previous class. Forbs are present still. Litter layer tends to be relatively continuous.

Herbaceous cover 50-65% and 0.5m in height.

Snowberry average cover could be 65% (DiBenedetto). Maximum up to 75%, minimum approx 45%. Skunkbrush cover average approximately 25%. Horizontal juniper average 44%, range of 25-65% cover. Each of the shrub species associated with own habitat type with moisture gradient. Skunkbrush is dry end, and snowberry/chokecherry is wet end.

Replacement fire occurs every 15-20yrs.

The combination of grazing and drought takes this class back to A, an early state (0.001 probability), B, a mid-open state (0.001 probability) or maintains this class (0.002 probability).

Grazing alone causes a transition back to an early stage (0.002 probability), to a mid stage (0.003 probability) or maintains this class (0.005 probability).

Drought modeled as wind/weather stress also maintains this class, with a probability of 0.05 or 5% of this class each year.

It is thought that historically, this class probably occupied even <15% of the landscape. It probably occupied approximately 5-10% of the landscape due to the frequency of fire in the adjacent mixedgrass prairie. Currently, however, there is probably much more of this class on the landscape due to missed FRIs - especially an increase in the snowberry shrubs on more mesic drainageways, draws and depressions - areas of higher available moisture.

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Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model 1

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** II

Historical Fire Size (acres)

Avg 10000
Min 1000
Max 100000

Sources of Fire Regime Data

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	15	8	30	0.06667	100
Mixed					
Surface					
All Fires	15			0.06669	

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.

Additional Disturbances Modeled

- ☐ Insects/Disease
- ☑ Wind/Weather/Stress
- ☑ Native Grazing
- ☐ Competition
- ☑ Other (optional 1) prairie dog disturbance
- ☑ Other (optional 2) drought + grazing

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**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 seve

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**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 seve

LANDFIRE Biophysical Setting Model

Biophysical Setting **2910860** **Rocky Mountain Lower Montane-Foothill Shrubland**

☐ *This BPS is lumped with:*

☐ *This BPS is split into multiple models:* *We initially considered lumping 1062 and 1086. However, in order to account for the CEMO component, we decided to make 1086 the CEMO portion. 1086 accommodates the mountain mahogany portion of 1086 only, which does function differently than the rest of the shrub component of 1062.*
True mountain mahogany is being split from 1086 due to different fire intervals, range and effects. It can be distinguished from 1062 and other aspects of other mapzones' 1086 by aspect - more exposed aspects and shallower, rocky soils for true mountain mahogany.

General Information

Contributors (also see the Comments field **Date** 6/16/2006

Modeler 1	Mark Williams	Mark_a_williams@blm.gov	**Reviewer**	Kathy Roche	kroche@fs.fed.us
Modeler 2	George Soehn	george_soehn@blm.gov	**Reviewer**		
Modeler 3	Kirk Strom	kirk_strom@blm.gov	**Reviewer**		

Vegetation Type

Upland Shrubland

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

CEMO2
ARTRV
PSSP6
ACHY

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This occurs in the Laramie Peak Range area of MZ29 (Chumley et al. 1998). Foothills, canyon slopes and lower mountains of the Rocky Mountains. The description here focuses on true mountain mahogany. Information in the FEIS online database indicates that the central distribution of true mountain-mahogany is located on the west side of the Rocky Mountains in the foothills and mountains of UT, CO and WY. The range of true mountain mahogany also extends north into MT, east into SD and NE, south from OK into Mexico, and west into AZ and NV.

It occurs in every section of MZ22. It is questionable as to whether true mountain mahogany exists in the Bighorn Basin.

Biophysical Site Description

This BpS ranges from roughly 4400-8500ft. This BpS occurs on relatively xeric sites with thinly to moderately well developed soils on moderately steep to steep southerly aspects.

Vegetation Description

Species dominance varies depending on site conditions and by geographic location. Shrubs include

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Cercocarpus montanus, Amelanchier utahensis, Purshia tridentata, Rhus trilobata, Ribes cereum, Symphoriocarpus oreophilus, Yucca glauca, sagebrush, bitterbrush, serviceberry and rabbitbrushes.

Grasses may include species of Hesperostipa, Pseudoroegneria spicata, indian ricegrass and western wheatgrass.

Disturbance Description

Historically, this type may have been in a Fire Regime IV -- primarily long-interval stand replacement fires. Nearly all the dominant species other than sagebrush in this BpS have the capability to resprout after disturbance.

Drought and grazing by native ungulates also occur in this system.

Cercocarpus montanus is a vigorous sprouter after fire.

Fire size is mostly in the 10s to 100s of acres and is influenced by adjacent grass and mountain shrub types.

Adjacency or Identification Concerns

Cheatgrass is present in this system today.

There is occassionally Rocky Mountain juniper and limber pine encroachment into this system.

Native Uncharacteristic Conditions

Juniper invasion is uncharacteristic.

Scale Description

Erhard's observations suggest that the scale of the most common disturbance extent is relatively small. Patch size of the system is in the hundreds of acres.

Fire size is mostly in the 10s-100s of acres and is influenced by adjacent grass and mountain shrub types.

Issues/Problems

Comments

This model for MZ29 was adopted as-is from the same model for MZ22.

The model for MZ22 was adapted from the model for the same BpS from MZ28 created by Dean Erhard (derhard@fs.fed.us) and reviewed by Vic Ecklund, Chuck Kostecka and an anonymous reviewer. Other modelers for MZ22 were Jay Esperance, Carl Bezanson and Tim Kramer. The model and description for MZ22 differs quantitatively and descriptively from MZ28, as the model for MZ22 is split between true mountain mahogany and other shrubs. The model being discussed here is that for true mountain mahogany. MZ22 10861 is also lumped with 1106 for MZ22.

The model for MZ28 was based on the Rapid Assessment model R3MSHB. Mike Babler made edits 6/16/2005. R3MSHB reviewers were Barry Johnston, bcjohnston@fs.fed.us; Brenda Wilmore, bwhilmore@fs.fed.us; Tim Christiansen, christta@wsmr.army.mil; and Bill Baker, bakerwl@wyo.edu.

Vegetation Classes

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Class A 5 %

Early Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

CEMO2 Upper
PSSP6 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Early seral community. Grasses and sprouting shrubs. Resprouts well after fire. This class lasts approximately five years.

Herbaceous cover might be approximately 15%. Grasses and shrubs would probably be same height in this class. Shrub cover might be 0-5%. (The canopy cover of true mountain mahogany resprouts was less than three percent, as per plot data 18 months after a prescribed fire.)

Some grasses that might be present are needle-and-thread, bluebunch wheatgrass, Sandberg bluegrass, blue grama and western wheatgrass. Hairy golden aster was the most dominant of a wide variety of forbs.

Replacement fire occurs every 200yrs.

Drought and grazing can also occur and affect a small portion (0.5% each year, or 0.005 probability) of this class each year, and do not cause a transition to another stage.

Class B 10 %

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 5

Indicator Species* and Canopy Position

CEMO2 Upper
PSSP6 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	20 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Greater shrub cover; grasses/forbs dominant in scattered openings. Herbaceous cover stays the same as in A.

This class lasts approximately 10yrs.

Replacement fire occurs every 150yrs.

Drought can also occur and affect a small portion (0.5% each year, or 0.005 probability) of this class each year, but does not cause a transition to another stage.

---

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**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 seve

Class C **85 %**

Late Development 1 Open

Indicator Species* and Canopy Position

CEMO2 Upper
PSSP6 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model 6

Description

Late development stage with greater shrub cover. There are more dead and decadent shrubs. Herbaceous cover stays the same as in earlier classes. (In current conditions, tree encroachment might be occurring in this stage due to lack of fire.)

Replacement fire occurs every 100yrs. There are more fuel in this class; therefore, there is more frequent fire.

Drought can also occur and affect a small portion (0.3% each year, or 0.003 probability) of this class each year, but does not cause a transition to another stage.

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Disturbances

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Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- [ ] Literature
- [ ] Local Data
- [x] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	100			0.01	100
Mixed					
Surface					
All Fires	100			0.01002	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- [ ] Insects/Disease
- [x] Wind/Weather/Stress
- [x] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911060** **Northern Rocky Mountain Montane-Foothill Deciduous Shrubland**

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

General Information

Contributors (also see the Comments field **Date** 11/18/2005

Modeler 1	Mike Babler	mbabler@tnc.org	**Reviewer**	Kathy Roche	kroche@fs.fed.us
Modeler 2			**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type

Upland Shrubland

Map Zone

29

Model Zone

- ☐ Alaska
- ☐ California
- ☐ Great Basin
- ☐ Great Lakes
- ☐ Northeast
- ☐ Northern Plains
- ☑ N-Cent.Rockies
- ☐ Pacific Northwest
- ☐ South Central
- ☐ Southeast
- ☐ S. Appalachians
- ☐ Southwest

Dominant Species*

AMELA
SYMPH
PRVI
PURSH

General Model Sources

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Geographic Range

Minor but relatively widespread. Occurs throughout the Intermountain West and Northern Rockies. In MZ20, this type is limited to very limited in extent.
In MZ29, this type might occur in the Bighorns and Black Hills.

Biophysical Site Description

This BpS occupies draws and foothills (all aspects) in the transition zone between grasslands/shrublands and forests, including aspen and montane forests. Ranges widely in elevation (3000-9000ft) throughout its geographic range.

Vegetation Description

Various mixes of shrubs such as serviceberry, Prunus spp, snowberry, snowbrush, bigtooth maple and Rocky Mountain maple. (Society of Range Management Cover Types 317-319, 418-421.)

Disturbance Description

Fire Regime Group IV, dominated by replacement fire (80%), but may have a small component of mixed severity fires (20%). None of these species has any resistance to fire – it will remove all above ground vegetation and these will sprout from the roots. The average fire return interval for this system may range from less than 60yrs to 100yrs+, and there is some debate about the role of mixed severity fire. Fire regimes of adjacent BpS will have significant impact on the frequency and severity of this BpS. One reviewer for MZ20 also felt that the contagion effect from the adjacent dominant BpS types might have produced a lower MFRI than what was modeled. This BpS will have significant variation in plant response to disturbance.

One reviewer for the Rapid Assessment (RA) felt that the overall MFRI should be reduced and dominated

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by mixed severity fire. The other reviewers agreed with the fire frequency and severity in the model, and it was unchanged. Peer review from RA resulted in the addition of some mixed severity fire. There were disparate opinions about the frequency of fire in this type, ranging from an average fire return interval of 60-100yrs. Adjusting the MFRI either direction resulted in only slight adjustments (+/-5%) in the resulting percent in each class.

Drought, insects/disease and native grazing may all impact this BpS. However, little or no data exist to attribute these disturbances, and they were not included in this model.

Adjacency or Identification Concerns

The fire regime of adjacent BpS will influence the fire regime here (ie: contagion effect). This system is widespread and may be adjacent to many shrubland systems, mountain grassland systems and forested types including montane aspen, ponderosa pine, and Douglas-fir forests and lodgepole pine in MZ29.

This type might be somewhat difficult to distinguish from 1085 NW Great Plains shrubland, but they should be distinguished, as 1106 shrubs are adjacent to forest/woodlands or lower treeline, whereas 1085 is adjacent to ravines, more riparian and grassland 1141 system.

There might be more of the late successional class today due to fire suppression.

There also might be a current invasion of conifers.

Native Uncharacteristic Conditions

There might be more of the late successional class today due to fire suppression.

There also might be an invasion of conifers currently.

Scale Description

Variance in scale is a result of topography and localized moisture variability.

Issues/Problems

Extreme variability in fire regime, scale and adjacency make this type difficult to model.

Comments

This BpS for MZ29 was adopted from the same BpS from MZ20 which was reviewed by Steve Barrett. Descriptive additions were made for MZ29 to better represent the area.

This BpS for MZ20 was adopted as-is from the same BpS from MZ19. No quantitative changes were made. Minor descriptive additions were made to more fully describe the system. Some class structural changes were made to match the descriptive boxes.

For MZs 10 and 19, modeler was Mike Babler and reviewers were Don Bedunah (bedunah@forestry.umt.edu), Clayton Kyte (clayton_kyte@nps.gov), Susan Miller (smiller03@fs.fed.us), Lois Olsen (lolsen@fs.fed.us), Robert Wooley (rwooley@fs.fed.us) and an anonymous reviewer. Derived from the Rapid Assessment model R0MTSB (Mountain Shrub, non-sagebrushes). The model was taken as-is. Peer review for the Rapid Assessment model incorporated on 4/11/2005. Additional reviewers included Thor Stephenson (thor_stephenson@blm.gov), Curt Yanish (curt_yanish@blm.gov) and Gavin Lovell (gavin_lovell@blm.gov).

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Vegetation Classes

Class A **10 %**

Early Development 1 All Structure

Indicator Species* and Canopy Position

AMELA	Upper
SYMPH	Upper

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

Grasses and forbs will dominate, with scattered shrubs in overstory. Grass cover may reach 100%.

Description

Early succession, usually after frequent stand replacement fires. Dominated by grasses and forbs, with some shrubs sprouting. Grass/forb canopy cover will be high and variable (0-100%), but cover of shrubs will be <15%.

This class succeeds to B after ~10yrs.

Replacement fire occurs every 100yrs.

Class B **45 %**

Mid Development 1 Closed

Indicator Species* and Canopy Position

AMELA	Upper
SYMPH	Upper
LUPIN	Lower
PRVI	Middle

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Shrub 0m	Shrub >3.1m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Less than 40% shrub cover, with sprouting shrubs dominant in scattered openings. This class was originally modeled as 0-40% cover with shrubs greater than 0.5m. However, to account for the possibility of shrubs being less than 0.5m, minimum canopy cover was increased to 21%.

This class succeeds to C after ~70yrs unless replacement fire occurs (causing a transition to class A), every 100yrs. Mixed severity fires will not cause a transition to another class, and occur every 400yrs.

Class C **45 %**

Late Development 1 Closed

Indicator Species* and Canopy Position

AMELA	Upper
SYMPH	Upper
LUPIN	Lower
PRVI	Middle

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	60 %
Height	Shrub 0m	Shrub >3.1m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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Greater than 40% shrub cover; all age classes present but dominated by overmature shrubs and sparse understory except in gaps.

This class persists indefinitely, unless a disturbance (replacement fire every 100yrs or mixed severity fire every 400yrs) causes a transition (to classes A and B, respectively).

Purshia might also be an indicator in this class.

Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	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

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	100	20	150	0.01	80
Mixed	400			0.0025	20
Surface					
All Fires	80			0.01251	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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**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 sev

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**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 seve

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911170** **Southern Rocky Mountain Ponderosa Pine Savanna**

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

General Information

Contributors (also see the Comments field **Date** 6/12/2006

Modeler 1	Cody Wienk	cody_wienk@nps.gov	**Reviewer**	Peter Brown	pmb@rmtrr.org
Modeler 2	Jeff DiBenedetto	jdibenedetto@fs.fed.us	**Reviewer**	Bill Schaupp	bschaupp@fs.fed.us
Modeler 3	Chris Thomas	cthomas@fs.fed.us	**Reviewer**	Ken Marchand	kmarchand@fs.fed.us

Vegetation Type
Forest and Woodland

Map Zone
29

Model Zone
☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

PIPO	PASM
JUSC2	CAREX
RHAR4	SCSC
PSSP6	QUMA2

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

This BpS is located in the Bighorns of WY, Laramie Range. This might describe areas in MZs 29 and 20. Could occur in MZ29 in sections M331B, M331I, 342A and subsection 342Fb.

Biophysical Site Description

The geology is typically sedimentary in origin. Often found on buttes, hogbacks, rocky outcrops, and steep, rocky slopes. Elevations range from 3200-4400ft, but in the Bighorns may be found up to 5700ft on southern aspects. In eastern MT and northeast WY, it is also found on southern aspects.

Vegetation Description

This type is dominated by interior ponderosa pine and is often the only tree present. Understory composition varies but Rocky Mountain Juniper, skunkbush sumac, mountain mahogany (in southern Black Hills and the eastern Pine Ridge), snowberry and yucca are common woody species (one reviewer noted that under the historic fire regime, the occurrence of yucca would have been a bit lower than at present). Currant and chokecherry are found in the MT portion of the BpS's range.

(Regional lead asked about JUSC2 as an indicator: JUSC2 can be considered an indicator for Laramie Peak Range. Rocky Mountain Juniper is listed as present in late successional communities for ponderosa pine/Idaho fescue, ponderosa pine/sun sedge and ponderosa pine/bluebunch wheatgrass habitat types by Hanson and Hoffman (1988) for southeastern Montana. But it's not mentioned as present in the other ponderosa pine habitat types (ponderosa pine/common juniper, ponderosa pine/chokecherry). Rocky Mountain juniper is not an indicator for ponderosa pine habitat types in southeastern MT or western ND)

Herbaceous species include needlegrasses, grama grasses, little bluestem, western wheatgrass, sedges and

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bluebunch wheatgrass. There is Idaho fescue as far east as Ashland, MT.

Disturbance Description

Generally frequent fires of low severity (Fire Regime Group I). Mixed severity fire occurs in the closed canopy conditions, and stand replacement fire is very infrequent (300yrs+). Low-severity fires are frequent and range from <10yrs to more than 20yrs (Brown and Sieg 1999, Fisher et al. 1987), but probably not more than 40yrs at the high end (3-70yrs range). The MFRI is approximately 12-15yrs for low severity fires.

There is considerable debate over the role of mixed severity and surface fires in the historical range of variability in this and other ponderosa pine forests in the northern and central Rockies (Baker and Ehle 2001, 2003; Barrett 2004; Veblen et al. 2000). Brown (2006) argues that surface fire was the dominant mode of fire disturbance and that the role of mixed-severity fires is overstated.

In the Rapid Assessment (RA), Workshop review indicated more mixed fire should occur in the early stage and surface fire should be modeled in all structural stages. Peer review comments during the RA disagreed on the role of mixed and surface fire in this type. The majority of review agreed with the original model's parameters for mixed fire, but thought surface fire could be slightly less frequent. One review contended that there is no evidence of mixed severity fire in this type at all, and that the overall MFRI should be around 25yrs.

For MZ29 and 30, it was suggested that mixed fire be removed from this model; reviewers agreed, and therefore mixed fire is not in the model.

Variation in precipitation and temperature interacting with fire, tip moths and ungulate grazing affects pine regeneration. Windthrow, storm damage and mountain pine beetles were minor disturbances in this type unless stands reach high densities. The interactions among drought, insects and disease are not well understood.

Ips species of bark beetles can cause significant mortality among pole-sized and larger diameter pines, especially those weakened by drought, fire injury and the hail-related native disease diplodia. This serves to maintain the late-development open stage (class D) and move the late-development closed stage (class E) to the late-development open stage (class D).

Adjacency or Identification Concerns

This type is either surrounded by Northern Plains grasslands and shrublands or is a transition between Northern Plains grasslands and shrublands and higher-elevation coniferous forests. Ponderosa pine in this BpS has encroached into the Northern Plains grassland and shrubland types in many areas due to fire suppression and grazing.

As this system model and description is copied to the BpS: Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna - Savanna, this system will be difficult to distinguish from that one, and is only distinguished by geography.

Invasive species in this system include cheatgrass, Japanese brome, crested wheatgrass, Kentucky bluegrass and intermediate wheatgrass. Crested wheatgrass and cheatgrass are at lower elevations mostly. Cheatgrass has altered the fire frequency and extent (although not on the Pine Ridge).

Currently, there have probably been at least 5-10 fire cycles that have been missed due to suppression,

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grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 50-80% canopy closure - uncharacteristic. Also - encroachment into prairies by pine and juniper is an issue today (Juniper becomes more of an issue further east; it's primarily ponderosa pine that is encroaching in the NE area), although JUSC2 is an indicator at least in the Black Hills. Generally. the juniper that is an issue with the prairies east of the Black Hills is the eastern redcedar. As it continues to be incorporated into windbreaks, it is continuing to increase into new areas.

Hardwoods exist in drainages, which encompasses a separate BpS. In NE, there is green ash, chokecherry, hackberry and American elm, which get crowded out by the ponderosa pine.

Currently expanding into grasslands because of fire suppression, grazing and natural expansion from Holocene rebound (Norris 2006).

Native Uncharacteristic Conditions

Currently, there have probably been at least 5-10 fire cycles that have been missed due to suppression, grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 50-80% canopy closure - uncharacteristic. Some areas have been thinned to "even spacing," rather than the "clumpier" arrangement that is shown in early photos.

Scale Description

Disturbance patch size probably ranged from 10s-10000s of acres.

System would be a patchy mosaic of 10s-1000 of acres. It could be a range of patches, such as in Missouri Breaks where it could be up to 10000ac patches.

Issues/Problems

Comments

This BpS was originally modeled for MZ29 and MZ30 including the Black Hills. However, post-model-review-and-delivery, the new Northwestern Great Plains-Black Hills Ponderosa Pine BpS was created by NatureServe. Therefore, this model 1117 was retained as-is for a portion of MZs 29 and 30, based on geography, and this model 1117 was also copied as-is for a different portion of MZ29 and 30, based on geography, and used for the BpS Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna split.

This model for MZs 29 and 30 was adapted from the Rapid Assessment (RA) model R0PIPOnp developed by Breck Hudson and reviewed by Bill Baker, Dennis Knight and Brad Sauer. Other modelers for MZs 29 and 30 were Paul Mock, David Overcast, Kim Reid. Other reviewers for MZs 29 and 30 were Carolyn Sieg and Mary Lata.

RA Workshop code was PPIN11.

Additional authors for the RA include Deanna Reyher, Carolyn Sieg, Breck Hudson, Cody Wienk, Peter Brown and Blaine Cook. This type was modeled based on earlier work done by an expert panel (Morgan and Parsons 2001). Collapsing of stages were necessary to fit the five-box model used for this process.

Vegetation Classes

Class A 5%

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

NAVI4	Mid-Upper
PASM	Mid-Upper
PSSP6	Mid-Upper
CAREX	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	90 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	Seedling <4.5ft	

- [ ] Upper layer lifeform differs from dominant lifeform.

Shrubs are the upper layer, perhaps, but cover is <20%.

Description

This community is dominated by herbaceous and woody species, including the graminoids needlegrasses, western wheatgrass, bluebunch wheatgrass, sedges, Idaho fescue and little bluestem in moister areas, and various shrubs including skunkbush and snowberry. Ponderosa pine seedlings are scattered and found in small clumps.

Little bluestem will also be indicator species.

Number of years in this class is variable depending on climatic patterns and fire disturbances. This class typically ends at 30yrs in this model. Without fire for 25yrs, this class can move to a mid-closed stage.

Needlegrasses can be tall up to one meter, but other graminoids are typically less than 0.5m.

Low severity surface fires occur every 30yrs. Replacement fires (since this is mostly grassland in this class) occur every 50yrs.

Class B 2%

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Multi-story stand of small and medium trees with saplings and seedlings coming in as clumps. Understory is sparse. Some juniper might be present - could be an outlier. Grasses and shrubs are shaded out.

This class lasts approximately 70yrs, then moves to a late closed stage.

Low severity surface fires occur every 15yrs and move this stage to a mid open stage. Replacement fires occur infrequently approximately every 300yrs.

Insect/disease was modeled at approximately occurring every 50yrs, not causing a transition.

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Class C 8 %

Mid Development 1 Open

Indicator Species* and Canopy Position

PIPO	Upper
NAVI4	Lower
PASM	Lower
PSSP6	Lower

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Graminoids could have up to 60-80% cover (Hansen and Hoffmann 1988). Grasses co-dominate.

Description

Predominantly single story stands with a few pockets of regeneration. Low shrubs such as snowberry and skunkbush and poison ivy are dominant as well as grass and forbs. Graminoids could have up to 70-80% cover. Rocky Mountain juniper present in patches.

Carex spp and little bluestem will also be indicator species.

This class lasts approximately 50yrs then goes to a late open stage. Without fire for 40yrs, this could transition back to a mid closed stage.

Low severity surface fires occur every 15yrs, maintaining this class. Replacement fires occur very infrequently (modeled at .0015 probability).

Class D 80 %

Late Development 1 Open

Indicator Species* and Canopy Position

PIPO	Upper
NAVI4	Lower
PASM	Lower
PSSP6	Lower

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Graminoids could have up to 60-80% cover. Grasses co-dominate.

Description

Predominantly single story stands of large ponderosa pine with pockets of smaller size classes (replacement). Snowberry, skunkbush and patches of Rocky Mountain juniper. Understory is dominated by shrub species and grasses and poison ivy. Graminoids could have up to 70-80% cover.

Carex spp and little bluestem will also be indicator species.

It is thought that class D, the late open stage, should occupy approximately 80% of the historical landscape.

Low severity fires occur every 15yrs and maintain this stage. Replacement fires occur very infrequently (0.0015 probability). If no fire occurs after 40yrs, this class could transition to the late closed stage.

Insect/disease occurs every 50yrs and maintains this stage.

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Class E **5 %**

Late Development 1 Closed

Indicator Species* and Canopy Position

PIPO Upper

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

This is a somewhat uniform late-development stage, multi-story stands of large, medium, small and seedling ponderosa pine. Shrubs and grasses are sparse. This type generally exceeds 70% canopy cover. DBH is less in this class than late-open.

Low severity surface fires occur every 15yrs and cause a transition back to the late open stage. Replacment fires occur every 300yrs.

Insect/disease occurs every 250yrs, causing a transition back to the late open stage. Drought can also occur - every 500yrs, causing a transition to the late open stage.

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg

Min 1

Max 50000

Sources of Fire Regime Data

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	380			0.00263	4
Mixed					
Surface	15	3	70	0.06667	96
All Fires	14			0.06931	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911250** **Inter-Mountain Basins Big Sagebrush Steppe**

☑ *This BPS is lumped with: 1080*

☐ *This BPS is split into multiple models: 1125 describes MZ29 better. 1080 has ARCA13, which doesn't apply in these map zones. Production is somewhat different, but not enough to split out (Benkobi).*

General Information

Contributors (also see the Comments field **Date** 10/3/2006

Modeler 1	Steve Cooper	scooper@mt.gov	**Reviewer**	Lakhdar Benkobi	lbenkobi@fs.fed.us
Modeler 2			**Reviewer**	Jeff DiBenedetto	jdibenedetto@fs.fed.us
Modeler 3			**Reviewer**	George Soehn	george_soehn@blm.gov

Vegetation Type

Upland Savannah/Shrub Steppe

Dominant Species*

ARTRW	PSSP6
PASM	HECO26
BOGR2	NAVI4
CHRYS9	CAFI

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Geographic Range

This system encompasses eastern and central MT (as opposed to finding it throughout the Rocky Mountains, etc. as BpS 1125 is usually described.) 1125 is common throughout MZs 20 and 29 currently (not necessarily historically), except in western part of section 331Da. In MZ29, it is common historically.

For MZ29, it would occur in northeast WY section 331G; Thunder basin grasslands; and NE of 331Gg.

For MZ29, basin big sagebrush is very uncommon. Artemisia tridentata ssp. vaseyana (BpS 1126) is found at higher elevations associated with the Bighorn, Pryor and Laramie ranges. Artemisia tridentata ssp. wyomingensis is found elsewhere, where Artemisia tridentata ssp. vaseyana doesn't occur. Mountain big sagebrush occurs in sections M331 associated with Bighorn and Laramie Ranges. Artemisia tridentata ssp. wyomingensis occurs everywhere else.

In MZ29, it is found in southeast MT, this could be due to a soil anomaly. It probably occurred historically all through the subsections of southeast MT. Also through MZ30 in 331Mi in the western Dakotas and the lower portion of 331Md. As one moves north in 331Md, there is less of it. It probably does not occur in 331Mc. Canopy cover of sagebrush is probably less than 10%.

Biophysical Site Description

This system is Great Plains Sagebrush Steppe for MZ20. For MZ29, we are describing sagebrush

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wheatgrass steppe, where western wheatgrass is dominant. MZs 20 and 29 are very similar for this type.

Soils are primarily dry from sedimentary processes in this system; soils are less fertile in this system, sometimes more calcareous. The Great Plains expression is found exclusively on "heavy" textured soils derived from shale and mudstones and can be strongly correlated with particular geologic formation or members thereof.

April, May and June have by far the most precipitation and this peaks in late May, early June. This pattern carries throughout the MT portion of the Great Plains though a gradient of more summer precipitation as you progress eastward but still the "spring" peak. It's not until you encounter tallgrass prairie does summer precipitation become predominant.

Wyoming big sagebrush occupies plains, foothills, terraces, slopes, plateaus, basin edges and even lower mountain slopes due to the fact that Artemisia tridentata ssp. vaseyana is not part of the mix in MZ20 nor in MZ29. Soils are shallow to moderately deep, moderate to well drained and almost exclusively fine textured soils. Wyoming big sagebrush generally occurs in the 5-15in precipitation zones. Soil depth and accumulation of snow enhances these communities in lower precipitation zones (Knight 1994).

In MZ29, Artemisia tridentata ssp. wyomingensis can occur from 2200ft up to 8000ft.

Bluebunch/Artemisia tridentata ssp. wyomingensis type is probably an inclusion in this BpS occurring on steep, south aspect slopes, typically badlands slopes/topography.

Vegetation Description

Wyoming big sagebrush is the dominant mid-to late seral species within this plant assemblage.

PASM and ELLA3 are by far the dominant grasses in MZ20 expression of this BpS. In MZ29, PASM, HECO26 and BOGR2 are by far the dominant grasses. Cool season grasses such as Indian ricegrass, bluebunch wheatgrass (Indian ricegrass and bluebunch wheatgrass occur only where coarser textured soils prevail), needle-and-thread (needle-and-thread grass has a broad environmental amplitude but more typically abundant on coarse soils; however, under heavy grazing, it does quite well on fine-textured soils.), blue grama, Sandberg bluegrass, squirreltail, threadleaf sedge and infrequently Thurber's needlegrass. Rhizomatous wheatgrasses, such as western wheatgrass and thickspike wheatgrass, and plains reedgrass, are common species within these MZs 20 and 29. Junegrass also occurs.

Common forbs are species of Astragalus, Crepis, Delphinium, Phlox and Castilleja, while associated shrubs and shrub-like species can be small green rabbitbrush, fringe sagewort, winterfat and broom snakeweed. Other dominant species of forbs include RACO3 and SPCO. Also, LIPU and PHHO occur.

Forbs most important for MZ20 include SPHCOC, DALPUR, PHLHOO, RATCOL and OPUPOL. Other forbs in MZs 10 and 19 include hawksbeard (Crepis acuminata), bird's beak (Cordylanthus spp) , bluebell (Mertensia spp), Rocky mountain aster (Aster scopulorum), Phlox species, lupine (Lupinus spp) and buckwheat (Eriogonum spp). In MZ29, all of the above are probably found except for lupine, which would occur in higher precipitation areas and associated with mountain big sagebrush.

Herbaceous species usually dominate the site prior to re-establishment. Site re-establishment is by seed bank, seed production from remnant plants and seeds from adjacent (untreated) plants.

Wyoming big sagebrush in upland sites have fewer understory species relative to the mountain big sagebrush subspecies, though at higher elevations or moister areas of this vegetation community there is a higher potential for herbaceous species, relative to mountain big sagebrush sites; no definitive statement on undergrowth herbaceous diversity can be made for Wyoming big sagebrush sites. Herbaceous cover increases transitioning into the mixed-grass prairie, and in open patches.

In MZ29, mountain big sagebrush is not found. Wyoming big sagebrush is found where basin big sagebrush is not present. It can occur with greasewood and silver sage, as well as rabbitbrushes and saltbush.

Disturbance Description

Many researchers believe fire was the primary disturbance factor within this plant assemblage. Other disturbance factors may include insects, rodents and lagomorphs, drought, wet cycles, gradual changes in climate and native grazing (Wyoming Interagency Vegetation Community 2002). Drought may have been a more significant disturbance than native grazing or insects, so it was included. Native grazing by large ungulates (eg, bison), and insects were included as occurring every 10yrs but causing no transitions to another class. Heavy-impact grazing in the late closed stage occurs less frequently and causes a transition to an open state.

Following fire or other significant disturbance, herbaceous species will dominate the ecological site post-burning and recovery to prefire canopy cover is quite variable and may generally take 50-120yrs, but occasionally occurs within a decade (Baker, in press). Site re-establishment is by seed production from remnant plants, and seeds from adjacent (untreated) plants. Discontinuity of fuel in Wyoming big sagebrush communities can result in mosaic burn patterns, leaving remnant plants for seed, but can be large expanses of complete mortality (Bushey 1987, Baker, in press). Fire does not stimulate germination of soil-stored Wyoming big sagebrush, but neither does it inhibit its germination (Chaplin and Winward 1982). Regeneration may occur in pulses linked to high precipitation events (Maier et al. 2001).

Overall fire return intervals in Wyoming big sagebrush appear to have ranged from 100-240yrs or more (Baker, in press) for MZ22. In MZ20, some believe that intervals are shorter, with replacement fire occuring approximately every 30yrs in some of the classes (based on BLM Fire Management plans and local expert estimate, Downey). However, there was disagreement with that short interval. It is also said that we are fairly certain of the time required for sagebrush recovery (50-150yrs, mostly around 100yrs). With this slow recovery and if fires returned to the site in 30yrs, eventually the whole landscape would be only class A and maybe B (open) (Cooper, personal correspondence). Therefore, for MZ20, FRI was modeled at an overall 90yr interval, similar to other adjacent map zones and similar to the FRI of 80yrs for BpS 1080 in MZ20 to which this BpS is thought to be very similar.

There was some disagreemenet among MZ20 modelers as to the FRI of 90yrs for this 1125 system. Up north, where there is a heavy grass component and much less cover of sagebrush than what is down south, and relatively connected topography and a lot of wind, it would burn more frequently (Downey, pers comm). Perhaps that would be considered BpS 1085 instead of BpS 1125. And even though BpS 1085, which is also comprised mainly of Wyoming big sagebrush has an FRI of 30yrs, these two systems are different as it relates in large part to setting and precipitation patterns, and continuity of fuel. Eastern MT has few breaks, versus mountainous systems that would be much less likely to have the huge sweeping fires. Although the species are the same Wyoming big sagebrush - the systems aren't (Martin, pers comm). The longer FRI for 1125 was therefore retained.

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Benkobi (pers comm) states that in MZ29, fire frequency could range from 36-40yrs (http:/gisdata.usgs.net). However, MZ29 reviewers did not want to change the model. However, because it was also stated that recovery occurred after at least 60yrs in MZ29, and due to the discrepancy from previous map zones, the FRI from MZ20 was retained.

Discontinuity of fuel in Wyoming big sagebrush communities often result in mosaic burn patterns, but large expanses can burn with complete mortality under extreme conditions (Bushey 1987, Baker, in press). Mixed severity fire was originally modeled in this BpS but due to a new understanding of definitions of severity types, it was thought that mixed severity fire does not occur in this system and rather patchy fires do occur, with replacement severity.

In MZs 20 and 29: 29yrs after a prescribed burn, there is still zero recovery of Wyoming big sagebrush (Cooper pers comm). It is thought that Wyoming big sagebrush communities take longer than 100yrs to recover. In Bighorn battlefield, historically there was much sagebrush. Though burned in mid-80s there is still no evidence of sagebrush re-establishment 10yrs later.

Antelope, mule deer and pygmy rabbits are native herbivores that browse sagebrush. These were also not included in the model. In MZ29, probably no pygmy rabbits. Sage grouse might also have an impact? It is questionable as to the impact/frequency of antelope and mule deer in MZ29.

Adjacency or Identification Concerns

This type is difficult to distinguish from mixed-grass prairie with a high shrub component. It is possible that with severe disturbance, a state change might occur to mixed-grass prairie - which in turn changes the potential for the site to return to sagebrush. Extensive severe burns for want of an adjacent seedbank would take extensive periods before ARTTSW was again a significant component. The reference condition might have been sagebrush, but now the abiotic facotrs and biophysical gradients indicate a mixed-grass prairie.

Secondary shrub and herbaceous components may vary considerably across the range of its extent. Wyoming big sagebrush sites may be a mosaic with or abut Juniper, ponderosa pine, salt desert shrub and grassland vegetation types across its range. However, the most common accompanying vegetation is Northern Great Plains midgrass prairie.

Broom snakeweed and halogeton may dominate sites disturbed by overgrazing, oil and gas development or other disturbances. Club moss in this system increases with the intensity and duration of grazing. BROJAP can be an increaser with burning/grazing. There is also BROTEC invasion but that doesn't occur in the Northern Great Plains, except in MZ29.

Juniper increase might be occurring due to lack of fire today, but it is not developing into a true juniper woodland, especially in MZ29.

Shrub cover increases in MZs 20 and 29 with overgrazing, and herbaceous layer decreases dramatically.

Might be difficult to distinguish from BpS 1080 and BpS 1085.

Much of 1080 has been lost due to land clearing for agriculture or converted to a cheatgrass or greasewood type. For basin big sagebrush in MZ29, this is the case. For Wyoming big sagebrush in MZ29, much has

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been lost due to burning for modern grazing. The understory is currently more annual bromes due to increased grazing.

Overgrazing has also been an issue in 1080. HESCOM and KOEMAC increase (MZ20) where grazing is intense and protracted. It is questionable as to whether HESCOM increases with grazing (some areas of MZ29), and might rather decrease with overgrazing. With overgrazing in some areas of MZ29, more bluegrasses.

Plant associations are similar between 1125 and 1080. Shrubland is perhaps further south. Herbaceous cover is the only distinguishing factor. 1125 is definitely the more prominent historically. 1080 more prevalent in central Wyoming. These (like mixegrass prairie) are distinguished by geography. Therefore, they're being combined for MZ29.

In Bighorns battlefield (around Hardin, MT), historic photos showed dense (up to 20%-30% cover, that is) shrub covered system, but currently, mostly grass - due to fires that burned there (Clark et al 1995 DRAFT).

If adjacent to pine systems, might be seeing more trees currently. (also in grass systems). This was seen in historic photographs throughout northern part of MZ29 and through western SD (Clark et al 1995 DRAFT).

Native Uncharacteristic Conditions

Over 45% shrub cover would be uncharacteristic for MZ20 and MZ29. In fact, Wyoming big sagebrush in MZ29 would not exceed 40% cover. The only reason it would be this high is in cases of extreme overgrazing or in the absence of fire or changes in fire regime - frequency.

Scale Description

Occurrences may cover between hundreds and thousands of hectares.

Disturbance patch sizes range from 10s-1000s of hectares. The patch and disturbance size gets larger as this shrub BpS intergrades with the grassland BpS, and also gets larger from MZs 19 and 20 into MZ29.

Issues/Problems

Difficult to identify where hybrids occur with other big sagebrush taxa.

Comments

This model for MZ29 was adapted from the same BpS from MZ20 created by Steve Cooper and Shannon Downey and reviewed by Steve Barrett. For MZs 29 and 30, descriptive additions and changes were made. Other reviewers for MZ29 were Bobby Baker and Jim Von Loh.

Model for MZ20 was adapted from the draft model for MZ22 for 1125b Inter-Mountain Basins Big Sagebrush Steppe-Wyoming Big Sagebrush, created by Mark Williams, Vicki Herren and an anonymous contributer and reviewed by Tim Kramer, Eve Warren and Destin Harrell. Changes were made to the description and model.

The model for MZ22 was adapted from Rapid Assessment model R0SBWYwy created by Tim Kramer (tim_kramer@blm.gov) and reviewed by Bill Baker, Don Bedunah and Dennis Knight.

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For the Rapid Assessment, the workshop code was WYSB. This model was combined with another Rapid Assessment model, R0SBWA (workshop code was WSAG1), modeled by George Soehn (george_soehn@blm.gov) and reviewed by Sarah Heide (sarah_heide@blm.gov) and Krista Gollinick-Waid (krista_waid@blm.gov). The two were combined based on peer-review and the similarity of disturbance regimes and species composition.

The RA Model is based on the original FRCC PNVG (WYSB1) with modifications from Wyoming Interagency Vegetation Committee (2002) and expert estimates. Peer review for the RA model was incorporated 4/30/2005. Additional reviewers were Karen Clause (karen.clause@wy.usda.gov), Ken Stinson (ken_stinson@blm.gov) and Eve Warren (eve_warren@blm.gov).

Vegetation Classes

Class A 35 %

Early Development 1 All Structure

Upper Layer Lifeform

- ☑ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model 2

Indicator Species* and Canopy Position

NAVI4	Upper
PASM	Upper
BOGR2	Lower
CAFI	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	80 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

☑ Upper layer lifeform differs from dominant lifeform.

Herbs dominate this class and shrubs are growing up, but do not yet dominate the class. Shrub cover less than five percent belongs in this class.

Description

Herbaceous dominated. In the presettlement condition, NAVI4 (in MZ20) and HECO26 in MZ29 would have been a major upper position component. Primarily grasses with forbs. Exact species will vary depending on location. Western wheatgrass, Sandberg bluegrass, plains reedgrass, needle and thread, bluebunch wheatgrass, threadleaf sedge, plains junegrass and blue grama would be dominant grasses. Forbs may include Astragalus, Crepis, Castelleja, Delphinium, Agoseris, Phlox and others. There may also be significant component of small green rabbitbrush.

Succession to class B, a mid-development open stage, occurs after 40yrs. This succession was originally modeled at 20yrs; however, it was later decided that that was a minimum age for succession, and it would take more like 40yrs to achieve 5-15% canopy cover of ARTTSW. There is one paper that shows no ARTTSW 15yrs post-fire and another paper for MZ19 that indicates no recovery after as much as 18yrs (Cooper, personal correspondence). In MZ29, recovery occurred after 60yrs.

Insect/disease (0.001 probability or 0.1% of the landscape each year), native grazing (0.1 probability or 10% of the landscape each year) and wind/weather stress (every 100yrs, 0.01 probability or 1% of the landscape each year) occur, but do not cause a transition.

Replacement fire was originally modeled at every 30yrs, based on expert estimate and local observations. - in BLM Fire Management Plans (Downey, personal correspondence). However, this was later changed to 90yrs based on recovery times of this type. This, and the other changes in age range, changed the class percentage from 20% to 35%.

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Class B **40 %**

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8 Upper
PASM Mid-Upper
NAVI4 Mid-Upper
HECO26 Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is greater than five percent but <15%. Understory is well represented by herbaceous species as described for class A. (Montana Academy of Sciences publication - re: in breaks, after 15yrs after fire, no sagebrush yet.)

ARFR4 also present in lower canopy.

Succession to class C, late development closed stage, occurs after 50yrs. (60yrs for MZ29)

Insect/disease (0.001 probability of 0.1% of the landscape each year), native grazing (0.1 probability or 10% of the landscape each year), and wind/weather stress (every 100yrs, 0.01 probability or 1% of the landscape each year) occur, but do not cause a transition to another stage.

Fire was modeled more frequently than in MZ22 based on expert estimate and data from BLM Fire Mangement Plans. Originally, mixed fire was modeled at occurring every 40yrs, maintaining the class in this stage (Downey, personal correspondence). However, this was later removed due to a new understanding of definitions of mixed versus replacement fire. This, and the other changes in age range, changed the class percentage from 55% to 35%. Replacement fire occurs every 90yrs.

Class C **25 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8 Upper
PASM Mid-Upper
NAVI4 Mid-Upper
HECO26 Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is >15%. Understory is well represented by herbaceous species as described for class A. This class is more common on drier sites.

Shrub cover max was 30% in MZ20. In MZ29, it was increased to 65% cover by other reviewers. However, it was decided that here could not be this amount of cover. Modal cover is 15%. The most measured was 32% cover. Some could have been higher cover but not much. Common in literature that grazing/over-grazing increases cover, not the opposite. It is probably more common in 20% range. 40% is high, but could be a max (Cooper, diBenedetto, personal comm). Regional lead changed to 40% per comments.

ARFR4 is also present in lower canopy.

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Insect/disease (0.001 probability of 0.1% of the landscape each year), native grazing (0.002 probability or 0.2% of the landscape each year) cause a transition to the mid-open stage.

Native grazing (0.1 probability or 10% of the landscape each year) occurs, but does not cause a transition to another stage.

Drought was modeled at an overall interval of 100yrs split between maintaining this stage or taking it to the mid-development stage.

Originally, mixed fire was modeled at occurring every 40yrs, maintaining the class in this stage (Downey, personal correspondence). However, this was later removed due to a new understanding of definitions of mixed versus replacement fire. Replacement fire occurs every 100yrs. This only changed the class percentage from 25% to 30%.

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	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
Min
Max

Sources of Fire Regime Data

☑ Literature
☑ Local Data
☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	90			0.01111	100
Mixed					
Surface					
All Fires	90			0.01113	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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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Additional Disturbances Modeled

- [x] Insects/Disease
- [x] Wind/Weather/Stress
- [x] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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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

Modeler 1	Dave Tart	dtart@fs.fed.us	**Reviewer**	Kim Reid	kreid@fs.fed.us
Modeler 2	Stan Kitchen	skitchen@fs.fed.us	**Reviewer**	Steve Cooper	scooper@mt.gov
Modeler 3			**Reviewer**	Jeff DiBenedetto	jdibenedetto@fs.fed.us

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

ARTRV	SYOR2
PSSP6	BAIN
FEID	BASA3
POSE	GEVI2

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

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

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

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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 Gruel (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 MFRIs 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
Welch and Criddle (2003) report greater than 50yr interval. They also report the following "10 biological

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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. Very few seedling mountain big sagebrush were observed in the fire aftermath and these on a very local

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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).

When inputting differing fire probability values in VDDT, the following class percentages were output

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(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 intrval: 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.

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.

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_stinston@blm.gov), Thor Stevenson (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.umt.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

- [x] 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	

- [x] 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
- [x] 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).

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

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

Indicator Species* and Canopy Position

ARTRV	Upper
PSSP6	Lower
FEID	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	50 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model 2

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 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.)

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	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

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.

Additional Disturbances Modeled

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

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

LANDFIRE Biophysical Setting Model

Biophysical Setting **2911270** **Inter-Mountain Basins Semi-Desert Shrub-Steppe**

☑ *This BPS is lumped with: 1081*
☐ *This BPS is split into multiple models:*

General Information

Contributors (also see the Comments field) **Date** 5/5/2006

Modeler 1	George Soehn	george_soehn@blm.gov	**Reviewer**	Eve Warren	eve_warren@blm.gov
Modeler 2	George Jones	gpjones@uwyo.edu	**Reviewer**		
Modeler 3	Dennis Knight	dhknight@uwyo.edu	**Reviewer**		

Vegetation Type

Upland Shrubland

Dominant Species*

ATCO	TETRA3
PIDE4	CHVI8
KRLA2	GUSA2
ATCA2	GRSP

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska	☑ N-Cent.Rockies
☐ California	☐ Pacific Northwest
☐ Great Basin	☐ South Central
☐ Great Lakes	☐ Southeast
☐ Northeast	☐ S. Appalachians
☐ Northern Plains	☐ Southwest

Geographic Range

Occurs throughout MZ22 in areas with <10in precipitation (none of the subsections that are part of M331.)

Biophysical Site Description

This type occurs from lower slopes to valley bottoms ranging in elevation from 4300-6500ft. Soils are often alkaline or calcareous. Soil permeability ranges from high to low, with more impermeable soils occurring in valley bottoms. Soil texture is variable becoming finer toward valley bottoms. Many soils are derived from colluvium on slopes and residual soils elsewhere. There may be water ponds on alkaline bottoms. Average annual precipitation ranges from 5-10in. Summers are hot and dry. Spring is the only dependable growing season with moisture both from winter and spring precipitation. Cool springs can delay the onset of plant growth and drought can curtail the length of active spring growth. Freezing temperatures are common between October and April.

This group generally lies above playas and lakes. It tends to be the lowest vegetation group in elevation. Upslope it is bordered by and can intergade with low elevation big sagebrush groups, commonly Wyoming big sagebrush, low sagebrush, black sagebrush communities and sometimes juniper woodland.

Vegetation Description

This ecological system includes low (less than three feet) and medium-sized shrubs found widely scattered (often 20-30ft apart), to high density (3-4 plants per sq. m) shrubs interspersed with low to mid-height bunch grasses. Common shrubs are shadscale, winterfat, budsage, fourwing saltbush, Wyoming big sagebrush, spiney horsebrush, low rabbitbrush, broom snakeweed and spiny hopsage. Some of these will dominate more than others depending on the site.

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**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 seve

Common grass species are Indian ricegrass, needle-and-thread, western wheatgrass, three-awn and Sandberg bluegrass. Prickly pear cactus, hood's phlox, scarlet globemallow, wild onion, Hooker's sandwort and Sego lily are the most common and widespread forbs. The variably abundant understory grasses and forbs are salt and drought tolerant. The relative abundance of species may vary in a patchwork pattern across the landscape in relation to subtle differences in soils and reflect variation in disturbance history.

Total cover rarely exceeds 25% and annual production is closely linked to prior 12 months' precipitation.

Stand replacing disturbances (insects, extended wet periods and drought) shift dominance between shrub and grass species. Following drought, the system will tend more toward class B (more shrub prevalence). Following fire and extended wet periods, the system will tend more toward class A (greater grass prevalence).

Disturbance Description

Under reference conditions disturbances were unpredictable, but abnormally high precipitation, drought, insects and fire may all occur in these systems. Extended wet periods tended to favor perennial grass development, while extended drought tended to favor shrub development.

Documented Mormon cricket/grasshopper outbreaks since settlement were associated with drought; outbreaks cause shifts in composition amongst dominant species, but do not typically cause shifts to different seral stages. Therefore insect disturbance was not modeled. During outbreaks, Mormon crickets prefer open, low plant communities. Consequently, herbaceous communities and the herbaceous component of mixed communities were more susceptible to cricket grazing.

Fire was rare and limited to more mesic sites (and moist periods) with high grass productivity.

Reviewers for MZ16 indicated that there is no evidence for fire in salt desert shrub during presettlement. Research from the USFS Desert Experimental Range supports this and indicates that the reference condition would have been shifting mosaics of communities based on drought, flooding and insect outbreaks. Although historic fire regimes in desert shrublands are difficult to quantify, West (1983) believes that on sparsely vegetated salt-desert types, fires were historically rare except under unusual circumstances such as following high precipitation years.

Native American manipulation of salt desert shrub plant communities was minimal. Grass seed may have been one of the more important salt desert shrub crops. It is unlikely that Native Americans manipulated the vegetation to encourage grass seed.

Stand replacing disturbances (insects, extended wet periods and drought) shift dominance between shrub and grass species. Following drought, the system will tend more toward class B (more shrub prevalence). Following fire and extended wet periods, the system will tend more toward class A (greater grass prevalence).

Adjacency or Identification Concerns

This BpS contains the typical Great Basin salt desert shrub communities. Salt desert shrub is also common in the Wyoming big sagebrush community and there is some species overlap with other BpS. A wide range of salt desert shrubs can occur in this group.

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**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 sev

Upland salt desert shrub communities are potentially invaded by cheatgrass which could lead to more frequent fire intervals. Other nonnative problematic annuals include Japanese brome, halogeton, Russian thistle and several mustards.

There are, however, still salt-desert shrublands in the western United States experiencing historic fire regimes. For example, the well-studied salt-desert communities of Raft River Valley, southwestern ID, have not experienced fire since at least the 1930s. The vegetation community changes of this area have been monitored since 1951 (see http://www.cnrhome.uidaho.edu/default.aspx?pid=81934) with the last photo-documentation done in 2002 showing a significant cheatgrass component.

Native Uncharacteristic Conditions

Scale Description

This type occurs in patches of less than one acre to hundreds of acres in size. Disturbance scale was variable during presettlement. Droughts and extended wet periods could be region-wide, or more local. A series of high precipitation years or drought could affect whole basins.
Mormon cricket disturbances could affect hundreds of acres for years to 1-2 decades. Most fires were rare and less than one acre, but may exceed hundreds of acres with a good grass crop.

Issues/Problems

Lack of references limited model development. Reviewers for MZ16 indicated that there is no evidence for fire in salt desert shrub during presettlement. Research from the USFS Desert Experimental Range supports this and indicates that the reference condition would have been shifting mosaics of communities based on drought, flooding and insect outbreaks. There was little to no information about the early successional species and their relationships in this system prior to the advent of aggressive and noxious non-natives. Because of the pervasive replacement of native, early successional species by non natives, an adequate description of the forb and grass early seral communities may be difficult to complete.

Since disturbance is rare and unpredictable, the disturbance and successional pathways were difficult to model.

Comments

Model copied from MZ22 at MFSL by M.H. Weber on April 16, 2007. This model for MZ22 was adapted from the model from the same BpS in MZ16. Descriptive and quantitative changes were made. This model was changed to a two-box model.

The model for MZ16 was based on the Rapid Assessment PNVG R2SDSH by Bill Dragt. Jolie Pollet, Annie Brown and Stanley Kitchen simplified the model and eliminated a class dominated by greasewood. Reviewers of R2SDSH were Stanley Kitchen (skitchen@fs.fed.us), Mike Zielinski (mike_zielinski@nv.blm.gov) and Jolie Pollet (jpollet@blm.gov).

Quality control process by Pohl on 4/6/05 resulted in slightly adjusted percentages in each class to more closely match VDDT results.

Vegetation Classes

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
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Class A **25 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

PASM	Lower
ACHY	Lower
ATCO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

The dominant lifeform are grasses, but shrubs are the upper level lifeform at <5% and <0.5m tall.

Description

Dominated by continuous grass with widely scattered shrubs and relatively younger shrubs than in class B. Over 10yrs, vegetation moves to class B as the primary successional pathway. Replacement fire occurs every 300yrs on average, and will set back succession to year zero. Extended wet periods (every 35yrs) will also have a stand replacing effect.

Class B **75 %**

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

ATCO	Upper
ACHY	Lower
PASM	Lower

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Discontinous grass patches, and higher shrub canopy cover than in class A. Extended wet periods (every 35yrs on average) could cause a stand replacing transition to class A or could maintain this class with a higher component of grasses with slightly less precipitation. That second scenario was not modeled. Replacement fire is rare (mean FRI of 500yrs). Class B will be maintained in the absence of disturbance. Drought (mean return interval of 35yrs) will maintain vegetation in Class B.

Class C **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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**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 sev

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

Late1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 10
Min 1
Max 1000

Sources of Fire Regime Data

- ☐ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	450			0.00222	99
Mixed					
Surface					
All Fires	450			0.00224	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

LANDFIRE Biophysical Setting Model

Biophysical Setting **2911350** **Inter-Mountain Basins Semi-Desert Grassland**

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

General Information

Contributors (also see the Comments field **Date** 2/24/2005

Modeler 1	Bob Unnasch	bunnasch@tnc.org	**Reviewer**	George Jones	gpjones@uwyo.edu
Modeler 2			**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type
Upland Grassland/Herbaceous

Map Zone
29

Model Zone
☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*
BOGR2 MUHLE
ACHY
HECO26
ARIST

General Model Sources
☑ Literature
☐ Local Data
☐ Expert Estimate

Geographic Range

Occurs throughout the Intermountain western US on dry plains and mesas. This might occur in the southwestern portions of MZ22. However, all reviewers and modelers for MZ22 were confused by this system and why it was occurring in this map zone and at such a high frequency. Most did not think it occurred in this map zone. However, upon inspection of a draft ESP map, experts understood a bit more as to why it was occurring in this map zone.

Biophysical Site Description

Ecological systems found at approximately 1450-2320m (4750-7610ft) elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesa tops, plateau parks, alluvial flats and plains, but sites are typically xeric. Substrates are often well-drained sandy or loamy-textured soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. These grasslands typically occur on xeric sites. When they occur near foothill grasslands they will be at lower elevations. These grasslands occur on a variety of aspects and slopes. Sites may range from flat to moderately steep. Annual precipitation is usually from 20-40cm (7.9-15.7in).

Vegetation Description

The semi-desert grassland indicator species are common, widespread species.

Grasslands within this system are typically characterized by a sparse to moderately dense herbaceous layer dominated by medium-tall and short bunch grasses, often in a sod-forming growth. The dominant perennial bunch grasses and shrubs within this system are all very drought-resistant plants. These grasslands are typically dominated or codominated by Achnatherum hymenoides, Aristida spp, Bouteloua

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**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 sev

gracilis, Hesperostipa comata or Pleuraphis jamesii (For MZ22 - P. jamesii only in the southern part of MZ22. The species does not occur, or at least is very rare, north of Interstate Hwy 80.) or Muhlenbergia spp and may include scattered shrubs and dwarf-shrubs of species of Artemisia, Atriplex, Gutierrezia or Krascheninnikovia lanata, Coleogyne (not in MZ22) and Ephedra (not in MZ22). Muhlenbergia-dominated grasslands which flood temporarily, combined with high evaporation rates in this dry system, can have accumulations of soluble salts in the soil. Soil salinity depends on the amount and timing of precipitation and flooding.

Disturbance Description

This system is maintained by frequent fires and sometimes associated with specific soils, often well-drained clay soils. Fire most often occurred in these sites, when adjacent shrublands burned. Fires were typically mixed (average FRI of 37yrs) and stand replacement (average FRI of 75yrs). Most species respond favorably to fire. Rabbitbrush tends to increase with spring and summer fires. (In MZ18, one reviewer sugggests deleting mixed severity fire. Other reviewers stated that mixed fire should remain. Because of the disagreement, mixed fire was left. Although mixed fire is not typical in a grassland system, the mixed severity fires were retained in this BpS due to the bunchgrasses and the possibility that in a 30-meter pixel, only partial topcover (since some is sand) would be topkilled.)

These sites were prone to flooding during high precipitation, resulting in erosion of topsoil and some short term loss of vegetative cover. (It is doubtful, at least in MZ22, if most of the sites are prone to flooding. That may be true of the lowland sites, but it seems highly unlikely for swales, mesa tops, plateau parks and plains.) In cases of 500yr+ flooding event, the site could downcut, thus lowering the water table, and favoring woody species in an altered state. However, only on playas and stream terraces and floodplains would there be a water table that could be lowered. On upland sites, which the site description suggests constitute the majority of sites for this type, there is no water table.

Infrequent native grazing has occurred, which may have resulted in heavy defoliation, but was confined to small acreage and generally temporary in nature.

Drought cycles likely resulted in a reduction in vegetative cover, production and acreage of these sites. Drought negatively affected woody species (mean return interval of 100yrs).

Native Americans likely used these sites for camping and some vegetation collection, while hunting and gathering in adjacent wetlands. Humans likely caused heavy impacts to soils and vegetation in small campsites, but overall impact was light and transitory.

Adjacency or Identification Concerns

Found adjacent to wet meadows, wetlands, sagebrush uplands and salt desert shrublands. Sites adjacent to sagebrush uplands tended to burn more frequently than sites adjacent to wet or salt desert shrub.

Many of these sites were impacted by introduced grazing animals post-European settlement and have been converted to shrub dominated systems with soil compaction problems that tend toward an increase in tap-rooted forb species. Class D is found more frequently now, due to altered disturbance regimes with livestock grazing, changes in fire frequency, altered water flow and climate change.

Distinguishing these grasslands by floristics alone is challenging because the semi-desert grassland indicator species are common, widespread species. In addition, indicator species for the other grassland systems (Carex duriuscula, Carex filifolia, Danthonia intermedia, Danthonia parryi, Festuca arizonica, Festuca campestris, Festuca idahoensis, Festuca thurberi, Leucopoa kingii, Muhlenbergia filiculmis,

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Muhlenbergia montana and Nassella viridula) may be absent in degraded stands.

After inspection of a draft ESP map for MZ22, the intermingling of the 1135 and 1139 plots was suspect. However, it is thought that perhaps 1139 lies at higher elevations than 1135.

Native Uncharacteristic Conditions

Scale Description

These sites are generally small and often moist. Fire in these systems is usually introduced from adjacent shrublands or native burning to improve herbaceous understory.

Issues/Problems

The scale of historic fire is unknown and numbers provided are a guess.
All MZ22 modelers and reviewers were confused by this system and thought it did not occur in this map zone and that it certainly did not occur with the frequency to which it was assigned in this map zone.
Most did not think this type occurred in MZ22.

Comments

Model copied from MZ22 at MFSL by M.H. Weber on April 16, 2007. This model was adopted as-is from the same BpS from MZ28 created by Bob Unnasch and reviewed by Vic Ecklunch, Chuck Kostecka and an anonymous reviewer.

For MZ28, this is nearly identical to the model for the same BpS in mapping zones 16, 23 and 24. Minor species edits were made (Mike Babler, mbabler@tnc.org, 5/5/2005). Additional reviewers for mapping MZ18 were Mike Frary (mike_frary@blm.gov), Linda Kerr (linda_kerr@nps.gov) and Paul Langowski (plangowski@fs.fed.us).

This system is similar to the Great Basin Grassland (R2MGWAws) developed by Cheri Howell (chowell@fs.fed.us) and edited by Louis Provencher (lprovencher@tnc.org).

Vegetation Classes

Class A **5 %**

Early Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	Upper
ACHY	Upper
HECO26	Upper
	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Post fire, flood or drought early seral community. Bare ground is 10-30%.Total vegetative canopy cover is 0-25%. Relative forb cover is 10-40%. Relative graminoid cover is 60-90%. Shrub cover is minimal or non-existent.

Replacement fire (FRI of 75yrs) maintains the vegetation in A, whereas mixed severity fire (FRI of 37yrs), while occurring, does not change the successional age.

Rare flood events (mean return interval of 500-yr) move the vegetation to a more shrubby condition, class D,

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after downcutting.

Succession is from class A to B after two years.

Class B **70 %**

Mid Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	Upper
ACHY	Upper
HECO26	Upper
	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	80 %
Height	Herb 0.6m	Herb 1.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Mostly stable and resilient system. Bare ground is <10%. Total canopy cover is 25-80%. Relative cover of grasses is >85%. Relative cover of forbs is 0-5%. Relative cover of shrubs is 0-10%.

Replacement fire (mean FRI 75yrs) causes a transition to class A, whereas mixed severity (FRI of 37yrs), while active, does not affect the successional age of class B.

Weather and flooding affects this system in three different ways: 1) Recurring drought with a 100-yr return interval will thin vegetation and keep it open; 2) The site will be scoured, but not downcut, by 100-yr flood events causing a transition to class A; and 3) Rare 1000-yr flooding event will cause a downcut and alteration of the site towards a more permanent woody condition (class D).

Succession is from class B to C after 35yrs.

Class C **20 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	Lower
ACHY	Lower
HECO26	Upper
	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	80 %
Height	Shrub 1.1m	Shrub 3.0m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

ERNA10, or ARTRT 10-75%,ht 1-3m

Description

This system differs from mid-open by an increase in the shrub cover component. Bare ground is <10%. Total canopy cover is 50-80%. Relative cover of grasses is 25-50%. Relative cover of forbs is 0-5%. Relative cover of shrubs (most frequently rubber rabbitbrush and basin big sagebrush) is 10-75%.

The dynamics of class C are similar to those of class B, except that drought causes a transition to class B (not class A) through the thinning of shrubs - 50yrs. Flooding occurs every 100yrs, as in B, and causes a transition to A, as in B.

Class C, unlike class B, experiences infrequent native grazing (browsing, 1/1000 probability/yr) that will reduce woody vegetation and cause a transition to class B.

Replacement fire every 75yrs; mixed fire every 35yrs, causing a transition to B.

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This class persists.

Class D 5 %

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

BOGR2	Lower
ACHY	Lower
HECO26	Upper
	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	81 %	100 %
Height	Shrub 1.1m	Shrub 3.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This is a combination of a mid and late closed stage. (This class starts at age one because class A can transition to this class.) This system differs from mid-open by a significant increase in the shrub cover component. Bare ground is <20%. Total canopy cover can exceed 100% due to shrub dominance. Relative cover of grasses is <25%. Relative cover of forbs is 0-5%. Relative cover of shrubs (most frequently rubber rabbitbrush and basin big sagebrush) is >75%.

Replacement fire (FRI of 75yrs) and 100-yr flood event are the only disturbances causing a transition to class A. Mixed severity fire (average FRI of 37yrs) opens the stand, but maintain in a woody state (transition to class C).

Class D is likely <5%. This class persists.

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg 100
Min 1
Max 500

Sources of Fire Regime Data

- [x] Literature
- [x] Local Data
- [x] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	75	40	110	0.01333	33
Mixed	37	20	54	0.02703	67
Surface					
All Fires	25			0.04037	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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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Additional Disturbances Modeled

- [ ] Insects/Disease
- [x] Wind/Weather/Stress
- [x] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

***Biophysical Setting* 2911390** **Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland**

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

General Information

Contributors (also see the Comments field **Date** 11/12/2006

Modeler 1	Elena Contreras	econtreras@tnc.org	**Reviewer**	
Modeler 2			**Reviewer**	
Modeler 3			**Reviewer**	

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

PSSP6	LEKI2
FEID	SCHIZ4
FECA4	ELMA7
ACNE9	ELTR7

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Northern Rockies throughout MT, northern ID. May occupy river valleys, including the Salmon, Snake and Clearwater Rivers. Drier portions of this type will resemble bluebunch wheatgrass communities in Columbia Basin.

In MZ20, this system occurs along the western and southern borders, in NRCS's MLRA-46 Northern Rocky Mountain Foothills. - in subsections 331Da, 331Kj, eastern portion of 331Kh

This occurs around the fringes of the Wind River range (MZ22), the eastern bighorn foothills (MZ29), and the edges of the Ferris mtns (MZ 29). NatureServe states that this occurs around the edges of WindRivers and Bighorns.

Biophysical Site Description

This type occupies productive uplands below lower treeline or in small pockets where cold air drainage or shallow soils inhibit conifer growth, generally ranging from 1000-5000ft. In MZ20, elevation would be approximately 2200-5000ft.

Elevation and aspect affect the precipitation and temperature, due to changes in foothills slopes.

Vegetation Description

This type is dominated by rough fescue or bluebunch wheatgrass with Idaho fescue as a less dominant in MZ20 and rough fescue as dominant associates. Bluebunch wheatgrass is more prevalent in drier areas. When dominated by bluebunch wheatgrass, not as much canopy. Mueggler and Stewart (1980) have described these types as: Agsp/Posa, FEID/Agsp and Fesc/Agsp. Additional species include needle-and-

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thread grass and Sandberg bluegrass, and a variety of mesic forbs (eg, showy cinquefoil, sticky geranium, phlox, lupine and yarrow). In MZ20, very little phlox, needle-and-thread and Sandberg bluegrass. In MZ20, more stoneseed.

For MZ20, additional species include Columbia needlegrass, green needlegrass, slender wheatgrass, thickspike wheatgrass and little bluestem. More spike fescue in southern area near M332Dc. North end has rough fescue (around subsections 331Da, parts of 331Kh,I,j), but central and south don't have rough fescue. Central and south still have bluebunch and Idaho fescue (as does north).

Disturbance Description

This type has frequent replacement fires (fire regime group II). Most species in this type are fire adapted and respond favorably to these fire types.

Where these systems occur near forested ecosystems, fire frequency will be strongly influenced by the adjacent forest's fire regime (eg, 10-20yrs). Where these systems occur below lower treeline, fire frequencies may be longer (eg, 20-30yrs), for an overall average of between 10-30yrs. The literature in FEIS suggests a MFRI of between 10-30yrs for this type.

In MZ22, fires would likely start in adjacent forests and burn through this type slowly, because fuel loading is generally low. Fires in this system are likely highly influenced by adjacent types. Fires could have ranged in this system from 10 to 100s of yrs.

For MZ29, the FRI was chosen to be between that for MZ20, MZ21, MZ22: 20, 30, 66 respectively. An FRI of 35yrs was chosen.

It is thought that there could have been Native American fire influence in many valleys and therefore FRI might be approximately 15yrs. However, it was modeled at 20yrs for MZ20.

Bison impact was prominent in the late fall and summer periods, depending on precipitation patterns.

Mormon crickets, grasshoppers might have had more of an impact in this system than currently defined, but unsure of historic impact and frequency. Therefore, this was not modeled.

Drought also occurs in this BpS. Drought probably occurs less frequently than in BpS 1141 due to more consistent precipitation patterns, more snow and higher elevation.

Adjacency or Identification Concerns

This variant of the BpS for MZ20 is different from the other mapzones - ie: MZ19, as plant species differ and precipitation. Since this is a broad type, the dry bluebunch wheatgrass-needle and thread variant (in MZ20 it's a bluebunch wheatgrass-thickspike wheatgrass variant) will probably have more bareground and a slightly higher MFRI. Response to fire may differ slightly also, as needle-and-thread is more sensitive to fire.

Non-native species present today can include spotted knapweed, leafy spurge, Japanese brome, Kentucky and Canada bluegrass, timothy, smooth brome and hounds tongue.

Without fire and poor grazing management today, creeping juniper can invade this BpS.

In WY this is distinguished from northwest Great Plains mixedgrass prairie by 1) presence of Festuca

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idahoensis, 2) lack of Bouteloua gracilis, 3) presence of Carex rossii and 4) presence of Artemisia nova or Artemisia tripartita ssp. rupicola. In this case, it's not northwest Great Plains mixedgrass prairie; it's where northwest Great Plains mixedgrass is transitioning with PASSMI fingering up into foothills.

The foothill-montane would be the transitional system around the Pryors - between plains/grassland/shrubland transitioning into limber pine, Rocky Mountain juniper and lower elevation Douglas-fir. In BpS 1140, we're describing above treeline vegetation. So foothill/lowermontane would have a shorter FRI, and BpS 1140 subalpine would have a longer FRI.

Native Uncharacteristic Conditions

Unlikely to see bare ground in this BpS. Although herbaceous cover might not exceed 50%, the remainder is litter and/or rocks.

Scale Description

This type can occupy broad expanses and also narrow bands below the lower montane forest. In large valleys, fires may have been expansive historically, up to thousands of acres. In MZ20, there are no large valleys.

Issues/Problems

This is a highly variable type, which includes most of Mueggler and Stewart's habitat types. The Lewis and Clark range type classification needs to be incorporated into this model also.

Comments

This model for MZ29 was adapted from the same model from MZ20 modified by Jon Siddoway and reviewed by Peter Lesica, Marry Manning and Steve Barrett. FRI for MZ29 was changed slightly by regional lead, and some descriptive modifications were made.

This model for MZ20 was adapted from the model from the same BpS for MZ19 created by Katie Phillips, Randall Walker and Larry Kaiser and reviewed by Lois Olsen. For MZ20, descriptive and model additions and changes were made to better represent MZ20.

The model for MZs 10 and 19 are based on Rapid Assessment model R0MGRA by Mary Manning (mmanning@fs.fed.us) and reviewed by Eldon Rash (erash@fs.fed.us).

Vegetation Classes

Class A **10 %**

Early Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Description

Indicator Species* and Canopy Position

FECA4	Upper
PSSP6	Upper
ACNE9	Mid-Upper
LEKI2	Low-Mid

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

[x] Upper layer lifeform differs from dominant lifeform.

Shrubs might be present at 0-5% in some areas. Shrub species may include Potentilla freticosa, Artemisia tridentada (mountain big sagebrush supspecies), Symphorocarpus, fringed sagewort and mountain silver

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sagebrush (Artemisia cana). On shallow, silty sites, shrubs such as skunkbush sumac, creeping juniper and yucca are present.

Post fire, early seral community dominated by bunchgrasses and forbs. Herbs and forbs will generally have higher cover than pre-burn and may include astragalus, balsamroot, lupines, yarrow and Thermopsis rhombifolia. Wild onion might also come in after fire.

This was originally modeled as a three-box model in MZs 10 and 19 with a mid-development stage. However, it was changed to a two-box model, combining B and C, as it was suggested that recovery would be quick and could recover fully after three years with no mid-development stage. Therefore, there would be 0-20% cover from 1-3yrs, but after three years, 21-50% cover. It is thought that class percentages would be 10% in A and the rest in the late stage, B.

Cover ranges from 0-20%. In the absence of fire or heavy animal impact, this condition succeeds to a mid-late-development condition (class B). Age ranges from 0-3yrs. Idaho fescue may be present, but will recover more slowly than the bluebunch wheatgrass after fire. Idaho fescue might suffer mortality during the fire.

Drought affects seven percent of the class each year (occurs every 15yrs throughout class). Grazing affects 20% of the class each year (occurs every five years throughout class).

Replacement fire occurs every 35yrs (in MZ29, 35yrs was used, whereas 20yrs was used for MZ20).

Post-model-review for MZ20 suggested class A be 0-40% cover and B 41-60% cover.

Class B **90 %**

Mid Development 1 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

FECA4	Upper
PSSP6	Upper
FEID	Low-Mid
LEKI2	Low-Mid

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	21 %	50 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Bunchgrasses dominate with low densities of shrubs (10-15%) in some areas, particularly where this BpS transitions to shrub or tree-dominated communities. Shrubs might be present at 5-15% in some areas. Shrub species may include Potentilla freticosa, Artemisia tridentada (mountain big sagebrush supspecies), Symphorocarpus, fringed sagewort and mountain silver sagebrush (Artemisia cana). On shallow, silty sites, shrubs such as skunkbush sumac, creeping juniper and yucca are present.

Mid-late-development with moderate canopy closure dominated by bunchgrasses with forb cover generally higher than pre-burn. Typically lasts five years in a mid-stage, then moves to the final late stage. The late development stage has a closed canopy of grasses and forbs. Bunchgrasses dominate with low densities of

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**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 seve

shrubs (<15%) in some areas, particularly where this BpS transitions to shrub or tree-dominated communities. Shrub species may include Potentilla freticosa, Artemisia tridentada (mountain big sagebrush supspecies), Symphorocarpus, fringed sagewort and mountain silver sagebrush (Artemisia cana). On shallow, silty sites, shrubs such as skunkbush sumac, creeping juniper and yucca are present.

Typically, cover doesn't get much higher than 50% cover. Maximum height usually reaches approximately 0.75m.

Drought affects seven percent of the class each year (occurs every 15yrs throughout class). Grazing affects 20% of the class each year (occurs every five years throughout class).

Replacement fire occurs every 35yrs (in MZ29, 35yrs was used, whereas 20yrs was used for MZ20).

Post-model-review for MZ20 suggested class A be 0-40% cover and B 41-60% cover.

Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Disturbances

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

Fire Regime Group:** II

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- [x] Literature
- [ ] Local Data
- [x] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	35	10	100	0.02857	100
Mixed					
Surface					
All Fires	35			0.02859	

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 inver 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.

Additional Disturbances Modeled

- [ ] Insects/Disease
- [x] Wind/Weather/Stress
- [x] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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**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 seve

LANDFIRE Biophysical Setting Model

Biophysical Setting 2911400 **Northern Rocky Mountain Subalpine-Upper Montane Grassland**

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

General Information

Contributors (also see the Comments field **Date** 11/18/2005

Modeler 1	Steve Barrett	sbarrett@mtdig.net	**Reviewer**	Jeff DiBenedetto	jdibenedetto@fs.fed.us
Modeler 2	Elena Contreras	econtreras@tnc.org	**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

PSSP6 ACRI8
FEID KOMA
ASTER TRSP2
ERIOG ACOC3

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Northern ID, western MT and eastern WA. In MZ20, this system is very limited in extent. In MZ20, this probably only occurs in some of the more mountainous areas - ie: MLRA 43B Central Rocky Mountains, which corresponds to subsection M332Db, and just below Havre in 331Ka. This BpS might also be just creeping into MZ20 from the corners of MZ19, on the southwest corner of MZ20.
In MZ29, just in M331Ba - Bighorn, Pryor Mtns. This also occurs in MZ29 in the mountains near Casper, WY and in uplift southwest of Broadus, MT, bordering WY.

Biophysical Site Description

This is a high-elevation (>6000ft), dry grassland system dominated by perennial grasses and forbs. It might occur on all aspects, and not necessarily only dry sites. Subalpine grasslands are small meadows to large open parks surrounded by conifer trees but lack tree cover within them. In general soil textures are much finer, and soils are often deeper under grasslands than in the neighboring forests. Sites are often wind-swept, resulting in lack of snowpack and summer drought (Daubenmire 1981).

Vegetation Description

Typical dominant species include: Festuca idahoensis, Aster spp, Eriogonum spp, Lupinus spp, Xerophyllum tenax, and Deschampsia caespitosa (Deschampsia has been grazed out currently in many areas). Rough fescue is present in MZ20 but not in 29. Bluebunch also wouldn't be present in MZ20 - would occur on much drier slopes. Bluebunch is major co-dominant in MZ29 with Idaho fescue. Would also have junegrass and Sandberg bluegrass, and threadleaf sedge, Agropyron caninum in MZ29 as associated species. Would have Richardson's needlegrass, western needlegrass, Letterman's needlegrass. Also in MZs 20 and 29 - Balsamorhiza sagittata, Bromus marginatus, Carex spp, Geranium viscossimum

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and Geum triforum (mesic forbs).

Adjacent forest types would be limber pine, Douglas-fir and subalpine fir spruce, intermingled throughout. Grasslands intermingled within the mosaic of the conifers.

Disturbance Description

Fire regimes are probably similar to adjacent forested vegetation, and will generally be long interval, stand replacement regimes (Fire Regime Group IV). Fires may finger into this system from adjacent forests.

There is some question as to whether this should have a shorter fire return interval. However, some other mapzones modeled this system with a long FRI (150-300yrs in MZs 10 and 19), which is supported by the fact that it is a high elevation system with few trees, and it is described by NatureServe as "upper montane to subalpine, high-elevation, lush grassland system dominated by perennial grasses and forbs on dry sites… subalpine dry grasslands…" However, the low end of the MFRI range could go as low as 40yrs, given the inclusion of dry low-elevation grasses in this model, but the inclusion of moist-high elevation XETE definitely argues for a higher MFRI; so an overall 75yrs MFRI was chosen for MZ20 and therefore MZ29. This 75yr MFRI is similar to the MFRI chosen for MZ20's 1145 as well, since the range could vary greatly and due to both of the systems' ambiguous descriptions.

The foothill-montane 1139 would be the transitional system around the Pryors - between plains/grassland/shrubland transitioning into limber pine, Rocky Mountain Juniper and lower elevation Douglas-fir. In BpS 1140, we're describing above treeline. So foothill/lower montane would have a shorter FRI, and BpS 1140 subalpine would have a longer FRI.

Conifer encroachment is not common due to the droughty nature of these grasslands, but undoubtedly fire also plays some role in preventing conifer encroachment. This system is a climatic climax - site maintained grassland system.

Historically, sheep grazing probably occurred more frequently than currently. Some accounts of bison and elk grazing but unsure of extent.

Periodic drought could have impacted this system. Unsure of frequency.

Adjacency or Identification Concerns

This 1140 is a subalpine-upper montane, not the foothill/montane grassland in MZ29. The foothill-montane 1139 would be the transitional system around the Pryors - between plains/grassland/shrubland transitioning into limber pine, RM Juniper, lower elevation Douglas-fir. In BpS 1140, we're describing above treeline.

Adjacent forest types would be limber pine, Douglas- fir and subalpine fir spruce, intermingled throughout. Grasslands intermingled within the mosaic of the conifers.

This system could be confused with adjacent foothill grassland type and more open sagebrush systems.

1140 is also very similar to 1146, the southern version of this type. For MZs 29 and 30, reviewers considered just using 1140 and not 1146.

Current grazing is by cattle and sheep. Elk also graze currently in this system.

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This system would probably not seem departed from historical. However, encroachment might be occurring adjacent to forested stands - trees might be encroaching - Douglas-fir and limber pine, but this isn't occurring as much in subalpine limit. This might be occurring in upper montane elevation limit.

Timothy, Kentucky bluegrass and smooth brome are invaders in this system in MZs 20 and 29. Where these invasives occur, they take over.

Native Uncharacteristic Conditions

Taller than one meter grasses would be uncharacteristic.

Scale Description

Patches are typically tens to hundreds of acres.

Issues/Problems

Comments

This model for MZ29 was adapted from the same BpS for MZ20 created by Steve Barrett and reviewed by Jon Siddoway, Mary Manning and Steve Barrett. Descriptive additions and slight changes were made for MZ29.

This model for MZ20 was adapted from the same BpS from MZ19 created by Katie Phillips, Randall Walker and Larry Kaiser. Quantitative and descriptive changes were made to better fit the concept of this BpS, esp for the north central region; original modelers' names were still retained, as they created most of the model. For MZ20, descriptive additions and changes were made to better reflect MZ20 sites. Descriptive changes were made, including dominant species changes. Two of original modelers' names were retained, as most of the model was theirs (at request of MZ20 modeler).

For MZs 10 and 19, this model received no peer review.

Vegetation Classes

Class A **5 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 0

Indicator Species* and Canopy Position

PSSP6	Upper
FEID	Upper
ACOC3	Upper
BASA	Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Post-replacement disturbance conditions dominated by herbs and sprouting grasses including green fescue (not in MZ20), Idaho fescue, bluebunch wheatgrass (not in MZ20), Xerophyllum tenax (not in MZ20) or Epilobium spp. See Veg Description for species.

In MZ20, rough fescue would be present (not in MZ29).

This class succeeds to a late-development stage, class B, in four years.

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Class B 95 %

Late Development 1 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 0

Indicator Species* and Canopy Position

PSSP6	Upper
FEID	Upper
ACOC3	Upper
BASA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	100 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Closed herbaceous cover dominated by green fescue (not in MZ20), Idaho fescue, bluebunch wheatgrass (not in MZ20) and Xerophyllum tenax (not in MZ20). Low shrubs may be present, particularly mountain big sagebrush, Erigonum spp and Phlox spp. See Veg Description for species.

In MZ20, Rough fescue would be present (not in MZ29).

Replacement fire occurs every 75yrs.

Class C 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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**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 sev

Disturbances

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 20
Min 1
Max 100

Sources of Fire Regime Data

- [x] Literature
- [ ] Local Data
- [x] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	75	40	200	0.01333	100
Mixed					
Surface					
All Fires	75			0.01335	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

LANDFIRE Biophysical Setting Model

Biophysical Setting 2911410 **Northwestern Great Plains Mixedgrass Prairie**

☑ *This BPS is lumped with: 1150*

☐ *This BPS is split into multiple models:* *1150 Tallgrass Prairie was lumped into the Mixedgrass Prairies 1132 and 1141, as we don't want to map this 1150 BpS for these mapzones. We would have to have a "fine-tooth comb" to do as such. There are individual associations of tallgrass in extreme northeast Montana, but not tallgrass communities. We might have 1/4 acre of the plant associations - andropogon, halii, but not a whole system. The tiny inclusions of tallgrass would just be a portion of a mixedgrass community. If 1150 does occur in MZs 29 or 30, it might be in small, small areas, and it might not be able to be mapped. Tallgrass communities are in MZs 39 and 40. In MZs 29 and 30 only in small microsites - some species but not much. There is not tallgrass prairie west of the Missouri River historically.*

General Information

Contributors (also see the Comments field **Date** 4/6/2006

Modeler 1	Shannon Downey	sdowney@blm.gov	**Reviewer**	Steve VanFossen	Steve.VanFossen@mt.usda.gov
Modeler 2	Steve Cooper	scooper@mt.gov	**Reviewer**	Brian Martin	bmartin@tnc.org
Modeler 3	Jeff DiBenedetto	jdibenedetto@fs.fed.us	**Reviewer**	Jon Siddoway	jon.siddoway@mt.usda.gov

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

PSSP6 SCSC
NAVI4 KOMA
PASM POSE
HECOC8 BOGR2

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This vegetation group covers the northern prairies east of the Rocky Mountains from north central MT to southeastern MT and northeastern WY.

This BpS occurs in every section throughout the MZ20. It occurs predominantly in subsections 331Dh (central and eastern portion) and 331La.

Subsection 331La coincides quite closely to the Brown Central Glaciated Plains MLRA52, as defined by the NRCS. The central and eastern part of 331Dh coincides with Northern Glaciated Plains MLRA. Also - MLRA 58a includes southeastern MT. This BpS also resides in MLRA53A Northern Dark Brown Glaciated Plains, Northern Rolling High Plains, MLRAs 58A,B,C,D, and Pierre Shale Plains, MLRAs 60A and 60B.

This system's extent also coincides with EPA Ecoregions Level III and IV, 42-Northern Glaciated Plains,

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43n-Montana Central Grasslands, 43m-Judith Basin Grasslands, 43o-Montana Unglaciated high Plains, and 43a-Missouri High Plateau (Woods et al 2002).

Historically, this BpS could also have extended throughout the subsections for 331Kb,most of d, f and e; in present, it might be more of a shrub community.

This BpS occurs in every subsection throughout the MZ29 and 30. It occurs predominantly depending on soil types and precipitation zones. It typically does not occur within mountain subsections. Mixedgrass prairie is the dominant vegetation type in the Northern Great Plains Steppe Ecoregion.

For the lump of 1150 Tallgrass Prairie with this type (1141): we would "have to have a fine-tooth comb" to map tallgrass prairie in these mapzones. There are individual associations in extreme northeast MT, but not tallgrass communities. There might be 1/4 acre of plant associations, but not a whole system. It is thought that Tallgrass Prairie 1150 system occurs mostly in Eastern Dakotas and NE, and maybe just small areas north of the Black Hills. This will not be found in the western part of MZ30, rather only the eastern part of MZ30 in small patches.

Biophysical Site Description

Elevations range from 1900-4000ft, or up to 6500ft in MZ29. The continental climate entails long cold winters, hot summers with low humidity and strong winds between November through April.

The northwestern part of this BpS is characterized by Chinook winds in winter commonly resulting in "red belt mortality" in adjacent coniferous forests (Van Fossen, pers comm).

Mean annual precipitation is generally 10-15in with most falling as rain or snow from April through June. The western part of this BpS is characterized by C3-cool-season plants and the eastern part of the BpS has an increase in abundance of C4-warm season plants, almost to the point of dominance in the plant community.

Occurs ubiquitously across soil types, except alkaline flats. Kinds, amounts and proportions of plants vary widely relative to soil texture, soil depth, percent slope and aspect. Bunchgrass communities dominate on shallow soils. Mid, short and bunchgrass communities comprise the remainder.

Topography is level to sloping.

Reviewers of this model (B.J. Rhodes, Bill Volk and John Carlson) for MZ20 stated that this system resides in the soil survey studies done by NRCS, and that their original modeling for this effort relied heavily on the Ecological Site Descriptions for MLRA 52 (USDA-NRCS 2004), 58A, 60B (USDA-NRCS 2003). However, MLRA 52 is dominantly deep, well drained clay loam, clay and loam textures, whereas MLRA 58A and 60B have a significant component of moderately deep and shallow silt loam, silty clay loam and loam soils (Van Fossen, pers comm). It has been suggested by one reviewer that Glaciated Plains be separated from Northern Rolling High Plains. However, this model was not split as such.

In terms of the tallgrass prairie 1150 (B. Martin): This BpS occurs in little depressional areas with greater than 16in precipitation in the area, in riparian stringers. It is too dry in MZs 29 and 30 for this type to occur but rarely.

Vegetation Description

The vegetation is dominated by cool and warm season perennial grasses (50-85% canopy cover). Grama

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grasses, rhizomatous grasses (western and thickspike wheatgrass, etc.) dominate the visual aspect of the community, though bunchgrasses (bluebunch wheatgrass, needle grasses, etc.) often comprised more than 50% of the community composition.

The timing of precipitation/precipitation flushes that occur in mid-June through mid-July, as one moves from west to east geographically, result in warm season grasses that are more prominent than cool season grasses. As go further east and north, MT and ND have a more typic ustic moisture regime and frigid temperature regimes. As one moves further west, there is a more aridic ustic frigid temperature regime. SD is more typic ustic; mesic as one moves further south (WY, south SD), due to latitudinal gradients and changes in elevation. Western (MLRA52) versus Eastern (MLRA53) Glaciated Plains: typic ustic - capture timing of precipitation changes. Eastern captures more warm season grasses, including, side oats grama, little bluestem, sand bluestem in sandy areas, big bluestem and prairie sandreed.

Thickspike wheatgrass (Elymus macrourus) (on lighter soils) and western wheatgrass (on heavier soils) are also present. CALO can also be a dominant species. Idaho fescue is a community dominant in MZ29 where precipitation is greater than 17in (Ashland Ranger District). Prairie sandreed and upland sedges occupy sandy textured soils throughout MZs 29 and 30. Bluebunch wheatgrass is more prevalent within WY and eastern MT in MZ29. Bluebunch only occurs on shallow sites, and occurs more on the west. Bluebunch more in MZ20 vs MZ29.

Carex filifolia also present, but not that prominent.

A diverse array of perennial summer forbs (black samson, scurfpea, prairieclovers, flax, dotted gayfeather, scarlet globemallow, etc.) occupy 10% of the community.

Shrubs and sub-shrubs (Wyoming big sagebrush, silver sagebrush, rabbitbrush, fringed sagewort, western snowberry, etc.) obtain less than five percent cover. Most of the ground surface is covered and bare ground is <10% on more mesic sites and 20% on more xeric sites (e.g. glacial till and claypan soils).

The most common shrub is silver sagebrush which resprouts after fire.

In pre-European conditions, there was a component of this BpS that had significant prairie dog impact and was characterized by broom snakeweed, prairie sagewort, sixweeks fescue and plains pricklypear.

Current conditions are different - please see Identification Concerns or Issues/Problems boxes.

In terms of the 1150 Tallgrass Prairie: The dominant grass is switchgrass. Big bluestem only occurs in Sidney, MT. Might have 1/4ac of plant associations Andropogon or Halii, but not whole system.

Disturbance Description

Grazing by large, concentrated herds of ungulates (bison, elk, pronghorn and deer) along with aboriginal and natural fire maintained healthy, productive and diverse grasslands. (This grazing regime is referred to as "Native Grazing" in the VDDT model.) Such grazing may have resulted in heavy defoliation and/or some soil churning, but was transitory. Temporary impact followed by rest-recovery time is characteristic. A reviewer stated that ungulate grazing might have limited the potential for replacement fires at times, as there might have been significant areas that couldn't carry a fire for very long periods of time. However, this comment was not integrated into the model.

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A small portion of the landscape was subjected to repeated or prolonged heavy animal impact, including heavy defoliation and repeated soil churning and/or compaction. Such areas included watering points for herds, bison or elk wallows, and prairie dog towns. This heavy animal impact disturbance was modeled as "Optional2" in the VDDT model and includes its impacts in its own class. Repetitive heavy animal impact sends the community to an alternative open successional pathway. This small prairie-dog impacted portion of the landscape was also characterized by different grasses (see Veg Description).

Periodic grazing and replacement fire, when it occurred in an intact community, resulted in removal of most of the above-ground biomass, but resulted in little mortality and relatively rapid recovery times.

Because MLRA 52 versus MLRA 58A and 60B are physiographically different enough due to soils, etc., response to fire might change in different areas of the map zone (VanFossen, pers comm).

Historically, the fire return interval averaged 8-12yrs for the region, but naturally occurring fuel breaks on slopes and badlands probably lengthened the mean interval. Fire-scarred tree-rings from areas within and adjacent to the northern Great Plains provide intervals within the 0-35yr range over the past 500yrs (Henderson 2005).

Fuel load recovery times are an alternative means by which to estimate the minimum average return interval for grassland fires, though this approach has not been formally attempted. A general decrease in productivity of ungrazed northern mixed-grass prairie is reported for 1-3yrs post-burn, and litter loads may take 11-16yrs to completely recover (as per various studies) (Henderson 2005). The total standing crop of fuel, combining both current year production and litter, is capable of recovering to pre-burn conditions in 4-8yrs (Shay et al. 2001). Theoretically, for repeated fires to occur without altering long-term grassland productivity and species composition, the mean return interval should be eight years or greater (Henderson 2005).

Given a minimum return interval of 0.5yrs, mode of 8yrs, and 95% probability of a fire occurring within 35yrs, the resulting right-skewed distribution makes possible return intervals >35yrs but probably never longer than 100yrs (Henderson 2005).

A negative exponential distribution probably best describes the historic fire size distribution, with a large number <1ha, median 10-100ha, mean 1000-10000ha and a low frequency of 50,000-1,000,000ha (Henderson 2005).

Grazing and prairie dog towns also reduced fuel loads and fire frequency, size and intensity; with the most substantial impacts in valley bottom shrublands and grasslands, and upland grasslands near water. Historically, the majority of human caused ignitions were concentrated in spring and fall seasons, while lightning-caused fires were concentrated in late summer. However, in the north central part of MT, in MZ20, lightning ignitions outside of the mountains are not primarily a late summer phenomenon, but rather, late spring and early to mid-summer phenomenon (not much happening after the end of July). Ignitions occur prior to green-up. If fall storms occur with lightning, those will also cause fires - and are often associated with heavy winds.

The prairie dogs towns would have shifted slightly over long periods of time – becoming more flammable when the dogs move away (or periodically decrease). At their largest expansion periods, prairie dogs would have occupied up to 80% of their potential habitat. So, this would have had, periodically, a huge effect on ungulate grazing, fire and, probably, soil hydrology changes as they change with litter and dominant species (Lata, pers comm).

The absence of grazing and replacement fire for many years (eg, 50yrs) would lead to an increased shrub component (snowberry and green ash) in precipitation zones greater than 14in, and a buildup of dead grass. (Buildups of litter generally result in decreased diversity and lower basal area of remaining grass plants.) Within 10-14in precipitation zones, Wyoming big sagebrush and silver sagebrush may also increase. Productivity of the grasses is decreased, resulting in greater mortality from smoldering fire.

Mormon crickets, grasshoppers and great plains locust might have had more of an impact in this system than currently defined, but unsure of historic impact and frequency (Siddoway).

Drought also occurs somewhat frequently. Some modelers felt it occurred every 30yrs, and some believed it occurred every five years. Short term precipitation variability may also influence species productivity. Drought periodicities centering around 58yrs were characteristic of southeast MT and eastern WY for the last ~300yrs. A 22yr rhythm was characteristic from 1892 to 1977, but less clear for the time between 1801 and 1889 and did not occur in 1714 to 1801. Ten or more years without drought in any of the four study areas occurred once or twice per century (Stockton and Meko 1983). In a Northern Great Plains HRV draft study by Judy von Ahlefeldt states that the frequency of droughts was greater then five years in length for 2-300yrs (Weakley 1943).

Adjacency or Identification Concerns

Areas with similar soils but steeper topography (>15%) are less productive and have a higher dominance of shrubs.

The natural grazing regime has been replaced with domestic livestock grazing that is targeted toward "moderate" grazing intensity. This is often characterized by grazing each year with removal of herbage over an extended period of the growing season without adequate rest and recovery from grazing. This is contrasted with the expected historic shorter, episodic grazing patterns. One result is more structural homogeneity. Under this grazing regime, taller, palatable grasses such as green needlegrass and bluebunch wheatgrass decrease, and short grasses (western wheatgrass, needle and thread grass, blue grama and Sandberg bluegrass) increase. Also under this grazing regime, litter may increase (depending on precipitation and intensity of grazing) with the expected results of decreased diversity and decreased vigor of remaining grasses. Only under season long grazing will warm-season grasses like little bluestem decrease. Season of use and/or twice-over grazing will impact the prevalence of little bluestem and other C4 plants.

Shrubs (Wyoming big sagebrush, silver sagebrush, western snowberry, rabbitbrush and fringed sagewort) increase greatly over the historic plant community. Compare the ecological site description to avoid using a shrub model for historic plant community when considering a grass site that has changed as a result of uncharacteristic grazing or unnaturally long fire return intervals. Unnaturally long intervals without fire may contribute to an increased shrub component (shrubs might include Opuntia spp and Yucca spp in NE). Xeric sites will experience an increase in sagebrush, whereas western snowberry will increase in mesic areas.

In modern times, invasive grasses such as smooth brome (only in small areas), Poa pratensis, crested wheatgrass, Kentucky bluegrass (Kentucky bluegrass and Poa pratensis only in small areas) have become widely established in some areas and are locally abundant and expanding. Other invasive species of concern include spotted, diffuse and Russian knapweeds, often along roads and stream corridors; leafy

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spurge and Canadian thistle, along stream corridors; yellow sweetclover; dalmation toadflax; and annual bromes, including Japanese brome. Dense clubmoss stands are also a problem in this class, as is blue grama - limiting productivity and diversity in this system.

Long-term high intensity grazing by domestic livestock without periods of rest and recovery can result in a conversion in the vegetation states from a mid-grass dominated community to shortgrass dominated communities (blue grama, sedges, Sandberg bluegrass, buffalograss in southern portions, and junegrass). This should be distinguished from the succession class (class B) that's influenced more by presence of prairie dog towns - which have a higher forb component with less of a midgrass component than the other classes. In species composition, the prairie dog versus domestic grazed communities, are very different.

In current conditions, there has also been an increase in the amount of woody vegetation on the plains, particularly increases in snowberry on mesic sites and expansion of ponderosa pine into grasslands and shrublands which were probably maintained in a grassland state under historic fire frequencies. The lack of fire has shifted grassland systems to shrublands or woodlands.

The expansion of ponderosa pine and shrubs, including snowberry, yucca and prickly pear is noticeable, but more so (at least for these species) in the eastern portion of MZs 29 and 30.

This BpS may be similar to the PNVG R4PRMGn from the Northern Plains model zone. Reviewers (Rhodes, Volk and Adams) of this model felt that the Northern Great Plains shrubland might have been a subcomponent of this BpS that was historically limited to less productive soil types, and with a much longer fire cycle. However, other reviewers (VanFossen, pers comm) disagreed with that statement and stated that silver sagebrush, in particular, is and has been a natural component of deep, well-drained, productive soils.

In MZ20, historically, this BpS could also have extended throughout the subsections for 331K; in present, 331Kb, most of d, f and e might be more of a shrub community. Big sagebrush is more susceptible to fire and so probably less prevalent historically.

There could well have been areas that were surrounded by prairie dog towns and protected from fire in that way historically. As per Clarke McClung, it occurs as such in NE (Lata, pers comm).

There might be places, as there are further south and east of MZs 29 and 30, that now have crested wheatgrass as a major component, as it was heavily seeded in the 1930s (Lata, pers comm).

There is more woody species invasion further east. At 20in precipitation, deciduous trees invade from the draws. If an area is not burned, it will lose the prairie. In eastern ND and SD, there are trees that will invade the prairie systems if they remain unburned. (The preceeding refers to the tallgrass prairie, which is almost all agriculture now. Much of the mixedgrass prairie is converted to agriculture as well.). That wouldn't occur in the west as much. Trees would be restricted to the microclimate situation or in draws (Martin, pers comm).

When thinking about similarity or departure from historic or uncharacteristic communities at landscape levels, the following situations might be useful to check mapping results against classification and model logic. The major influences on current vegetation composition and structure in the Great Plains are (diBenedetto, pers comm):
1) Conversion of grassland/shrublands to cropland (uncharacteristic types)

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2) Introduction of introduced species, primarily crested wheatgrass, annual bromes, smooth brome etc., and yellow sweetclover (uncharacteristic type)

3) Shift from mid-grass dominated grassland communities to short-grass dominated communities through season long heavy grazing (departure from historic condition, if percentage is outside range of variability. Prairie dog towns would fit into this category. This dynamic can be a response to long-term periodic drought as well (departure from historic range). The mid-grass to short grass change is a shift that has occurred historically in response to fluctuating climate (drought, above normal precipitation cycles) and grazing intensity/recovery. More may be in short-grass, under current intensive pastoral grazing systems vs. migratory grazing patterns that occurred historically. Grazing would shift mid-grass communities to short-grass dominated communities. (Bison may or may not have influenced this, but season long heavy livestock grazing seems to cause this shift.) So a high percentage of the landscape in short-grass, versus mid-grass would indicate a departure.

4) Shift from grassland communities to forest, wooded or shrub dominated communities in absence of fire (departure or uncharacteristic for grass BpS). This may be a key shift that has occurred or is occurring on the Great Plains along with conversion of rangeland to cropland and planting of exotic grass species (CRP lands). This is probably more meaningful in terms of fire disturbance relationships than the short-grass, mid-grass shift.

With the exception of areas occupied by prairie dog towns, the characteristic late successional communities should be dominated by mid-grass dominated plant communities. Tall grass dominated communities would only occur as unmapped inclusions associated with topo-edaphic positions. Tall grass dominated communities include those dominated by prairie sandreed, big bluestem and prairie cordgrass.

DISTINGUISHING BTWN 1132 AND 1141:
This would be difficult to distinguish from BpS 1132. 1132 has more tallgrass species that wouldn't grow in MT, however. Dominant species in 1132, however, as listed by NatureServe, are dominants in many other systems (Martin, pers comm).

There are slight nuances of the models of 1141 and 1132 that distinguish them, but they are inconsequential in terms of the FRI and percentages within classes and general functioning of the model. Nuances are due to differing modelers and perspective of disturbances.

The central mixed-grass prairie is not well defined but in general is a transition area between the tall grass prairie and mixed grass prairie. There is higher precipitation and taller grasses than in 1141. There are more shrubby species. 1141 is further west. And has ARTR2, whereas 1132 has more chokecherry/sumac.

This BpS is easily confused with Central mixed grass prairie (BpS 1132). Main difference is 1132 has higher moisture regime, more tall grass plants, and lack of fire results in more shrubs and trees.

This wouldn't function differently than 1132. And it wouldn't key out differently (Cooper, pers comm). The only way you might be able to tell this apart is by geography. 1141 is further west. Also - chokecherry and sumac in 1132 versus ARTR2 in 1141.

Productivity might be lower in 1141 - soils generally not quite as deep, less rain and probably less litter build up as well, although the higher moisture in 1132 would allow litter to decompose at a faster rate

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(Lata, pers comm).

Native Uncharacteristic Conditions

With lack of fire, increased shrub or tree cover would be uncharacteristic.

Scale Description

Historically, natural grazing and fire generally encompassed hundreds to hundreds of thousands of acres. Repeated heavy animal impact such as prairie dog towns occurred at the scale of 10s-1000s of acres, as well as ungulate impacts - bison.

A negative exponential distribution probably best describes the historic fire size distribution, with a large number <1ha, median 10-100ha, mean 1000-10,000ha, a low frequency of 50,000-1,000,000ha and rare outliers >1,000,000ha (Henderson 2005).

Issues/Problems

This BpS covers a large diverse area with relatively little extensive data or published studies for vegetation classification. Fire frequency is based primarily on inference based on understanding of the plant community dynamics and anecdotes or historical research (mostly oral histories) regarding Native American burning.

Due to issues with mapping grass systems and separating out successional classes by height and cover of grasses, this model has been reduced to a two-box model.

Comments

Model for MZs 29, 20 and 30 was originally adapted from RA model R0PGRn created by Shannon Downey. Model for MZ20 was originally modeled with five boxes - by Shannon Downey and Steve Cooper. However, during a review session, reviewers (BJ Rhodes, John Carlson, Rich Adams and Bill Volk) suggested changes and changed this model to a three-box model. Agreement and input was received from the original modelers. Subsequent review of this model for an adjacent MZ by modelers (Jeff DiBenedetto, Brian Martin, Cody Wienk, George Soehn and Bobby Baker) led to adoption of a different three-box model. After agreement from original modelers and reviewers, this last three-box model is the one that was used for MZ20. Because the original five-box and other three-box models originally developed, were abandoned, the details and the changes are not detailed here. Subsequent to succession class review for MZ20, model for MZs 29 and 30 was changed based on mapping constraints. Therefore, model for MZs 29 and 30, is different than that for MZ20 in succession class proportions, age ranges and cover/height and boxes. Other reviewers for MZs 29 and 30 were Shannon Downey, Jeff Jones, Steve Cooper and Mary Lata.

Other reviewers for this model for MZ20 were Steve Barrett, Mary Manning (USFS), Steve VanFossen (NRCS) and Jon Siddoway (NRCS).

Vegetation Classes

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Class A 25 %

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

PASM	Upper
HECO26	Upper
BOGR2	Upper
ARFR	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Herb 0m	Herb 0.5m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Class A is the post-fire early-seral stage, combined with the very short-stature vegetation resulting from prairie dog disturbance or repeated high intensity herbivory or trampling (eg, watering points or buffalo wallows).

This class may also be a short term response to severe drought, combined with other impacts (Optional 1 - modeled as occurring very infrequently - 0.001 probability, but causing a transition all the way back to the beginning). (NOTE: Previously, in MZ20, this class was defined as just a prairie dog stage with the herbivory/trampling and severe drought components -and defined as a class B instead of A. But due to mapping constraints and inability of mapping to distinguish grass species and grass heights at a fine level, and therefore a prairie dog stage versus an early successional or mid successional stage, all early post-replacement and very short stage grasses were placed into this class A.)

A variety of forb species such as fetid marigold, scarlet globemallow and curlycup gumweed tend to dominate this class. Common grass species include purple three-awn, buffalo grass, Sandberg bluegrass, blue grama and western wheatgras. Fringed sagebrush can also be a component of this class.

Also - this represents the immediate post-disturbance intact historic plant community functioning under grazing and/or fire, dominated by cool and warm season rhihzomatous perennial grasses, as well as bunchgrasses. Little bluestem, prairie sandreed and bluebunch wheatgrass occur as dominant species in small patches. Other species in this class are Artemisia, grama grasses, western yarrow and prairie junegrass. Other species might include blue grama and western yarrow. STIPA, PSSP6 and SCSC might also be indicators.

Due to the combination of the prairie dog stage (indicator species: BOGR2, POSE, ARFR vand DYPA) and the early successional stage (indicator species: PASM, NAVI4, HECO26 and BOGR2), the indicator species were combined for this class.

Because this is the post-fire early regeneration stage, or a prairie dog stage, this is generally a short grass functional group which are communities dominated by species such as: poas, dryland sedges, blue grama, buffalograss, clubmoss, junegrass and forbs either singly or in combination. It may also be characterized by higher bare soil. This might be a shortgrass EVT. A higher proportion of this class on the landscape today would indicate departure.

This class lasts approximately three years. If in a prairie dog state, then the class would last longer in order to transition out of it; however, this is accounted for, by having a prairie dog disturbance in the model, resetting succession and keeping it in this class. The three year interval attempts to capture what would happen post-fire or post-drought. (Also - post-heavy-grazing in current conditions would take longer to transition out of this class.)

Native grazing (bison, prognhorn and prairie dog) can be locally heavy due to increased succulence of young

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grasses. This occurs on 20% of this class each year, keeping it in this stage. This was split 50/50 between native grazing and Optional 2, prairie dog grazing. Prairie dog grazing takes this stage back to the beginning, whereas grazing just occurs without causing a transition.

Drought can occur every 30yrs, not causing a transition.

Replacement fire occurs but not as frequently, due to lack of fuel, every 20yrs.

(Note about identifying in current conditions: Long-term high intensity grazing by domestic livestock without periods of rest and recovery can result in a conversion in the vegetation states from a mid-grass dominated community to shortgrass dominated communities (blue grama, sedges, Sandberg bluegrass, buffalograss in southern portions and junegrass). This is different in species composition than a prairie dog community. However, for LANDFIRE mapping purposes, it is not possible to distinguish between the different types of short grasses occurring.)

Prairie dog disease is also a potential impact, but because the prairie dog stage was combined with early succession, this disturbance was not modeled for MZs 29 and 30.

It is thought that a prairie dog class should comprise approximately 5-8% of the landscape, and no more than 10% (Dan Uresk, pers comm). Research for historical Northern Great Plains vegetation would have prairie dog communities within an early successional stage of max 10-15% across an entire landscape. So only a portion of the early successional stage would be a prairie-dog-type community - ie: maybe 5-8%.

Class B 75 %

Mid Development 1 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

PASM	Upper
NAVI4	Upper
HECO26	Upper
BOGR2	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	90 %
Height	Herb 0m	Herb 1.0m
Tree Size Class		

- [x] Upper layer lifeform differs from dominant lifeform.

Shrub species could be present with approximately 0-10% cover. Common shrubs - silver sagebrush, winterfat, fringe sagewort and rubber rabbitbrush. Less common would be skunkbush sumac, mostly on slopes and shallow soils.

Description

Class B represents the intact historic plant community functioning under grazing and/or fire, dominated by taller, cool and warm season rhihzomatous perennial grasses, as well as bunchgrasses. This is the all-encompassing mid-late-development, functioning fine stage.

This model was originally created as a three-box model; however, post-succession class review for an adjacent mapzone, resulted in a decision to change the model to a more simpler version for LF mapping constraints.

Little bluestem, prairie sandreed and bluebunch wheatgrass occur as dominant species in small patches. Other species in this class are Artemisia, grama grasses, western yarrow and prairie junegrass. Other species might include blue grama and western yarrow. STIPA, PSSP6 and SCSC might also be indicators.

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Little below-ground mortality occurs after replacement fire, and resprouting of perennial grasses and forbs often occurs within days or weeks, depending on season. Grasses show greater vigor; some forb establishment may occur as a result of exposure of mineral soil. Canopy cover recovers quickly after resprouting.

Shrub species could be present at 0-10% cover. Silver sagebrush and winterfat (on deeper soils) are the most common shrub, and would start resprouting. Wyoming big sagebrush can also be a component (on shallower soils) of this BpS, although a small component.

Clubmoss might be present in Glaciated Plains at 0-5% cover, but not on shallow clay sites or dense clay sites, sands, saline upland, saline lowland, subirrigated or wet meadow.

Replacement fire occurs every 5-15yrs.

Drought occurs every 30yrs and maintains this stage. A reviewer felt that drought occurred more often, every five years, but because most wanted to model it at 30yrs, it was left as such.

Native grazing by large ungulates could have occurred, inlcuding bison grazing. It is likely heavy locally due to increased succulence of young grasses. It might occur with a probability of 0.2 (every five years, or 20% of this class each year).

Native grazing by prairie dogs could also occur on a small portion of the landscape (0.001 probability of 0.1% of this class), bringing this state to A.

Optional 1 was also modeled, which includes a combination of disturbances of drought, native bison grazing and a small amount of fire (not enough to be its own category). When all of these disturbances occur in concurrence, you might get a transition to the short-stature A-class type community. This occurs on a small portion of the landscape (0.001 probability of 0.1% of this class).

Insect/disease occurs very infrequently with a probability of 0.0001. It has been suggested that grasshoppers and Mormon crickets might have a larger impact historically than the probability assigned here. However, unsure of impact and frequency.

With a lack of fire, this class might shift to having more shrubs and tree invasion.

Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☑ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

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Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** II

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	13	2	40	0.07692	100
Mixed					
Surface					
All Fires	13			0.07694	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

☑ Insects/Disease
☑ Native Grazing
☑ Other (optional 1) drought+native bison grazing + small fire portion
☑ Wind/Weather/Stress
☐ Competition
☑ Other (optional 2) prairie dog grazing

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911440** **Rocky Mountain Alpine Turf**

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

General Information

Contributors (also see the Comments field **Date** 3/6/2006

Modeler 1	Jim Ozenberger	jozenberger@fs.fed.us	**Reviewer**	Kim Reid	kreid@fs.fed.us
Modeler 2	Andy Norman	anorman@fs.fed.us	**Reviewer**		
Modeler 3	Rod Dykehouse	rdykehouse@fs.fed.us	**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

CASC10 FEID
CAEL3 DECA18
CANA2 GERO2
CARU3 KOMY

General Model Sources

☐ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

This widespread ecological system occurs above upper timberline throughout the Rocky Mountain cordillera, including alpine areas of ranges in UT and NV, and north into Canada. It also occurs above upper timberline throughout the Bighorn Mountains of northcentral WY. A minor component above timberline occurs in the Pryor Mountains of southcentral MT. This system would only occur at the absolute highest sites in MZ29, in very scarce areas - probably not mappable.

Biophysical Site Description

The alpine belt is above timberline (approximately >3000m) and below the permanent snow level (<4500m). Found on gentle to moderately slopes, flat ridges, valleys and basins, where the soil has become relatively stabilized and the water supply is more or less constant.

Vegetation Description

This system is characterized by a dense cover of low-growing, perennial graminoids and forbs. Rhizomatous, sod-forming sedges are the dominant graminoids, and prostrate and mat-forming plants with thick rootstocks or taproots characterize the forbs. Dominant species include Artemisia spp (ARAR9 in MZ21), Carex elymoides, (Carex siccata in MZ21), Carex scirpoidea, Carex nardina, Carex rupestris, Deschampsia caespitosa, (Festuca brachyphylla in MZ21), Festuca idahoensis, Geum rosii (Bighorn Mtns) or Geum trifolium (Pryor Mtns), Kobresia myosuroides, Phlox pulvinata, and Trifolium dasyphyllum. Although alpine tundra dry meadow is the matrix of the alpine zone, it typically intermingles with alpine bedrock and scree, ice field, fell-field, alpine dwarf-shrubland and alpine/subalpine wet meadow systems. (Dominant species differ between MZ21 and MZ29.)

Disturbance Description

Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost and a short

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growing season. Dry summers associated with major drought years (mean return interval of 100yrs) would favor grasses over forbs, whereas wet summers cause a more diverse mixture of forbs and graminoids.

Avalanches on steeper slopes, where soil accumulated can cause infrequent soil-slips, expose bare ground. Avalanches were modeled as occurring once every 1000yrs in the mid-development stage (class B).

Very small burns (replacement fire) of a few square meters caused by lightning strikes were included as a rare disturbance, although lightning storms are frequent in those elevations. The calculation of lightning strikes frequency was not based on fire return intervals, but on the number of strikes (in this case five) per 1000 possible locations per year, thus 0.005.

Fires are not a significant disturbance in this BpS. It is thought to be approximately 500yrs or more and modeled as such. Fire frequency is insignificant enough in MZ21 alpine BpSs that all alpine BpSs could be combined based on fire frequency; however, the alpine BpSs do have different species composition and biophysical gradients; therefore, the alpine types were not combined.

Native herbivores (Rocky Mountain bighorn sheep, mule deer and elk) were common in the alpine but probably did not greatly affect vegetation cover because animals move frequently as they reduce vegetation cover. Native grazing was not included in the model.

Adjacency or Identification Concerns

Many experts assert that the alpine will be one of the more threatened community types by global climate change in the coming decades. With climate change, the treeline is moving up in elevation. Invasive species are typically not a concern in these types.

Native Uncharacteristic Conditions

Scale Description

This ecological system can occupy large areas of the alpine. Patch size varies from a few acres to 1000ac on mountain ridges and tops. Stand-replacement fires may be caused by lightning strikes that do not spread due to the sparse cover of fine fuel and extensive barren areas acting as fire breaks.

Issues/Problems

There is no data on fire, effects of lightning strikes or recovery time after stand-replacing events.

Comments

This model for MZ29 was adopted from the same BpS from MZ21 created by Jim Ozenberger, Andy Norman and Rod Dykehouse and reviewed by Sara Canham, Brenda Fiddick and an anonymous reviewer. Small descriptive changes were made, but the model did not change. Kim Reid made descriptive changes for MZ29 and is therefore listed as the reviewer.

The model for MZ21 was adapted from the models from MZs 19, 10, 18 and 16, created by Louis Provencher (lprovencher@tnc.org). However, FRI for those mapzones' models was modeled at 200yrs instead of 500yrs as per class description. Reviewers for MZ21 all agreed that FRI should be at least 500yrs. Therefore, a new model has been developed for MZ21 and used for MZ29.

For MZ19, this model was adopted as-is from MZs 16 and 18.

Input to the model for MZs 16 and 18 was based on discussion with Kimball Harper (retired USFS

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scientist; UT), an alpine specialist of the Utah High Plateau.

Vegetation Classes

Class A 5 %

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

CAREX	Upper
DECA18	Upper
FEID	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Very exposed (barren) state following a lightning strike. Soil (not rock) may dominate the area. Grasses are more common than forbs. (FEBR is an indicator in MZ21.) Succession to class B after three years.

NOTE - This class was originally modeled with canopy closure of 0-10%. However, because we cannot map a class with less than 10% canopy cover, as that would map as sparsely vegetated, the canopy cover was increased to 20%.

Class B 95 %

Late Development 1 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

CAREX	Upper
DECA18	Upper
GERO2	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	30 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Alpine community is dominated by graminoids and herbaceous perennials and few low-growing shrubs. Plant cover may vary from two percent on exposed sites to as much as 25% on mesic and more protected sites. (ARAR9 in MZ21 is an indicator.)

Infrequent replacement fire in the form of lighting strikes (mean FRI of 500yrs), severe summer droughts (mean return interval of 100yrs) and rare avalanches on stepper slopes with soil (once in 1000yrs) cause a transition to class A.

NOTE - This class was originally modeled with canopy closure of 11-30%. However, because we could not map canopy cover in class A as 0-10%, the cover amounts were changed to abide by the mapping rules. This class cover was therefore modeled with 21-30%, even though cover could be much lower. It is questionable as to whether this BpS should really only have a one-box model.

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Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Disturbances

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 1
Min 1
Max 1

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	500			0.002	99
Mixed					
Surface					
All Fires	500			0.00202	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting 2911450 **Rocky Mountain Subalpine-Montane Mesic Meadow**

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

General Information

Contributors (also see the Comments field **Date** 11/1/2006

Modeler 1	Jeff DiBenedetto	jdibenedetto@fs.fed.us	**Reviewer**	Kim Reid	kreid@fs.fed.us
Modeler 2			**Reviewer**	Eldon Rash	erash@fs.fed.us
Modeler 3			**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

ERIGE2	LUPIN
MERTE	SOLID
PENST	DECA18
CAMPA	CAREX

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Found in the Rocky Mountains, restricted to the subalpine zone typically above 3000m in the southern part, 1500m in the north. These tall forb systems are scattered throughout the Bighorn and Pryor Mountains of MZ29. Uncommon in Pryor Mountains.

Biophysical Site Description

Finely textured soils. Snow deposition, wind swept dry conditions limit tree establishment. On gentle to moderate gradient slopes. Soils seasonally moist in spring, and might occassionally dry out later in the growing season. Deep and poorly drained, higher elevation valley bottoms and other flat areas commonly flooded in spring and by early summer snowmelt. Elevations between 6000-9000ft.

This is a forb-dominated, lush wet system.

Vegetation Description

Vegetation is typically forb-rich (more currently than historically), with forbs contributing more to overall herbaceous cover than graminoids. Important taxa include Agastache urticifolia, (Chamerion angustifolium in MZ21), Erigeron spp, Senecio spp, Helianthella spp, Mertensia spp, Penstemon spp, Campanula spp, Hackelia spp, Lupinus spp, Solidago spp, Ligusticum spp, Osmorhiza spp, Thalictrum spp, Valeriana spp, Veratrum spp, Delphinium spp, Aconitum spp and Wyethia amplexicaulis.

Graminoids are Deschampsia caespitosa, Carex spp and Juncus spp, Danthonia intermedia and Phleum alpinum.

Disturbance Description

Fires are primarily replacement and occur at rotations related to adjacent vegetation. Where near

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mountain big sagebrush, this may be 135yrs (MZ21 original modelers), and where near lodgepole pine, this may be 300yrs, which represents the MZ21 minimum and maximum intervals, respectively. (These intervals were questioned by some MZ21 reviewers.) The ignition source is generally not in this type and could possibly be associated with native burning in the fall and spring, but spreads from adjacent shrub or tree dominated sites, such as mountain big sagebrush, lodgepole pine and aspen.

In MZ29, this would also be adjacent to mountain big sagebrush, lodgepole, subalpine fir, spruce and Douglas-fir.

Also, in MZ21, because fire was assumed to occur in the fall and spring when the summer's green and wet biomass would be dead and cured, replacement fire has little effect on annual tall forbs themselves. Fires would affect encroaching shrubs. In MZ21, fire occurrence would primarily be concentrated to the fall burning season due to narrower growing season at higher elevation fringes. Meadows only approach burning conditions in extreme drought or late season at higher elevation.

In MZ29, fire occurrence would primarily be concentrated to the fall burning season due to narrower growing season at higher elevation fringes.

FRI should be similar to adjacent forest type, but then a bit less frequent, because this is a bit wetter.

Hailstorms are another disturbance in this system, although this is questionable.

Fire intervals (less fire) for MZ21 were originally decreased approximately 7x (from 30yrs to 200yrs). After an extensive model review process, LANDFIRE leadership/guidance determined that the original modelers for MZ21 used an interpretation of the fire information available that did not represent the majority expert opinion/interpretation of the fire literature. The original MZ21 model was therefore altered to reflect majority opinion/interpretation of literature regarding the fire regime of this system and that used in MZs 10, 19 and 23. A FRI of 40yrs replacement fire was used. Mixed fire was removed from the model adapted from MZs 10 and 19 due to a new understanding of severity types.

During review for MZ20, this frequent fire return interval of 40yrs MFRI was questioned. Multiple other models (in the Great Basin and MZs 10 and 19) used a frequent FRI, as this type occurs in mosaics with woodlands and dense shrublands. It is doubtful, however, that mesic, forbaceous meadows at about 3000m would have MFRIs of less than 150-300yrs, in contrast to the Great Basin's model and FRI of 40yrs. If this type is primarily a high elevation, subalpine wet-forb community (ie, MZs 10 and 19 description says >3000m--which would be too high for the Northern Rockies, where it would be more like 2000-3000m), a 150-200yr MFRI would likely apply. However, if this type is a lower montane-to-subalpine type (as per NatureServe (NS) description), a lower MFRI could apply. MZ20 decided to go with a model with a 75-100yr MFRI (using 85yr MFRI as a midpoint), since NS's description called for more of that type of an MFRI as opposed to the high-high elevation, which would not occur in the north-central region (Barrett, pers comm). Also - this 85yr MFRI is similar to the MFRI chosen for MZ20's 1140 as well, since the range could vary greatly and due to both of the systems' ambiguous descriptions. MZ29 also adopted MZ20's reasoning.

Moreover, the general absence of frequently fire-scarred trees adjacent to high elevation mesic meadows suggests that the BpS likely has fire frequencies similar to the adjacent tree'd landscape (Barrett, pers comm). The MFRI depends on the size of these meadows and fuel load of adjacent veg presumably conifer forest. If the meadow is larger, it might act as a fire break and not completely burn. It depends on the moisture in the meadow and fuel load. Determining one value for an MFRI will be difficult - will depend on size of meadow, landscape position and associated valley type, surrounding vegetation type, patterns of fuel build-up, moisture, density and type of meadow - wet, dry, forb dominated, sedge dominated, moss dominated, etc. (Manning, pers comm).

Burrowing mammals can increase density.

Adjacency or Identification Concerns

This BpS could be confused with low forb/alpine shrub communities. Often adjacent to aspen/tall forb communities, mountain big sagebrush/tall forb communities and upper montane/subalpine spruce-fir communities.

Different from 1140 Montane Subalpine Grassland - this BpS doesn't have wheatgrass or Idaho fescue.

With heavy grazing these sites can convert to undesirable forbs and grasses such as Cirsium spp (thistle), Galium spp (bedstraw), Helenium hoopesii (Orange sneezeweed), Polygonum spp (knotweed), Rumex spp (sorrel or dock), Taraxacum officinale (dandelion), Madia glomerata (mountain tarweed), Descurainia spp.(tansymustard), Poa pratensis (Kentucky bluegrass), Agrostis exarata (bentgrass), Dactylis glomerata (orchardgrass), Bromus inermis (smooth brome), Bromus tectorum (cheatgrass) and Poa bulbosa (bulbous bluegrass). Roads and trails can impact these sites.

Deschampsia probably significantly reduced due to livestock grazing (Mueggler and Stewart re: DECA/CAREX h.t.)

Due to grazing, higher forb and less grass component (so is departed), it would appear departed if looking at it on the ground. Structure might not appear departed, however. It would be difficult to show departure in this system via remote sensing. Biomass would be similar between grasses and forbs. Composition would change, but biomass may not.

In MZ29, there is some invasion of spotted knapweed, Centaurea biebersteinii, dalmatian toadflax and Linaria Dalmatica, which can occur along recreational use activity corridors.

Expansion of Douglas-fir along the perimeter of the habitat has produced some encroachment in MZ21.

Native Uncharacteristic Conditions

Grasses over one meter would be very uncharacteristic.

Scale Description

In MZ29, they range in size from less than ten acres to 150ac. In MZ21, larger meadows are present in the Absaroka-Beartooth Range in the 500-1000ac range in a few areas, noted in Yellowstone National Park as Big Game Ridge, Chicken Ridge, Pitchstone Plateau and Two Ocean Plateau.

Issues/Problems

There is not much information about this type.

Comments

For MZ29, this model was adapted from the model for the same BpS in MZ21 but used MZ20 FRI. MZ21 model adopted from 10,19 created by Cherie Howell and Julia Richardson. Reviewers for MZ21 were Bill Romme, Jim Ozenberger, Andy Norman and Dave Tart. MZ20 additional modelers/reviewers were Steve

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Barrett and Mary Manning. MZ29 altered successional class boxes to better represent the system. MZ29 used MZ20's FRI.

For MZ21, this model was adapted from the LANDFIRE model for the same BpS 1145 in MZs 10 and 19 created by by Cherie Howell (chowell02@fs.fed.us) and Julia Richardson (jrichardson@fs.fed.us) and reviewed by Nathan Williamson (Nathan_Williamson@nps.gov), Vic Ecklund (vecklund@csu.org) and Chuck Kostecka (kostecka@webaccess.net). For MZ21, edits were made to the description, class percentages and model, and major changes were made to fire return intervals. FRI were lengthened (less fire) approximately 7x the original models. Changes to original model and description changed by original MZ21 modelers: John Simons (john_simons@blm.gov), Tim Klukas (tim_klukas@nps.gov) and an anonymous contributor. Reviewers for MZ21 were Bill Romme, Jim Ozenberger, Andy Norman, Sarah Canham (scanham@fs.fed.us) Brenda Fiddick (bfiddick@fs.fed.us) and Dave Tart. After an extensive model review process, LANDFIRE leadership/guidance determined that the original modelers used an interpretation of the fire information available that did not represent the majority expert opinion/interpretation of the fire literature. The original MZ21 model was therefore altered to reflect majority opinion/interpretation of literature regarding the fire regime of this system and that used in MZs 10,19 and 23, with some revisions based on a new understanding of severity definitions; therefore, original modeler names from MZs 10 and 19 were retained. Mixed fire was removed from the model by regional lead.

For MZs 10 and 19, this is nearly identical to the model for the same BpS in MZs 16, 23, 24 and 28. The model was reviewed for MZs 10 and 19 by Mary Manning (mmanning@fs.fed.us). Minor edits were made to the description for MZs 10 and 19.

Vegetation Classes

Class A **5 %**

Early Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

ERIGE2	Upper
LUPIN	Upper
DECA18	Upper
CAREX	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Vegetation is typically forb-rich (currently more than historically), with forbs contributing more to overall herbaceous cover than graminoids. Succession to class B after three years.

Fire spread would occur in late summer to early fall. Removal of dead biomass would be highly variable, but in these early development meadows, fire would also remove dead annual forbs. Replacement fire occurs every 85yrs.

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Class B 95 %

Mid Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

ERIGE2 Upper
LUPIN Upper
DECA18 Upper
CAREX Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Herb 0.6m	Herb 1.0m
Tree Size Class	None	

[x] Upper layer lifeform differs from dominant lifeform.

Shrubs may be present, but will be less than five cover and less than 0.5m.

Herbs 0-100% cover with a minimum height of 0.6m, and a maximum of 1.0m.

As per new direction from MFSL, the dominant lifeform is in the structural data boxes, as opposed to the upper layer lifeform.

Description

Vegetation is typically forb-rich (currently more than historically), with forbs contributing more to overall herbaceous cover than graminoids. Some shrub species might be present - less than five percent cover and less than 0.5 m.

Replacement fire removes shrubs and occurs every 85yrs.

Class C removed from MZ29 model, as it seemed to be moving into a different BpS with this C description.

Both historically and currently, you'd probably have 95% in this stage. The difference/departure today is due to livestock grazing affecting species composition. Shift from grass dominance to forb dominance.

Class C 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

[ ] Upper layer lifeform differs from dominant lifeform.

Description

Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

[ ] Upper layer lifeform differs from dominant lifeform.

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**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 sev

Description

Class E **0 %**

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Disturbances

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 50
Min 1
Max 250

Sources of Fire Regime Data

☑ Literature
☑ Local Data
☑ Expert Estimate

Fire Intervals	*Avg FI*	*Min FI*	*Max FI*	*Probability*	*Percent of All Fires*
Replacement	85	30	200	0.01176	100
Mixed					
Surface					
All Fires	85			0.01178	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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**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 sev

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911460** **Southern Rocky Mountain Montane-Subalpine Grassland**

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

General Information

Contributors (also see the Comments field **Date** 9/1/2006

Modeler 1	Kathy Roche	kroche@fs.fed.us	**Reviewer**	Steve Cooper	scooper@mt.gov
Modeler 2			**Reviewer**	Jim Von Loh	jvonlon@e2m.net
Modeler 3			**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Dominant Species*

FESTU DAPA2
FETH FEID
FEAR2
MUMO

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Geographic Range

This BpS occurs in northern AZ, southern and northern NM, southern CO, UT's Rocky Mountains and some parts of WY maybe.

For MZ29: this occurs in the southernmost areas of MZ29, which is a transitional region between southern Rocky Mountain floristics to northern Rocky Mountain floristics. Reviewers are uncomfortable calling subalpine grasslands in the Laramie Range "southern Rocky Mountains". This system will be very uncommon. Several reviewers for MZs 29 and 30 felt that this type did not occur in MZ29 or 30 (Eldon Rash). It is thought that this type occurs on the west side of MZ29 (Laramie Peak Range) and the eastern edge of MZ22 and probably in the north-central to slightly northwest part of MZ29 in the dome of the Black Hills.

Biophysical Site Description

This Rocky Mountain ecological system typically occurs between 2200-3000m on flat to rolling plains and parks or on lower sideslopes that are dry, but it may extend up to 3350m on warm aspects. Soils resemble prairie soils in that the A-horizon is dark brown, relatively high in organic matter, slightly acidic and usually well-drained.

This subalpine grassland occurs in "parks" where there is both finer textured soils, different snow accumulation patterns and "frost pockets" that all combine to limit trees.

Vegetation Description

This BpS usually consists of a mosaic of two or three plant communities with one of the following dominant bunch grasses: Danthonia intermedia, Danthonia parryi, Festuca idahoensis, Festuca arizonica,

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Festuca thurberi, Muhlenbergia filiculmis and Pseudoroegneria spicata, or various sedges (Carex spp) in moist (concave) sites. The subdominants include Muhlenbergia montana, Boutela gracilis and Poa secunda. These large-patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole pine, ponderosa pine and aspen forest. Festuca kingii (HESKIN?) might be a major component as well in MZ29.

In MZ29 in Bighorns, Pryors, FEID is the most common grass.

Disturbance Description

For MZs 23 and 24, fire regime group II was chosen. MZs 23 and 24 modelers state that the predicted historic stand replacement fire regime is approximately 20-60yrs, based upon historic photographic analysis, personal communication (Barry Johnston, USFS Region 2) and inference from mean/max and min fire regimes of adjacent forest types (PIPO 3-12yr, ABCO/PSMEG 14-46yr, PIEN/ABLAA 60-180yr+). Anthropogenic (pre-European) fire use ignitions may have occurred every 5-15yrs. The current regime is greater than 60yrs in montane and 100years in subalpine systems.

For MZ29, FRG IV was chosen. MZ29 modelers state that fire return interval is strongly controlled by the surrounding forest and by aspect and fits the disturbance description for 291140 the Northern Subalpine Grass system. Therefore, the FRI was chosen at 75yrs overall replacement fire. (MZs 23 and 24 had an overall FRI of 10yrs, with 20yr replacement and 20yr surface/low severity. Reviewers for MZ29 disagreed with this.) It seems to take a long time for enough fuel (biomass) to build up after a replacement fire for there to be much chance of another one in less than 60-100yrs. Many of these areas are snow covered during the WY "early fire season" when the grasses cure out at the lower elevations and many of these areas can have frost during any part of the year --making the fine fuel moisture recovery reduce fire starts and fire spread.

Adjacency or Identification Concerns

In MZ29, this is almost the same as BpS 1140 the northern version.

Montane grasslands are very similar and intergrade with their subalpine counterparts, but are separated to represent those species that do not occur at higher altitudes.

This subalpine grassland might be difficult to distinguish from the montane grassland. There is a montane grassland that occurs below the mountain shrubs in elevation and below the forest zone, then there is this subalpine grassland that occurs intermingled with the higher elevation forests but not above the timberline (it is separate from alpine grass/tundra). The subalpine grassland occurs in "parks" where there is both finer textured soils, different snow accumulation patterns and "frost pockets" that all combine to limit trees. The grasses are generally shorter and where taller, less continuous than in the lower elevation grassland.

This would be difficult to distinguish from pure alpine sites/systems. This system might also be confused with a mountain big sagebrush type, because if the mountain big sagebrush type burns, it will look like this type and have the same species as in this type. So - the seral condition of 1126: mountain big sagebrush will be difficult to distinguish. This could also be confused with the Wyoming Basins Low Sagebrush shrubland when the low sagebrush burns, as it will appear to be this system as well, at least while the low sagebrush is in early stage.

Increase in Poa secunda currently versus historically. Clumps of Idaho fescue become smaller and smaller until die out, then converts to the Danthonia and Poa secunda. But still in same system.

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Sheep and cattle in this system currently. Heavy grazing now. System not adapted to that. So - loss of fescue. Bluebunch wheatgrass is a decreaser species in this system also, in addition to FEID.

Kentucky bluegrass is a big increaser in these sites - in areas with a little excess moisture, but Kentucky bluegrass is still in this system. Although - these species are taking over. (the bluegrass increase is not necessarily seen in MZ29.) Smooth brome is also an increaser in the montane areas. Timothy (Phleum pratensi) is also an increaser and an exotic in this system - especially where there are horses.

This system will probably not appear departed, however, when looking from a satellite or looking at cover/height.

Native Uncharacteristic Conditions

Scale Description

Type occurs in large patches of 100-1000ac.

Issues/Problems

Comments

This model for MZ29 was adapted from the same BpS from MZ23 created by Wayne Robbie and Louis Provencher. Model was changed for MZ29 to fit more in line with reality for that area. Slight quantitative changes/FRI made for MZ29.

This model for MZ23 is identical to the model for the same BpS in MZ16 (Utah High Plateaus) and did not receive any peer review for MZs 23 and 24. This model is based on the Rapid Assessment PNVG R3MGRA developed by Wayne A. Robbie (wrobbie@fs.fed.us). Model was used as-is and description adapted to conform with Utah High Plateau and the NatureServe definition for Southern Rocky Mountain Montane - Subalpine Grassland. Reviewer of R3MGRA was Bill Baker (bakerwl@uwyo.edu).

Review of this type noted that there is insufficient information to distinguish fire regimes for all the variants of this type in the Southwest and Southern Rockies. The following are other grassland types that belong in here: Anthonia parryi, Muhlenbergia montana, Festuca idahoensis, Agropyron spicatum and Deschampsia cespitosa. There is little or no scientific basis for estimating fire intervals for this type.

Vegetation Classes

Class A 5 %

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

FETH	Upper
FEAR2	Upper
ANPA	Upper
ERFO	Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Low cover and frequency of Thurber fescue (FETH), Arizona fescue (FEAR2), sheep fescue (FEOV), mountain muhly (MUMO), timber/Parry's oatgrass (DAIN/DAPA), Kentucky bluegrass (POPR) and nodding brome (BRAN); tufted hairgrass (DECE) and various sedges (CAREX spp) in moist (concave) sites. BLTR is

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common. Replacement fire occurs with a mean FRI of 75yrs. Succession to class B after five years.

Class B 10 %

Mid Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

FETH	Upper
DAPA2	Upper
FEAR2	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	60 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Thurber fescue (FETH), Arizona fescue (FEAR2), sheep fescue (FEOV), mountain muhly (MUMO), timber/Parry's oatgrass (DAIN/DAPA), Kentucky bluegrass (POPR) and nodding brome (BRAN); tufted hairgrass (DECE) and various sedges (CAREX spp) in moist (concave) sites. Replacement fire occurs every 75yrs on average. Succession to class C after five years.

Class C 85 %

Late Development 1 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

FETH	Upper
FEAR2	Upper
DAPA2	Upper
MUMO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	61 %	100 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Thurber fescue (FETH), Arizona fescue (FEAR2), sheep fescue (FEOV), mountain muhly (MUMO), timber/Parry's oatgrass (DAIN/DAPA), Kentucky bluegrass (POPR) and nodding brome (BRAN); tufted hairgrass (DECE) and various sedges (CAREX spp) in moist (concave) sites. Replacement fire (mean FRI of 75yrs). Competition maintains vegetation structure (0.01 prob/yr).

Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	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 500
Min 10
Max 1000

Sources of Fire Regime Data

☑ Literature
☐ Local Data
☐ Expert Estimate

Fire Intervals

	Avg FI	*Min FI*	*Max FI*	*Probability*	*Percent of All Fires*
Replacement	75	10	100	0.01333	100
Mixed					
Surface					
All Fires	75			0.01335	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911470** **Western Great Plains Foothill and Piedmont Grassland**

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

General Information

Contributors (also see the Comments field **Date** 11/1/2006

Modeler 1	Elena Contreras	econtreras@tnc.org	**Reviewer**	Eldon Rash	erash@fs.fed.us
Modeler 2			**Reviewer**	Kathy Roche	kroche@fs.fed.us
Modeler 3			**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

BOGR2 MUMO
SCHIZ4 PASM
BUDA HECO26
NAVI4 SPCR

General Model Sources

☑ Literature
☐ Local Data
☐ Expert Estimate

Geographic Range

Occurs in the southern Great Plains, in southern CO and eastern NM.
It is questionable whether this occurs in MZs 29 and 30. It could be on the front range with cool season species, but it's aggregated with other grass types. It could occur in the Wolf Mtns - 331Gf, 331Kf - in between these. This is more of a Colorado Front Range type with sandy soils. If it occurs anywhere, it might be in MZ30 331Fb.

This primarily occurs in MZ33 in SE WY, along the bluffs. It also occurs in the southern portions of MZ29, but isn't going to be common. It could also occur along the western boundary of MZ29 in the Laramie Peak Range.

Biophysical Site Description

This type typically occurs on plains and draws, or on gently rolling uplands of the southern Great Plains. In NM and CO, elevations range from 1600-2200m (5250-7200ft). Precipitation ranges from 12-14in and occurs predominantly during the summer.

Vegetation Description

Wolf Mountains has Idaho fescue and bluebunch.

This type typically occurs on the rolling uplands of the Great Plains. Vegetation is mid and short grass dominated little bluestem, blue grama, buffalo grass and needle-and-thread, with intermingled forbs and scattered half-shrubs. This type correlates with Kuchler's (1964) types 65, 66, 67, 68.

Disturbance Description

Return interval for fire could be extended by ungulate grazing. Episodic disturbance caused by insect

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infestation (grasshoppers, range caterpillars and Mormon crickets) occurred. Insects could also extend the fire return interval.

This system was historically grazed by bison, now grazed by cows for the most part.

Periodic drought can also change fire return intervals. First fire return interval decreases as drought occurs then lengthens as drought continues and less biomass is produced.

This type was modeled with an overall FRI of 10yrs - question as to whether this is too short. Also there should not be any mixed fire in this type, as it is a grassland model, it should all be replacement fire. Regional lead removed mixed fire.

Adjacency or Identification Concerns

Higher elevation sites of this type borders the juniper steppe type. This also borders cottonwood riparian in places and mountain shrublands - mostly sagebrush in others.

If this is adjacent to juniper, then juniper invasion of the grasslands would be an uncharacteristic condition.

Also - cheatgrass occurs.

There would probably be lower canopy cover today from season long, yearly grazing of cows combined with high stocking of deer and elk. Bison grazing was probably more intermittent and likely to vary from year to year.

Native Uncharacteristic Conditions

There would probably be lower canopy cover today from season long, yearly grazing of cows combined with high stocking of deer and elk. Bison grazing was probably more intermittent and likely to vary from year to year.

Scale Description

This would occur in small patches in MZs 29 and 30, if at all.

Along the western border of MZ29, this occurs in patches of 10s to 1,000s of acres.

Issues/Problems

Comments

This model for MZs 29 and 30 was adopted from the same BpS from MZ28 created by Gale Green and Wayne Robbie and reviewed by Vic Ecklund and Chuck Kostecka. Regional lead, however, made model fixes to abide by mapping rules and a new understanding of severity types.

This model is based on the Rapid Assessment model R3PGRs, which was reviewed by B. Baker (bakerwl@wyo.edu). FRCC model PGRA4 was the original model. Review suggested one model for all plains grasslands. Because of species composition differences, and class differences, 1147 and 1149 were not combined.

Final QA/QCof the RA model resulted in the elimination of a VDDT rule violation, and changed the resulting amount in classes B and C by 5% (Pohl, 8/17/2005).

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Vegetation Classes

Class A 5 %

Early Development 1 All Structure

Indicator Species* and Canopy Position

BOGR2	All
BUDA	All

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Dominated by resprouts and seedlings of grasses and post-fire associated forbs. Low to medium height with variable canopy cover. This type typically occurs where fires burn relatively hot in classes B and C.

This class was originally modeled in MZ28 with cover of 0-10%. However, due to mapping rules, it was changed to 0-20% for MZs 29 and 30.

This class succeeds to C after four years. It can also succeed to B as an alternative successional pathway (0.01 probability).

Replacement fire occurs every 15yrs. Mixed fire was originally modeled for MZ28; however, it was removed for MZs 29 and 30, due to a new understanding of lack of mixed fire in grassland systems.

Class B 25 %

Mid Development 1 Closed

Indicator Species* and Canopy Position

BOGR2	Upper
BUDA	Upper
SCHIZ4	Upper

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	70 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Greater than 35% herb cover. Generally associated with more productive soils, but can be caused by cumulative high moisture seasons increasing the cover and productivity of class C. Low to medium height.

This class can persist.

Mixed fire was originally modeled for MZ28; however, it was removed for MZs 29 and 30, due to a new understanding of lack of mixed fire in grassland systems. Replacement fire occurs every 15yrs keeping in this class. Replacement fire also occurs every 100yrs bringing this class back to A, and replacement fire every 100yrs bringing to C. Wind/weather stress (drought) occurs every 13yrs, or affects 7.5% of this class each year.

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Class C **70 %**

Mid Development 1 Open

Indicator Species* and Canopy Position

BOGR2 Upper
BUDA Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	30 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☑ Herbaceous
☐ Shrub
☐ Tree

Fuel Model 1

Description

Less than 35% herb cover. Generally associated with less productive cobbly and gravelly soils, but can also be caused by cumulative drought shifting class B to this class. Low to medium height.

This class was originally modeled in MZ28 with cover of 11-30%. However, due to mapping rules, it was changed to 21-30% for MZs 29 and 30.

Alternate successional pathway without fire for 20yrs, brings this class to B.

Mixed fire was originally modeled for MZ28; however, it was removed for MZs 29 and 30, due to a new understanding of lack of mixed fire in grassland systems. Replacement fire every 100yrs bringing to A. Replacement fire every 12yrs not causing a transition.

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Disturbances

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

Fire Regime Group:** II

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- [x] Literature
- [ ] Local Data
- [ ] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	12	2	35	0.08333	100
Mixed					
Surface					
All Fires	12			0.08335	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- [ ] Insects/Disease
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

LANDFIRE Biophysical Setting Model

***Biophysical Setting* 2911480 Western Great Plains Sand Prairie**

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

General Information

Contributors (also see the Comments field **Date** 4/6/2006

Modeler 1	Peter Lesica	peter.lesica@mso.umt.edu	**Reviewer**	Steve Cooper	scooper@mt.gov
Modeler 2	Vinita Shea	vinita_shea@blm.gov	**Reviewer**	Jim Von Loh	jvonloh@e2m.net
Modeler 3	Ben Pratt	ben_pratt@fws.gov	**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

CALO SPCR
SCSC
BOGR2
HECO26

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Predominantly the eastern portion of MZ20. Also found in scattered pockets elswhere throught the zone. It probably occurs on the Charles Russel National Wildlife Refuge. In 331Kf, this might occur.

In MZs 29 and 30, more of this type than in MZ20 because more sandstone and sandy soils. Mostly only in MZ30. About 30K acres (guesstimate) maybe found in the southern portion of MZ29. Occurs around Broadus and Ekalaka. Medicine Rocks State Park almost all sand prairie. 331Kf, in 331Gf and d. Occurs in Little Missouri Grasslands in Dakotas.

There are good classification data and local descriptions of this type for Theodore Roosevelt National Park near Medora, ND as part of the USGS-NPS Vegetation Mapping Program (Jim Von Loh, pers comm).

Biophysical Site Description

This BpS would be found in NRCS's sand type or the Sandy Ecological site description. Occurs around sandstone outcrops.

Lower productivity on these sandy sites versus the mixedgrass prairie sites.

Vegetation Description

Dominant vegetation includes prairie sandreed (Calamovilfa longifolia), little bluestem (Schizachyrium scoparium), blue grama (Bouteloua gracilis), needle-and-thread grass (Stipa comata) and sand dropseed (Sporobolus cryptandrus). Shrubs seen may include horizontal juniper (Juniperus horizontalis), silver sagebrush (Artemisia cana) and skunkbrush (Rhus trilobata). Further east (not in MZ20), BOHI2 and

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ANHA might occur.

It's uncommon to find Wyoming big sagebrush, and when you do - it's usually Wyoming big sagebrush with bluebunch wheatgrass or needle-and-thread grass, that you would find on a sandy soil. The sagebrush in this type is usually silver sagebrush. It would be unusual to have more than 10-15% shrub cover except in the case of Juniperus horizontalis, where cover can go up to 80% or more.

Disturbance Description

Fire, grazing and drought were the primary disturbances. Disturbances were cyclic with the earliest and latest seral stages fluctuating widely in accordance with changes in climate.

The principal large grazer of the system was most likely bison (Bison bison) which, when occurring in large numbers, would have locally disturbed large areas due both to grazing impact and physical disturbances such as trampling and wallowing. Grazing impacts are more pronounced near water and removed from steep, rough terrain. Overall the whole system would have been frequently impacted by large ungulate grazers.

Prairie dogs might have been a very minor component of the system. Where they occurred, prairie dogs grazed vegetation close to the ground which provided a local firebreak. It is questionable, however, as to whether prairie dogs prefer sandy soil and actually occurred here. It is thought that prairie dogs would not occur on these sandy sites and rather they usually occur on fixe textured soils.

Fire was a frequent and widespread occurence. The most extensive fires are likely to have occurred in years with wet springs followed by hot, dry summers when grazing pressure was low. Wet springs would have resulted in more productive and more continuous plant cover (ie, fuel) that would have supported and expanded fires ignited under dry conditions occurring later in the season. In addition, litter accumulation over several fire-free years would also have supported widespread fire, in any conditions. The litter component, a determining factor in fire size and frequency, is correlated with seral stage. Three to five fire-free years produce enough litter to carry another fire. Post-fire shifts in species composition depend on the timing and condition of fire. It is also speculated that native burning might have been an influence in this BpS.

Fire regime similar to adjacent grassland.

Extended periods of severe drought is likely to have affected both species composition and the stability of the sandy soil, particularly when compounded by wind and heavy grazing. Droughts could affect the entire region.

Adjacency or Identification Concerns

Northwestern Plains Mixed Grass Prairie systems are often found nearby, especially in the western portion of the zone. The sand prairie, however, occurs on the sandy sites. You should identify this system by sandy/soil types.

Pine savanna is sometimes at top of these sandy sites. Trees on northerly or easterly slopes, might be looking at sandy outcrop. Portion of upper slope might be associated with sand prairie. Top will be mapped to pine savanna or woodland.

The disturbance regime has been drastically changed since European settlement. Agriculture replaced bison and fires have been effectively suppressed.

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Bromus much less prevalent on sandy soils than on mixedgrass prairie, but does occur. There aren't any invasives for this system that are particularly an issue.

It is uncommon to find Wyoming big sagebrush, and when you do - it's usually Wyoming big sagebrush with bluebunch wheatgrass or needle-and-thread, that you would find on a sandy soil. The sagebrush in this type is usually silver sagebrush. It would be unusual to have more than 10-15% shrub cover except in the case of Juniperus horizontalis, where cover can go up to 80% or more.

This system is much less departed than 1141. This system is probably not very far departed from the HRV, if at all.

Native Uncharacteristic Conditions

Over 60% cover herbaceous would be uncharacteristic… probably wouldn't be a sandy site anymore. Herb height also wouldn't be over one meter.

Scale Description

This is generally a patch that occurs within the larger northwestern Great Plains mixed grass. Size probably varies widely, but is generally going to be 10s of thousands of acres in MZ29 at the large side versus hundreds of acres or less in MZ20.

In terms of disturbance impact, in MZ20, entire patches are going to be impacted, whereas it will vary to an unknown level in MZ29.

Issues/Problems

Very little data are available from presettlement times.

Comments

This model for MZs 29 and 30 was adapted from the same BpS from MZ20 created by Peter Lesica, Vinita Shea, Ben Pratt and reviewed by Steve Barrett and Brian Martin.

This model for MZ20 was adapted from the Rapid Assessment model R4NESP Nebraska Sandhills Prairie created by Tom Bragg (tbragg@mail.unomaha.edu), Mary Lata (mlata@fs.fed.us) and Dave Shadis (dshadis@fs.fed.us) and reviewed by John Ortmann (jortmann@tnc.org). Major descriptive and quantitative changes were made so that the model more appropriately represented MT, instead of NE.

Vegetation Classes

Class A **20 %**

Early Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

SPCR	Upper
HECO26	Lower
SCSC	Upper
CALO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Herb 0m	Herb 0.5m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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Class A represents immediate to three year post disturbance conditions. Vegetation consists of resprouting and seedling grass and forbs. Total bare soil is greater than before the disturbance particularly on less productive sites. The vigor of new growth and the specific species affected depend on the season of the disturbance and on pre- and post-disturbance environmental conditions (eg, available soil moisture). Litter is low initially but increases until, by year three, there is enough to support fire under average burning conditions. Fire was therefore modeled as occuring somewhat less frequently than in class B. In uplands, where soil-type is dominated by coarse-grained sands with low water-holding capacity, post-disturbance primary production initially decreases thus fire may only carry under ideal conditions. Under these conditions, grazing is likely to be light. In lowlands, with finer-textured soils, primary production is determined largely by moisture availability.

HECO26 was used as an indicator species for MZs 29 and 30 instead of BOGR2.

ARCA13 can resprout immediately after fire, so it could be present in this stage as well. It could, however, be killed following intensive fires. But since not much litter in these sites, possibility of intense fire reduced.

It was originally suggested that there would be a prairie-dog influenced stage at approximately two percent of the landscape. However, there was some disagreement as to whether this class should exist or not for this system, as it is thought that these sandy sites might have been unlikely to have prairie dog towns. It was only distinguished from A by different species (Buchloe dactyloides - only in the extreme southeast portion of the stage and Bouteloua gracilis, and Agropyron dasystachyum). Canopy cover was 0-20%. This (very unlikely) prairie dog influenced class was therefore merged into the early successional stage, class A. It is doubtful that prairie dogs would colonize very sandy sites; most prairie dog sites have fairly fine-textured soils.

Repeated grazing of these areas will prevent succession to class B. Grazing occurs with a probability of 0.05. Prairie dog grazing was modeled as optional 1, with a very unlikely probability of 0.0007. Both of these will set succession back to the beginning.

Replacement fires occur every 40yrs (due to less litter until the last years of this class, they were modeled as occurring less frequently than in class B. (20yr vs 40yr FRI does not change percentages in each class.)

Class B **80 %**

Late Development 1 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

CALO	Upper
SCSC	Upper
BOGR2	Lower
ARCA13	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	60 %
Height	Herb 0m	Herb 1.0m
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

This system was originally modeled as a four-box model with a mid and late stage; however, it was changed to a three-box model, combining the mid and late stages, since species and structural info was very similar, as were disturbances. It was then combined into a two-box model because of the lack of a prairie dog stage.

This mid-to-late seral stage would persist three years after a fire. The maximum cover height for grasses would be approximately 60%, even though in other mapzones, cover might be much higher.

Other species indicators could be JUHO2 and SPCR - in the later part of this stage. Various sprouting shrubs

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may be established. The shrubs are as tall or taller than the grasses, but they would not be dominant; shrubs might occupy approximately 10% of the area. Some of the shrubs include Juniper horizontalis and skunkbush sumac (Rhus trilobata). Other woody species such as chokecherry (Prunus virginiana) and snowberry (Symphoricarpos occidentalis) may also be established.

This stage includes moderate grazing by native ungulates and insects.

Litter accumulates providing continuous fuel for fires thereby increasing the probability of larger fires. However, for the model, fires were attributed similarly between classes A and B.

Prairie dogs might impact this class with a very unlikely probability of 0.0007, bringing this class back to class A.

Other native grazing occurs with a probability of 0.01, bringing the class back to an early seral state, or with a probability of 0.15, maintaining this stage.

Replacement fires occur every 20yrs.

Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

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**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 sev

Description

Disturbances

Fire Regime Group:** II

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

- [x] Literature
- [ ] Local Data
- [x] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	20	2	100	0.05	100
Mixed					
Surface					
All Fires	20			0.05002	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- [ ] Insects/Disease
- [ ] Wind/Weather/Stress
- [x] Native Grazing
- [ ] Competition
- [x] Other (optional 1) Prairie Dogs
- [ ] Other (optional 2)

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**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 sev

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

LANDFIRE Biophysical Setting Model

Biophysical Setting 2911490 Western Great Plains Shortgrass Prairie

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

General Information

Contributors (also see the Comments field **Date** 10/18/2006

Modeler 1	Daniel Milchunas	Daniel.Milchunas@ColoState.edu	**Reviewer**	Eldon Rash	erash@fs.fed.us
Modeler 2	David Augustine	David.Augustine@ARS.USDA.gov	**Reviewer**		
Modeler 3	Harvey Sprock and many more	many	**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

BOGR2 ATCA2
BUDA KRLA2
PASM HECO26
NAVI4

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

In MZ29, occurs in 331Fn and 331Fr. In the south end of MZ29 it occurs in a transition zone between MZs 29 and 31. Maybe in 331Fb, but very unlikely, also maybe 331Ff. It would occur in SD but below MZ30. Truly, MZ33 is where shortgrass is starting to occur. It might finger up north of the MZ33 line, but a very small area. This would only occur in the southern portions of MZ29. This doesn't occur in MZ30. Perhaps this occurs in eastern WY?

The range of this system is essentially limited to the Central Shortgrass Prairie and Southern Shortgrass Prairie ecogregions, although it may be peripheral in a few other ecoregions such as the Central Mixedgrass Prairie, Northern Great Plains Dry Steppe and Osage Plains/Flint Hills Prairie (Comer et al. 2003).

This occurs in the southern Great Plains from northeastern to southeastern CO and south through western OK, eastern and northeastern NM, and the west Texas Panhandle. Historically, some stages of this type might have been less extensive than currently. This system probably didn't occur much throughout KS historically. But in southeastern CO and the eastern 1/3 of CO, southwestern KS, and in southeastern WY, it did occur. It does not/did not occur in the center of NM, as that would be a desert grassland type. (However, it does occur on the western facing piedmonts of the central mountain chains of NM in the northern Rio Grande corridor.) Precipitation, grazing and decadal fluctuations could have changed the historic distribution, and this is most likely to have occurred along the ecotone with the mixed grass prairie (Lauenroth et al. 1994).

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Some feel that this type does not occur/extend into the westernmost areas of NM and the south/southwest corner of MZ27 such as portions of of ECOMAP subsections 315Ad western half, 315Ab, M313Bd, M313Bb, M331Fh, 321Ad, M313Bf or M313Bg (Laurenroth and Milchunas 1991), which would be drier and desert grassland types. However, modelers from NM state that this type does occur and is dominant historically and currently throughout most of MZ27, except for the southern portions of subsections 315Ad and Ab.

Shortgrass occurs mostly west of KS border (although it also occurs in western KS)- see precipitation gradients. However, west of KS there is a mix of more productive shortgrass prairie and mixedgrass. West of I-25 border, it is drier shortgrass. Some shortgrass however, is in southwest corner of KS. (Mixedgrass is in the northern portion of KS and NE.) There are north-south bands (isoclines) of productivity of shortgrass vegetation, corresponding to increased precipitation going east due to the rainshadow of the Rocky Mountains. See Lauenroth and Milchunas (1991).

The northern boundary is near the CO-WY border at the 41°N latitude, and extends south to latitude 32°N in western TX (Laurenroth and Milchunas 1991).

Biophysical Site Description

This system occurs primarily on flat to rolling uplands with loamy, ustic soils ranging from sandy to clayey. In NM, it is more aridic than ustic. This type typically occurs on loamy to clayey uplands (moderate to fine textures).

In NM and CO, elevations range from 1500-2000m. In KS, elevations can be 1000m.

Shortgrass prairie occurs dependent on precipitation gradients - long-term precipitation patterns and north-south bands or isoclines of productivity of shortgrass vegetation, corresponding to increased precipitation going east due to the rainshadow of the Rocky Mountains.

Mean annual precipitation is approximately 300-500mm (Lauenroth and Milchunas 1991) (ranges from 8-14in and might go up to 16-18in in MZ27 NM in the northeast), but there is a gradient into the mixedgrass prairie at the higher end, and there is a band against the Rocky Mountains that occurs in the approximate 350-375 mm split, between drier versus wetter area; as you go east, it becomes wetter with higher precipitation and you move out of the shortgrass system. In rainshadow, probably lower end of 10in in MZ33.

Most precipitation occurs in the summer months.

The windiest areas of the US occur in the shortgrass steppe (Lauenroth and Milchunas 1991).

Vegetation Description

For MZ29, very infrequent. South of the 37 degree parallel, dominance of warm season grasses - shortgrass, blue grama, buffalograss (MZs 27 and 33) and galleta grass. Above 37 parallel, C3 cool season grasses=mixedgrass, and C4 warm/short and warm/tall in NE sandhills.

Historically, vegetation was dominated by shortgrass, and the subdominants were midgrasses and a small amount of shrubs on the fringes. Dominant species include blue grama, western wheatgrass, needlegrasses (needle-and-thread grass more associated with sandier sites), buffalograss (historically, buffalograss present, but not much; currently it's prevalent though in CO and northern NM), with intermingled forbs. Shrubs included four-wing saltbush, winterfat, with lesser amounts of rabbitbrush, broom snakeweed, fringed sage, and also plains prickly pear, in NM - walking stick cholla, yucca glauca, ring muhly, mat muhly, and sandsage which would occur on soils with coarser texture control section in NM. (Today, however, very low diversity - mostly buffalograss in CO, blue grama in NM, cactus and snakeweed - which has increased its range since historic.) Also - Spherelcia coccinea is a common forb in NM. Currently, there is widespread low-statured mesquite, although historically was present but not as prominent.

For the dominant species list, it covers mostly MZ33-CO. For MZ27-NM, order should be:
BOGR2
PASM
SPCR
ATCA2
KRLA2
HECO26
BUDA
ARFI2

Disturbance Description

This type likely occurred in MZ29 before Euro-American settlement because of heavy grazing in places by bison.

Large-scale processes such as climate, fire and grazing influence this system. The often dry, semi-arid climate conditions can decrease the fuel load and thus the relative fire frequency within the system. However, historically, fires that did occur were often very expansive.

There is debate as to the FRI for this shortgrass system. Because of the lack of long-lived trees, and trees that do exist are in relatively productive sites, there is absolutely no way to reconstruct a reliable historic fire return interval. All estimates of historic fire return intervals must be based on those for surrounding vegetation types that do have means for reconstruction, and then extrapolating based on differences in primary production and herbivore removal of fuel loads. Therefore, there is no means to directly obtain the estimate, and the range is varied. It depends on many factors - portions will be drier, and portions will vary in frequency over time and there will be decadal variation. There is a wide variability of FRI across this system, based on precipitation and fuel.

One camp feels that the FRI was historically approximately 25-35yrs (Harvey Sprock, Terri Schulz, Rich Sterry, Este Muldavin, et al. pers comm). Bison grazing created patchy fuel and therefore small fires at times. So return interval to one spot was longer than expected - ie: a fire can burn somewhere on the landscape often, but it may not necessarily return to the same spot for 25-50yrs or more (Chris Pague, Terri Schulz and Harvey Sprock, pers comm).

However, another camp feels it was shorter. It is thought that some of the differences and suggestions for a longer FRI could come from present range management applications. It is thought that the range of FRI in shortgrass for MZs 27 and 33 is between 5-20yrs, dependent on the precipitation gradient east to west (David Augustine, USFS, pers comm). Some feel, however, that five years is too short, as that is more similar to a tallgrass system (multiple MZs 27 and 33 reviewers).

An arbitrary precipitation gradient between drier versus wetter somewhere around approximately 350-375

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mm annual precipitation delineates a change in fuel and fire behavior across the west to east gradient in precipitation/aboveground primary productivity. While there is no precise line, we may make a general rule-of-thumb that prescribed burns below 375mm are generally more difficult to burn. Farther east, with a higher precipitation, it is easier to burn. At generally around 470mm, fire easily burns through the landscape (David Augustine, USFS, pers comm), especially where some growing season deferment occurs.

Some feel that in the western portion of MZs 27 and 33, the FRI would be a little longer, in the 15-20yr range, whereas in the eastern portion, it would be shorter, in the 5-10yr range. It is a gradient. It is thought that the areas intergrading with mixedgrass would be even shorter as one goes further east into western KS - approximately five years (David Augustine, USFS, pers comm).

Also - both lightning-induced fire and spring fires set by Native Americans are recognized as important pre-European components of the fire regime (Williams 2003). The rates of lightning ignitions are high in both the wet and drier areas of the shortgrass. The shortgrass prairie also probably burned more frequently with Native Americans (Williams 2003).

Some studies from other systems have inferred a short historical fire return interval for the shortgrass (David Augustine, USFS, pers comm). The FRI should be somewhere between the frequency from mixedgrass prairie to desert grassland. A review of the role of fire in desert grasslands indicated that the natural frequency of fire was probably on the order of every 7-10yrs (McPherson 1995). Even though this is a shortgrass system we're describing, production in the shortgrass is higher, and so FRI should be similar, even though historical grazing would have affected the FRI in portions of the shortgrass more than others (David Augustine, USFS, pers comm). Studies on mixedgrass prairies indicate variable fire return intervals that typically range from 3-5yrs (Bragg and Hulbert 1976, Bragg 1986, Umbanhowar et al. 1996). Given rainfall on the shortgrass prairie that is intermediate between desert grasslands and mixed-grass prairie, historic fire frequency may have been between these estimates, ie, on the order of 5-10yrs (David Augustine, USFS, pers comm). There are also good arguments for shortgrass having a higher FRI either than desert or mixedgrass, primarily because 1) the shortgrass region gets more dry lightning storms (higher ignition probability) than mixedgrass and has more times of the year when fuel are dry and "ignitable" than mixedgrass. The eastern 2/3 of MZs 27 and 33, shortgrass mapzones, also has much more continuous fuel than the desert grasslands, hence greater probability of large fires than the desert grasslands (David Augustine, USFS, pers comm). This is contested by others.

A counter-argument does not feel that shortgrass should be in between the desert grassland and mixedgrass intervals and should rather be longer. Both of those systems are more productive and less variable in terms of precipitation and therefore production compared to shortgrasss. This argument states that sandhills and bluestem (the references listed above re: short FRIs in mixedgrass) are very productive special areas within the mixedgrass, not really mixedgrass and not the drier mixedgrass. Also note that in Zak et al. (1994), the productivity for desert grasslands is actually greater than that for shortgrass. This could be due to a variety of factors, some of which being timing, event size and longer growing season, or even methodology. Also, evidence from the Sevilleta suggests the desert grasslands may burn more readily than shortgrass, but they may not be as resilient (Este Muldavin, pers comm).

Augustine (pers comm.) cites evidence of large fires historically as evidence of the shorter interval. Older examples include from Wright and Bailey (1982): "In the semiarid areas, big prairie fires in the past usually occurred during drought years that followed one to three years of above average precipitation, because of the abundant and continuous fuel. Consequently, wildfires traveled for many kms when the winds and air temperatures were high and relative humidity was low. An example is an account of a fire

(Haley 1929) that started in the fall of 1885 in the Arkansas River country of western KS. It jumped the Cimarron River, burned across the North Plains of Texas, and did not stop until it reached the rugged Canadian River Breaks, a distance of 282km (175miles). About 0.4 million ha (1.0 million acres) of the XIT Ranch alone burned in Texas."

However, some feel that there is little reason to believe that fires swept the shortgrass so often (5-10yrs) due to high variability. There may be a discrepancy about FRI and the occurrence or records of some large fires. Some large fires occurred and that probably is not rare. However, there is scant to no evidence in much of the shortgrass prairie that large fires are frequent in the same locations. Even the evidence stated above only reports on some fires -- all in different locations. Really small fires might also have been common, but rarely occurred in the spot that another fire struck. Patchiness, lack of probability and lack of opportunity were all players. We do not know how often fires occurred in the same location. We do not even know exactly how bison grazed the landscape or how indigenous people used fire in the shortgrass. Most of the myths of these practices are myths indeed. In 15yrs in CO there have been few repeat fires in shortgrass, ie, at the same place. This may indicate that the return interval is long while fire itself is not particularly rare. This would match the rainfall pattern as well, ie, rainfall is not easily predictable (Chris Pague, TNC, pers comm.).

Some feel that the ecological reasons for a shorter interval might not be evident until near the mixedgrass.

Overlap in agreement between the long versus short-interval perspectives probably occurs in the eastern edge of the shortgrass zone (ie, Baca County and east as well as northeast CO). There are likely to be more consistent fuel -- and probably a shorter FRI. There are also probably more dry strikes in shortgrass (but not consistently more fuel). The Palmer Divide might also have more fuel in most years.

However, there is also other evidence for a shorter interval in northeast NM. Ford and Johnson (2006) found that a six-year dormant-season fire (ie, burned once in six years) as a fire treatment shows the potential for increased site production relative to ‘reference condition’ unburned grassland, which might imply that shortgrass might have had a similarly short return interval. However, there is a question as to whether or not this would be similar to historic conditions, considering the prevalence of heavy grazers presettlement.

It was also thought that the FRI in MZs 27 and 33 should be similar to that for shortgrass in MZ34, which is approximately 10-15yrs. The FRI for shortgrass in Rapid Assessment model R3PGRs, which covered this same area, was 10yrs FRI. The FRI for southern plains grassland in the FRCC model PGRA4 was approximately 10yrs varying due to effects stated in this MZs 27 and 33 descriptions. The FRI for the original model from the MZ27 NM modelers was 15yrs FRI. In terms of having consistency across mapzones and between mapzones, and between all sources of information, and weighing all factors and resources, the regional lead (RL) chose a similar interval of approximately 20-25yrs to account for the west to east gradient for these mapzones and the confounding evidence and opinions. All modelers/reviewers informed.

Note that changing the FRI from 22yrs to 15yrs or 10yrs only slightly altered percentages in each of the successional stages to where approximately five percent more was in A and five percent less was in C. Also, FRG 2 is consistent.

Note that large fires might be currently rare in some areas due to several factors, including aggressive suppression action, fuel reduction due to continuous grazing being more uniform across the landscape,

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heavy stocking, presence of roads and discontinuous land ownership (checkerboard effect). In recent years, the combined extent of prescribed and wildland fires on the Grasslands has varied annually but has been approximately 0.5-2% of the total area, or a fire return interval of >50yrs (Coarse filter analysis of habitat conditions on the grasslands).

Return interval for fire could be extended (longer return interval) by continuous ungulate grazing. Fire return intervals are now occurring more infrequently - over 50yrs (Harvey Sprock, Terri Schulz, Rich Sterry, pers comm).

The short grasses that dominate this system are extremely drought and grazing-tolerant. These species evolved with drought and large herbivores and, because of their stature, are relatively resistant to overgrazing. The shortgrass system adapted evolutionarily with historical heavy grazing (Milchunas et al. 1988). The return intervals for grazing varied. There were probably areas distant from water sources that were not grazed as heavily as those near water. However, the shortgrass steppe is probably the system with the highest intensity of grazing than other systems historically (Milchunas 2006, Lauenroth et al. 1994).

Black-tailed prairie dogs (BTPD) are an ecologically important component of the grazing regime in shortgrass prairie and would have occurred extensively. (Prairie dogs were less important both historically and currently in sandsage prairie, canyonlands and riparian habitats due to edaphic and topographic limitations on burrow construction). There were some very large towns, but there were also areas without any towns. Quantitative historical estimates of BTPD abundance are difficult to obtain, but the U.S Fish and Wildlife Service estimated that about 160 million hectares (395 million acres) of potential habitat historically existed in the US, and about 20% was occupied at any one time (Gober 2000). (Coarse filter analysis of habitat conditions on the grasslands). Shortgrass has most of the suitable soil types for prairie dogs. In general, they need loamy or clay soil.

In historic times, there was frequent and broad-scale grazing by bison, elk, deer and pronghorn antelope. Through the growing season, bison might have been there for relatively short periods in some years; however they might have been there longer in other years. There were also resident herds of bison in areas of CO historically. These areas would also have been populated by bison in sufficient numbers to support populations of wolves. Bamforth (1987) suggested that bison herds under relatively undisturbed conditions (<1846) most often ranged in size from several hundred to several thousand.

Shaw and Lee (1997) reviewed diaries of European travels in the southern Great Plains from 1806 to 1857. Organized by historical period and biome type, the authors suggest populations of three major large herbivores—bison, elk and pronghorn—changed in the first half of the nineteenth century; bison were most numerous on the shortgrass prairie prior to 1821, pronghorn were most abundant on the shortgrass prairie between 1806 and 1820, again in the 1850s.

In drier areas in the western portion of MZs 27 and 33, distance from water was probably a factor in grazing gradients. Individual herds were probably tied to river drainages and migrations from those drainages.

The dry half of the Great Plains has high inter-annual rainfall variability, so historically, the population declined faster in dry years. This resulted in a time lag or temporal variability, in which density could be reduced greatly. Bison historically moved nomadically in response to vegetation changes associated with rainfall, fire and prairie dog colonies. The time lag for return movements provided deferment during the re-growth period for which according to both historic and archeological records may have ranged from 1-

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8yrs (Malainey and Sherriff 1996 and others).

If there was a series of droughts followed by a wetter year, there would have been little grazing pressure, which would then result in a higher severity or frequency of fire. Drought and grazing were probably most important disturbances historically and greatly influenced fire frequency and extent. This is a drought tolerant system. However, extended drought (over 3-4yrs) will reduce cover.

Historic variability in bison grazing appears to have been on the temporal and spatial scales of years and tens to hundreds of square miles, while current variability in livestock grazing is at scales of weeks to months and acres to several square miles (David Augustine, USFS, comm).

Insects were also a natural disturbance agent on the landscape - grasshoppers, range caterpillars and Mormon crickets.

Note that we are also not modeling the white grub disturbance interaction, which could be an important disturbance. It can cause a shift in stages and could cause a large impact. It combined with drought could be highly impacting and could cause a similar impact as prairie dogs. However, it was not modeled.

A healthy shortgrass prairie system should support prairie dog complexes, viable populations of pronghorn, endemic grassland birds and other Great Plains mammals.

However, currently in areas, there is overgrazing and continuous grazing, creating more areas heavily dominated by shortgrass (in areas where there might have been more mixedgrass) and increasing fire intervals (less fire).

Adjacency or Identification Concerns

In MZ29, this type might only occur due to overgrazing. Maybe it becaime more widespread for a while after Euro-American settlement resulted in more concentrated grazing.

The distinction between this system and the Northwestern Great Plains Mixedgrass Prairie is unclear and the two should be better described, but here’s how this system is thought of in WY... This Shortgrass Prairie system is strongly dominated by the sod-forming grasses, Bouteloua gracilis and Buchloe dactyloides; other species are minor players. Those two species are major species in the geographic region described in the NatureServe document because that is where summer thunderstorms provide a large proportion of the annual precipitation. And, yes, it was created by heavy grazing. Frederic Clements and John Weaver recognized it as an example of their concept of the grazing disclimax. The prevalence of Buchloe dactyloides distinguishes it from heavily grazed examples of the NW Great Plains Mixedgrass Prairie, which are dominated by Bouteloua gracilis but lack Buchloe (and which occurs outside of the area where summer thunderstorms are so important). And Buchloe is a major species only in very southeastern WY. That’s why the Shortgrass Prairie system is present only in the southern end of MZ29. Maybe this system is restricted to MZ33 farther south, but its presence in MZ29 seems likely (George Jones, pers comm).

This system is similar to Kuchler's (1964) "Bouteloua-Buchloe" vegetation type except at the northern border (Lauenroth and Milchunas 1991).

This system occurs in the area corresponding to Kuchler's Plains Grassland PNVG and the RA's R3PGRs Shortgrass Prairie and FRCC PGRA4 Southern Plains Grassland.

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This system could be confused with mixedgrass prairie. Production is less in shortgrass versus mixedgrass prairie. They can be distinguished - higher occurrence of blue grama - thus shortgrass. If have more mixedgrasses, should be considered mixedgrass prairie. If have 50% or more midgrasses, would probably be mixedgrass.

Shortgrass occurs mostly west of the KS border; however, west of KS there is a mix of more productive shortgrass prairie and mixedgrass. Some shortgrass however, is in the southeast corner of KS. Mixedgrass is in the northern portion of KS and NE. There is a gradient into mixedgrass. West of approximately the I-25 border in CO, there is drier shortgrass. These boundaries are relevant to fuel loading. On the eastern border of MZ27, it also grades into mixedgrass prairie of small remaining quantities near TX (those areas of TX not in agriculture).

This system should not be confused with the desert grassland and plains mesa types occuring in the southern skewing west/southwest corners of MZ27. See RA's depiction of the plains mesa and desert grassland types versus this shortgrass type. See RA PNVGs and Kuchler types and Laurenroth and Milchunas (1991) for historic potential. The desert grassland types have more tobosa and galleta grasses. Consider BpS 1122 Gyp, 1504 Bottomland Swale/Tobosa Flats, 1503 Loamy Plains, 1147 Foothill/Piedmont.

Some (John Tunberg, NRCS et al, Este Muldavin, pers comm), however, state that shortgrass occurs in all sections/subsections of MZ27 in NM.

In MZ27 in NM, in the west end near Las Vegas, it grades into pinyon-juniper (PJ) and ponderosa pine, as it does in CO near Trinidad.

This system could be adjacent to Foothill/Piedmont Grassland. It is also adjacent to desert grasslands in the south - sand dune/mesquite dunelands in the south and east. It is also adjacent to tobosa plains in the south and gyp hills in the east end of MZ27, NM east of Estancia. On the eastern edge of MZ27 in NM, it is adjacent to playas scattered throughout (closed depressional wetland systems).

Some (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm) feel that there is more shortgrass now than historically in areas at the ecotone with mixedgrass prairie - due to management practices today. Shortgrass prairie has expanded currently due to continuous grazing. Central Mixedgrass Prairie has been greatly reduced currently due to agricultural conversion. In CO, some believe that historically had lower producing mixedgrass, but now it is shortgrass (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm) and that even some of the shortgrass prairie today that would have existed historically, is departed. Much is continuously grazed.

In contrast, Milchunas et al. (1998) considers the shortgrass to be climatically determined, with large herbivores and aridity being convergent selection pressures. Grazing and climatic cycles do, however, result in shifts in the location of the mixedgrass-shortgrass ecotone (Lauenroth et al. 1994). Research on short duration grazing shows no difference with continuous grazing on plant community composition (Derner and Hart submitted). Long rest periods would be necessary to increase heterogeneity (Fuhlendorf and Engle 2001).

Currently, fire suppression and certain grazing patterns in the region have likely decreased the fire frequency from historical regimes, and it is unlikely that these processes could occur at a natural scale today.

A large part of the range for this system (especially in the east and near rivers) has been converted to agriculture. Areas of the central and western range have been impacted by the unsuccessful attempts to develop dryland cultivation during the Dust Bowl of the 1930s.

There is also much residential development in this system.

Currently, there are some non-natives - cheatgrass, kochia, but not a big invasive problem.

Some mesquite hummocks might also occur currently in MZ27 NM more than historically. Currently, there might be more widespread low-statured mesquite, although historically, it might have been present but not as prominent. If mesquite is over three feet high, it's a different BpS. There might be more mesquite, cholla and prickly pear currently - which is uncharacteristic. There is little data on this, however.

There is also some encroachment of juniper into these grasslands currently in MZ27 NM. If there is over 10% juniper canopy cover in grasslands, that would be uncharacteristic.

In MZ27 in SE CO, this system might have been former prairie chicken habitat.

There are conflicting views about what this landscape looked like historically versus currently.

One viewpoint states that currently, today, most of the landscape is in class B. The departure in this system would be in the lack of the classes A and C on the landscape today (Daniel Milchunas, CSU and David Augustine, USFS, pers comm). This is because cattle have been evenly distributed throughout the landscape. Historically, there were a mix of heavily grazed, heavily disturbed areas, moderately grazed areas more distant from water, and lightly grazed areas even more distant from water, during low population cycles of bison, or where bison had not returned recently. Management today, together with water improvements on the range, results in a relatively greater amount of the middle class. Management today is also removing prairie dogs and fire. Therefore, historically, there were more disturbed areas (class A) and undisturbed areas (class C).

Another view, however (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm), states that currently, continuous, heavy grazing practices have turned class B stage more into class A, the sod portion - which didn't happen often historically. This opposing view also states that there is not much of the class B, historic climax plant community, today. This opposing view also states that the sod class class A, that would have been a very small, localized condition historically. However, today, it would be very prevalent. Historically, the landscape would have just had small areas of continuous grazing or migration corridors.

Another similar viewpoint states that the go-back-cropland would be in class A, and today there are extensive areas of abandoned dust bowl cropland that now have blue grama sod with low cover and productivity. The surface soil horizon is eroded by wind and is no longer apparent. Bedrock is exposed in some areas (John Tunberg, Rex Pieper, Clarence Chavez, pers comm). This viewpoint also states that most would be in the sod class today.

Grazers, combined with prairie dogs and fire, would allow the native bison grazers to beat up an area. That stage no longer exists today, which is in part why some of those shortgrass prairie grassland birds are in such significant decline today (Herkert 1994, Knopf 1994, Peterjohn and Sauer 1999).

Note that there is a difference in cover amounts between southern NM MZ27 and northern NM MZ27; however, the model and probabilities are the same. Also note some species order differences between southern and central shortgrass.

Native Uncharacteristic Conditions

If grass is over 1/2 meter, it would be uncharacteristic because it would be in a different BpS.

Scale Description

This is a matrix community - small to large patches. Disturbances can also occur within a matrix - small to large, huge patches. Driving variable is climate (drought, low rainfall, etc), grazing and to a lesser extent fire.

This type probably occurs in very small patches, smaller than a few acres in MZs 29 and 30.

Issues/Problems

This system was originally modeled with two models - one for CO MZs 27 and 33 and one for NM southern version of MZ27. Even though there are monsoonal and climatic differences/factors - differences in geography, moisture and function between the two areas, those factors were easily textually represented. Therefore, the southern and central versions were combined into a more all-encompassing model for all of MZs 27 and 33 which includes southern and central shortgrass. Cover will be different between the two (state line - NM vs CO Raton Pass, Mesa de Maya) and this is described textually in the successional class descriptions. Note that there is a difference in cover amounts between southern NM MZ27 and northern NM MZ27; however, the model and probabilities are the same. Also note some species order differences between southern and central shortgrass.

There is some disagreement about historical versus current manifestation of this system.

Also - Instead of calling the classes early, mid and late, which do not actually apply in shortgrass prairie and the different stages that we are describing, we are calling all of the stages “mid-development.” Succession in a grassland system does not abide by typical definitions as in a forested community. The stages of the grassland are created and/or maintained by disturbances or lack thereof.

Also - Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover. These covers do not reflect reality on-the-ground.

Comments

This model for MZ29 was adopted from a draft model from MZs 27 and 33 created by Daniel Milchunas, David Augustine, Harvey Sprock, Terri Schulz, Rich Sterry, Dan Nosal, Keith Schulz, Rex Pieper, John Tunberg, Clarence Chavez and Lee Elliott and reviewed by Steve Kettler, Este Muldavin, Keith Schulz and Paulette Ford. See MZ27 and MZ33 for further evolution comments. MZs 27 and 33 model changed after MZ29 model was delivered. Therefore, regional lead made the MZs 27 and 33 changes to the MZ29 model. Reviewer for MZ29 notified.

The model for MZ33 in CO was based on MZ28 created by Galen Green, Wayne Robbie and Anne Bradley and reviewed by Vic Ecklund and Chuck Kostecka.

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This model for MZ28 was based on the Rapid Assessment model R3PGRS, which was reviewed by anonymous. Minor edits made on 5/6/2005 by Mike Babler.

The Rapid Assessment model was originally based on the FRCC model PGRA6. Review suggest combining all plains grasslands. Because of species composition differences, and class differences, 1147 and 1149 were not combined.

Vegetation Classes

Class A 20 %

Mid Development 1 Open

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	Upper
BUDA	Upper
ARIST	Upper
VUOC	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover, since the cover in class A actually ranges from a low, mosaic-bare-ground cover to a high sod-cover, which includes litter too. Due to mapping constraints and past issues with mapping herbaceous cover and resultant errors, this class A is being set at 0-20% even though it was originally suggested to be 0-70%. Either way, these covers do not reflect reality on-the-ground. Remote sensing will show part of this stage as litter plus veg.

Also - the NM draft older version had a cover of 0-20% for the prairie-dog-type-stage and the sod class with a cover of 41-50%.

Description

Instead of calling the classes early, mid and late, which do not actually apply in shortgrass prairie and the different stages that we are describing, we are calling all of the stages “mid-development.” Succession in a grassland system does not abide by typical definitions as in a forested community. The stages of the grassland are created and/or maintained by disturbances or lack thereof.

Class A is the low biomass (0-1in based on the Robel pole density / visual obstruction method), heavy disturbance dependent community. It combines two types of communities. One consists of the high cover blue grama buffalograss sod that looks like a golf course (high cover in patches). The other is the low cover bare soil, Aristida and forb stage, which could have taller grasses than the sod, but they are spaced apart due to bare soil between. See biomass in Milchunas et al. (1994) and Milchunas and Lauenroth (1989) and basal cover for sod class by point frame in Milchunas et al. (1989).

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 seve

Please note that this system should be distinguished on-the-ground by biomass and not cover, since the cover in class A actually ranges from a low, mosaic-bare-ground cover to a high sod-cover, which includes litter too. Due to mapping constraints, we are defining dropdown boxes on cover; however this stage could go up to 70% cover, including litter, with very low biomass. Basal cover for high cover sod is approximately 45% or higher if including litter. Basal cover for low cover prairie dog area is approximately 20-25% cover. On-the-ground, this class should be distinguished by biomass.

There are relatively few cool season grasses in this stage. There is always blue grama in this stage, as in the others. Cactus is present (and could even be a dominant in the class A sod depending on soil type). Aristida is present, which increases with prairie dog colonies, as are the annual grasses - sixweeks fescue, red three-awn, ragweed and annual forbs. [Currently, you would see non-native annuals in this class such as cheatgrass and kochia - only in the high biomass type. Annuals and exotics are actually less abundant in the sod type than any other class (Milchunas et al. 1989; Milchunas and Lauenroth 1989; Milchunas et al. 1988); the landscape might also have non-native bindweed on prairie dog towns today, but not historically.] On loamier or sandier sites, there is sand dropseed. For the southern NM version, other indicator species are lemonweed, showy goldeneye and verbena.

Original draft model indicator species for the prairie dog stage also included ARPUL, AMPS and SPCR. Original indicator species for the sod stage also included OPPO.

There are low intensity fires in the low biomass high cover sod and relatively rare fire in the low biomass low cover bare soil. Fires are spotty through here and not as frequent as in other stages. They do not cause a change in stages.

This stage is produced by heavy grazing, and long-term prairie dog colonies which will maintain this stage long-term. This stage can also be maintained by heavy continuous grazing if the area is near water. Also – if an area is burned and grazed, the high cover version of this stage will be reached if not continuously grazed.

Grazing that gives adequate plant recovery periods occurs in this stage.

If there is no fire and no prairie dog or heavy grazing maintaining this stage, then in approximately 5-10yrs, this stage will transition to the class B stage. This was modeled as "alternate succession" occurring as a probability of 0.1, for modeling purposes.

Drought occurs.

It is thought that there should be approximately 20-30% of this stage historically, based on historical prairie dog communities combined with bison grazing (Gober 2000, David Augustine, USFS, pers comm). However, the viewpoint which created this model feels that there is very little of this stage on the landscape today. Prairie dog plague today would also not allow this class to be maintained for long today.

Another opposing viewpoint feels that the sod portion of this class would have been a very small, localized condition historically and that today it would be very prevalent. This view states that historically, there would just have been small areas of continuous grazing or migration corridors.

This stage would also include buffalo wallows (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm). (Today, it might be go-back-cropland.) It is also thought however, that today there are extensive areas of abandoned dust bowl cropland that now have blue grama sod with low cover and productivity. The surface soil horizon is eroded by wind and is no longer apparent. Bedrock or subsoil/parent material is exposed in some areas (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm). This view is questioned, however, by others.

Class A was originally modeled in the draft model as the prairie dog stage lasting 20yrs, as it would take a long time to move out of this stage due to the prairie dog communities. Class C was originally modeled as the sod class.

Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover, since the cover in class A actually ranges from a low, mosaic-bare-ground cover to a high sod-cover, which includes litter too. Due to mapping constraints and past issues with mapping herbaceous cover and resultant errors, this class A is being set at 0-20% even though it was originally suggested to be 0-70%. Either way, these covers do not reflect reality on-the-ground. Remote sensing will show part of this stage as litter plus vegetation.

Note that the NM southern version had a canopy closure of 0-20% for the prairie-dog-type stage class A and 41-50% for the sod class.

Class B **60 %**

Mid Development 2 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	Upper
PASM	Upper
BUDA	Upper
STIPA	Upper

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	21 %	80 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

Scattered shrubs may be present (up to 15%, maybe up to one meter) - four wing saltbush and winterfat. There might be scattered cholla in MZ27, east of Colorado Springs. Once cholla gets thick, shifts to another BpS.
Note that the draft NM southern version of the Historic Climax Plant Community (HCPC) class had a cover of 21-40%.

Description

Instead of calling the classes early, mid and late, which do not actually apply in shortgrass prairie and the different stages that we are describing, we are calling all of the stages “mid-development.” Succession in a grassland system does not abide by typical definitions as in a forested community. The stages of the grassland are created and/or maintained by disturbances or lack thereof.

Class B is the mid biomass (2-4in based on the Robel pole density / visual obstruction method), mid cover stage. See biomass in Milchunas et al. (1994) and Milchunas and Lauenroth (1989).

This stage again consists of blue grama. Cactus is often present and could even be the second dominant depending on soil type. There are less needle and thread and western wheatgrass than in class C. This also includes the “historic climax plant community” with blue grama, buffalograss, and western wheatgrass, galleta grass, green needle grass (not in NM much), fringed sage, New Mexico feather grass in the south. Historically, there would have been more midgrasses (Harvey Sprock, et al., pers comm). In NM, there would

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be scatterings of black grama and vine mesquite on heavier soils.

Fire does occur in this stage. If there is 1-2yrs of no grazing or 4-10yrs of no fire, then 4-10yrs post-fire, this class would transition to the high biomass class C stage. This was modeled as "alternate succession" occurring as a probability of 0.05, for modeling purposes.

Prairie dogs could occur in this stage. If they do, the long-term prairie dog grazing causes a transition to class A.

Proper grazing that allows adequate plant recovery periods occurs but does not cause a transition. With heavy grazing, this class could transition to class A.

Drought was modeled with a probability of every 40yrs and causes no transition.

The current modelers (Augustine, et al) feel that currently, most of the landscape is in class B. However, another viewpoint feels that there probably is not much of class B on the landscape today.

Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover. Due to mapping constraints and past issues with mapping herbaceous cover and resultant errors, this class B is being set at 21-80% even though it was originally suggested to be 61-80%. Either way, these covers do not reflect reality on-the-ground.

Class C **20 %**

Mid Development 3 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

BOGR2	Upper
HECOC8	Upper
PASM	Upper
STIPA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	81 %	100 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

Scattered shrubs may be present - snakeweed and prickly pear cactus

Description

Instead of calling the classes early, mid and late, which do not actually apply in shortgrass prairie and the different stages that we are describing, we are calling all of the stages “mid-development.” Succession in a grassland system does not abide by typical definitions as in a forested community. The stages of the grassland are created and/or maintained by disturbances or lack thereof.

Class C is the high biomass (4in+ based on the Robel pole density / visual obstruction method), high cover stage. See biomass in Milchunas et al. (1994) and Milchunas and Lauenroth (1989) and basal cover in Milchunas et al. (1989).

The same grasses are present as the previous. However, there are also more C3 perennial cool season grasses. (However, some have questioned the increase in cool-season grasses with succession as being speculative. There are definite edaphic differences. Gravelly sites in NM often support H. neomexicana even under intense grazing regimes.) Blue grama is still present and dominant. Needle-and-thread, galleta grass and also

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western wheatgrass are more prominent. Note also that more annuals and exotics occur in the ungrazed class than in the heavily grazed sod class (Milchunas et al. 1989; Milchunas et al. 1992).

This stage is arrived at through lack of fire and grazing, although while already in this stage, fire would be more likely to occur due to the increased biomass.

Fire does occur in this stage. If there is fire and then grazing, this will over time transition to class B, and with long-term heavy grazing to class A. Fire alone may not cause a transition, but can especially on coarser textured soils and also when fire occurs with heavy grazing. Regular grazing can just move the class to class B.

Prairie dogs are unlikely to occur in this class, but when they do, they will occur as a patch within the matrix and will cause a transition.

Drought occurs.

As per the current modelers (Augstine, et al), it is thought that there should be approximately 10-20% of this stage historically. However, there might be very little of this stage on the landscape today, although some feel that there might be a large amount of it on the landscape today in NM.

Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover. These covers do not reflect reality on-the-ground.

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

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Fire Regime Group:** II

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	22			0.04545	100
Mixed					
Surface					
All Fires	22			0.04547	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- ☐ Insects/Disease
- ☑ Wind/Weather/Stress
- ☑ Native Grazing
- ☐ Competition
- ☑ Other (optional 1) prairie dogs
- ☑ Other (optional 2) heavy grazing and fire

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LANDFIRE Biophysical Setting Model

Biophysical Setting 2911530 Inter-Mountain Basins Greasewood Flat

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

General Information

Contributors (also see the Comments field **Date** 5/5/2006

Modeler 1	George Soehn	george_soehn@blm.gov	**Reviewer**
Modeler 2	George Jones	gpjones@uwyo.edu	**Reviewer**
Modeler 3	Dennis Knight	dhknight@uwyo.edu	**Reviewer**

Vegetation Type

Wetlands/Riparian

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

SARCO PUCCI
DISTI
SPAI
PASM

General Model Sources

☐ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

Occurs throughout much of the western US in intermountain basins and extends onto the western Great Plains. Occurs throughout zone in all subsections at lower elevations. In MZ20, this BpS is thought to be limited to very limited in extent.

In MZs 29 and 30, might occur - but in little areas - in playas. This type goes into western ND in MZs 30 and 29. In central area of MZ29. In streams and closed depressional areas.

Biophysical Site Description

Typically occurs near drainages, on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites typically have saline soils, shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations.

Vegetation Description

This system sometimes occurs as a mosaic of multiple communities, with open to moderately-dense shrublands dominated or co-dominated by Sarcobatus vermiculatus (greasewood). Atriplex confertifolia (shadscale) or Krascheninnikovia lanata (winterfat) may be present or co-dominant. Occurrences are often surrounded by mixed salt desert scrub. Herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of Sporobolus airoides (alkali sacaton), Distichilis spicata (saltgrass) or Eleocharis palustrus (spikerush). In MZ22 very little Atriplex confertifolia (shadscale) but rather Atiplex gardneri. Artemsesia tridentata tridentata is common in southwest part of MZ22 more in riparian systems, Artemesia wyomingensis occurs more on the playa types.

Disturbance Description

Historically, fire was extremely infrequent. There is conflicting evidence about mean FRI in this system.

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Anderson (2004) claims a FRI <100yrs, whereas expert opinion considers fire rare to absent in greasewood. As a compromise, a mean FRI of 200yrs was chosen here.

Greasewood is a vigorous resprouter following low to moderate severity fires, although severe fires may result in some mortality. Some re-seeding may occur from nearby remnant plants.

Greasewood may be killed by standing water that lasts greater than 40 days.

Adjacency or Identification Concerns

Greasewood communities are susceptible to invasion by non-native annual grasses (cheatgrass).

Native Uncharacteristic Conditions

Scale Description

One to hundreds of acres.

Issues/Problems

Comments

This model for MZs 29 and 30 was adopted as-is from the same model from MZs 20 and 22, created by George Soehn, George Jones and Dennis Knight and reviewed by Steve Cooper.

This model for MZ20 was adopted as-is from the draft model from the same BpS from MZ22. No changes were made yet.

This model for MZ22 was adapted from the model from the same BpS from MZ23 created by Jolie Pollet, Annie Brown and Stan Kitchen. Quantitative and descriptive changes were made, and it was changed to a two-box model.

The model for MZ23 is identical to the model for the same BpS in MZ16 (Utah High Plateaus) and did not receive any peer review.

Vegetation Classes

Class A 5 %

Early Development 1 All Structure

Indicator Species* and Canopy Position

DISTI	Lower
SPAI	Lower
	Upper
	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model 2

Description

Some grasses, with greasewood sprouts present. Some representation of other sprouting species may be present such as rabbitbrush (Ericameria nauseosus). Grass species vary geographically, but include the following: inland saltgrass, bottlebrush squirreltail and alkali sacaton. Succession to class B after two years.

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Class B 95 %

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 2

Indicator Species* and Canopy Position

SARCO	Upper
DISTI	Lower
SPAI	Lower
	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	50 %
Height	Shrub 0m	Shrub 3.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Greasewood shrubs maturing or have reached maturity, and will increase canopy closure. Perennial grasses will still be in the understory. Vegetation will revert to class A with replacement fire (mean FRI of 200yrs). Flooding (mean return interval of 75yrs) causes a transition to class A.

Shrubs probably only reach heights of 1.5m.

Class C 0 %

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Description

Class D 0 %

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Description

Class E 0 %

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Description

Disturbances

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**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 sev

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 50
Min 10
Max 200

Sources of Fire Regime Data

- [ ] Literature
- [ ] Local Data
- [x] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	210	100	800	0.00476	100
Mixed					
Surface					
All Fires	210			0.00478	

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.

Additional Disturbances Modeled

- [ ] Insects/Disease
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting 2911590 Rocky Mountain Montane Riparian Systems

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

General Information

Contributors (also see the Comments field **Date** 10/30/2006

Modeler 1	Peter Lesica	peter.lesica@mso.umt.edu	**Reviewer**	Peter Lesica (re-rvw'd)	peter.lesica@mso.umt.edu
Modeler 2			**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type

Wetlands/Riparian

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

POPUL CRRI
SALIX EQAR
COSE16 POBAT
CAREX BEOC2

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

For MZ29, the Rocky Mountain riparian systems will occur in the mountains (Bighorns, Black Hills, and perhaps Bear Lodge, Ferris or the Laramie range), while Great Plains riparian and floodplain will be lower elevations/in the plains matrix and better covered by 1162. The exception to this is the strings of narrow-leaf cottonwood (Populus angustifolia) found along the Laramie river and other rivers in the WY portions of MZ29, which are Rocky Mountain in character. It might occur in M331B, 331N, M334A.

See Adjacency/Identification Concerns box regarding smaller second and third order prairie streams and where they occur or what they're classified as. Also see Adjacency/Identification Concerns box for how to distinguish from Floodplain.

This system is found throughout the Rocky Mountains and Colorado Plateau regions. In MZ21, it occurs throughout the zone and is more common than BpS 1154 (black cottonwood) on rivers. It is associated with the isolated mountain ranges in MZ20.

Biophysical Site Description

This system occurs within a broad elevation range from approximately 900m (3000ft) to 2800m (9200ft) within the flood zone of rivers, on islands, sand or cobble bars, and streambanks. The upper limit for MZ20 is probably approximately 2050m (6725ft). Typically this system exists in large, wide occurrences on mid-channel islands in larger rivers or narrow linear bands on small, rocky canyon tributaries and well drained benches and hillslopes below seeps/springs. May also include overflow channels, backwater sloughs, cut-off meanders, floodplain swales and irrigation ditches. Surface water is generally high for variable periods. Soils are typically alluvial deposits of sand, clays, silts and cobbles that are highly stratified with depth due to flood scour and deposition.

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For MZs 29 and 30, the Rocky Mountain riparian systems occur in the mountains in higher elevation areas, the intermountain parks. Possibly 4000-8000ft.

Vegetation Description

This ecological system occurs as a mosaic of multiple communities that are tree dominated with a diverse shrub understory. Deciduous woody trees dominate, including: Populus deltoides (not in MT montane systmes - don't occur much over 4000ft in Montana - instead P. deltoides and Fraxinus pennsylvanica should be in Great Plains riparian - ie: Floodplain Systems), Populus angustifolia (east of the Continental Divide) and the tree willow, Salix amyglioides. Fraxinus pennsylvannicus is found at lower elevations. Fraxinus pennsylvanicus is not in MT montane systems - doesn't occur much over 4000ft in MT. It does become a dominant in MZ30 riparian areas where it comes in after P. deltoides, grows much more slowly, but persists after P. deltoides because it can recruit into shaded, relatively undisturbed sites. Riparian trees for MZ29 would be limited to Populus angustifolia and/or P. balsamifera var. trichocarpa.

Dominant shrubs include Acer negundo, Alnus incana, Cornus sericea, Crataegus rivularis, Prunus virginiana, Sheperdia argentea and numerous tall willow species: Salix lutea, S. geyeriana, S. boothii, S. drummondiana, S. lasiandra, S. bebbiana and S. exigua. Acer glabrum exists in MZ20, but it isn't a dominant shrub - Acer negundo is more common. Alnus incana and Betula occidentalis are minor components of MZ20. For MZ29, Alnus incana or A. viridis, Salix exigua, S. bebbiana, S. drummondiana, S. boothii, Cornus sericea, Betula occidentalis and Acer glabrum would be common shrubs. Juniperus occidentalis can often be common along montane rivers. This cottonwood-dominated vegetation probably doesn’t get over 6000ft and will be found in gentle terrain, perhaps along major tributaries of the Tongue and Powder rivers.

Matrix vegetation will be steppe, grassland or coniferous forest.

It’s not clear whether this system is meant to include all streamside vegetation in the mountains, or if that is 1160. If it is 1159, it should be remembered that a lot of canyons, even at fairly low elevation have spruce, alder, dogwood and a few willows along the streams, especially if the matrix vegetation is coniferous forest and the channel is constrained by geology, usually in steeper terrain. Perhaps this type of riparian vegetation would just be mapped with the adjacent coniferous forest.

Gentle terrain at elevations over 6000ft will most likely have willow-dominated riparian vegetation- Salix geyeriana, S. boothii, S. bebbiana, S. planifolia etc. Matrix vegetation will be steppe or grasslands as well as coniferous forest.

Forbs and graminoids include Carex spp, especially Carex utriculata and Carex aaquatilis, which occur in nearly homogeneous stands, and numerous mesic forbs (eg, Geum macrophyllum, Mertensia ciliatus, Equisetum arvense and Senecio hydrophilus).

Disturbance Description

This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Flood events of increasing magnitude will cause maintenance to stand replacing disturbances.

Beaver (Castor canadensis) crop younger cottonwoods (Populus spp) and willows (Salix spp), and frequently influence the hydrologic regime through construction of dams (ponding water and slow release). Beavers show considerable movement along rivers as available trees are felled. However, beavers usually do not build dams on larger streams or rivers but rather build dens in the banks.

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Fire is mostly occurring as a result of spread from surrounding uplands. Many of these species, especially shrubs, respond favorably to fire. They are vigorous sprouters and are also shade intolerant; the absence of fire and shading by conifers will cause a decrease in these communities. Most fires would ignite and move thrrough upland fuel until they reached a riparian zone; then either go out because of high fuel moisture, continue spreading into dry riparian fuel or leap across damp streams and continue up the hill on the other side. Streams could be a barrier to low/moderate intensity fires, but would hardly slow down a high intensity crown fire (Michael Harrington, pers comm, observations on the Bitterroot 2000). It is thought that the lower elevation forests (ponderosa pine dominated) were capable of burning during a large portion of the summer and fall because of the rapid drying of the types of fine fuel present, whereas intersecting riparian area fuel had a longer seasonal exposure to soil moisture and high humidity. So, this indicates a period, especially in early summer where it seems upland were burnable and riparian zones were less so. These two zones generally become more similar as summer deepens (Harrington, pers comm).

Olson (2000) found that riparian Weibull median probability fire return intervals for riparian forests (in OR, however), ranged from 10-40yrs. Forest type and slope aspect played a larger role than proximity to a stream when it came to differentiating fire regimes in the study area. Stream channels also did not act as fire barriers during the more extensive fire years (Olson 2000).

The fire disturbances, flooding events and beaver herbivory is modeled at much longer intervals in MZ21 than in MZs 10 and 19. The fire return intervals in MZ21 (175yrs FRI overall) for this BpS are approximately the same as those for 211154. MZ12 used a 300yrs+ FRI. For MZ20, FRIs (65yrs FRI overall) are modeled similarly to those in MZs 10 and 19 (50yrs FRI overall). It is thought that the associated regime for MZ20 would be usually influenced by the surrounding dominant montane forest, which is largely FRG I or III. For this riparian BpS in MZ20, it is expected that FRG would be II or III.

It is doubtful that ice scour is important in these systems the way it is in the larger, low-gradient river systems. The water is moving with too much force to get massive ice buildup; there is not much evidence of large-scale ice scour in the mountains east of the Divide. It was therefore removed from the model for MZ29.

Adjacency or Identification Concerns

This BpS encompasses the mid and lower-elevation riparian systems within the northern Rocky Mountains. Higher elevation riparian systems are covered in BpS 1160.

The absence of recurrent floods and fire as a structuring agent, coupled with shade tolerant conifer establishment (less frequent fires due to fire suppression or less frequent flooding due to impoundment would result in conifer encroachment into these deciduous-dominated, early-seral communities) can lead to loss of shade intolerant deciduous woody species.

Grazing and trampling by domestic and wild ungulates can shift the composition toward weedy and/or nonriparian species. Associated bank damage, which results in headcutting and incision, can result when bank stabilizing vegetation is removed and/or damaged by ungulate activity. Livestock grazing, however, would result in downcutting only along smaller streams. Browsing of cottonwood and willow by cattle and/or native ungulates and beavers could retard the development of this type in favor of herbaceous vegetation.

Loss of beavers can, coupled with heavy ungulate use, shift dominance in these systems to herbaceous

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species. (This comment was questioned during review.)

Exotic trees of Russian olive (Elaeagnus angustifolia), especially in lower elevation, wide valley bottom systems, are common in some stands. Herbaceous noxious weeds, including leafy spurge, tansy and spotted knapweed readily invade and persist in these systems today. Tamarisk is becoming a concern. Perennial pepperweed may be an issue as well. Russian olive and tamarisk, however, would unlikely be over 5000ft in MZ29 at least.

Trapping of beaver affects beaver presence, thus the storage of ground water and the recharging of the local aquifer.

This system to be distinguished from 1162 Floodplains Systems by geographic range/ecoregions. The Great Plains Floodplain systems are in the Northwestern Glaciated Plains and the Northern Great Plains; the Rocky Mountain Montane Riparian systems are in the lower elevations (ie, not alpine) of the Northern and Middle Rockies, some of which occur as isolated mountain ranges in the Great Plains. Broadly generalized, the Great Plains Floodplain systems typically have broader floodplains and more terrace development.

For MZ29, the RM riparian systems will occur in the mountains, while Great Plains riparian and floodplain will be lower elevations, in the plains matrix, and better covered by 1162. The exception to this is the strings of narrow-leaf cottonwood (P. angustifolia) found along the Laramie river and other rivers in the Wyoming portions of MZ29, which are Rocky Mountain in character despite being surrounded by grasslands and sage-steppe. These riparian zones in the middle of sage-steppe are really Rocky Mountain systems, not Great Plains. So Rocky Mountain riparian is in higher elevation areas, the intermountain parks rather than the eastern WY and east MT plains grasslands.

Also - montane riparian systems of central MT and probably the Black Hills too, will have steeper gradients, narrower floodplains, and be dominated by Populus angustifolia or P. balsamifera as opposed to P. deltoides for Great Plains floodplains. Rivers like the Powder, Tongue and probably Little Missouri start as montane rivers and become Great Plains rivers.

There might be some difficulty distinguishing the Floodplain Systems from the Riparian from the Wooded Draw/Ravines - and determining where to assign smaller, second and third order prairie streams. The second and third order prairie streams can sometimes have cottonwood and be like small rivers (Riparian, Floodplain); sometimes they are dominated by other woody spcies, such as water birch, box-elder, green ash (Wooded Draw/Ravine) and willows, depending on how far east you go; sometimes they have very few woody plants other than silver sagebrush (Floodplain box E). Streams in the eastern half of MT (east of the Big Snowies) could probably be modeled as either a cottonwood successional sequence or a woody draw successional sequence, depending on the size of the drainage basin. If the basin is big enough there will eventually be a flood big enough to result in cottonwood regeneration. This may not happen very often naturally, so these types of drainages would be in class E Floodplains (silver sagebrush) a lot of the time. This is especially true now that we have all the impoundments in the headwaters of these prairie streams. Drainages that just don't have the area to get a serious flood would probably have been some sort of woody draw, dominated by green ash in the eastern third of the state or other woody species like hawthorn or chokecherry in the more western part of the Great Plains. In terms of assigning the drainage to one or the other type of system would depend on basin size.

It’s not clear whether this system is meant to include all streamside vegetation in the mountains, or

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perhaps that is covered by 1160. If it's in 1159, it should be remembered that a lot of canyons, even at fairly low elevation have spruce, alder, dogwood and a few willows along the streams, especially if the matrix vegetation is coniferous forest and the channel is constrained by geology, usually in steeper terrain. Perhaps this type of riparian vegetation would just be mapped with the adjacent coniferous forest.

Fire suppression and impoundment (unsure of how often dams are a problem in these montane systems in MZ29) would result in more late-seral vegetation on the landscape; ie, more conifers, such as spruce and juniper (maybe pine) in with the cottonwoods. However, the paucity of beavers probably means that there are more mature cottonwoods and willows now than there might have been in presettlement times. So perhaps pre-European settlement, there was probably more early-seral vegetation due to floods, fire and beavers.

Native Uncharacteristic Conditions

Fire suppression and impoundment (unsure of how often dams are a problem in these montane systems in MZ29) would result in more late-seral vegetation on the landscape; ie, more conifers, such as spruce and juniper (maybe pine) with the cottonwoods. However, the paucity of beavers probably means that there are more mature cottonwoods and willows now than there might have been in presettlement times. So perhaps pre-European settlement, there was probably more early-seral vegetation due to floods, fire and beavers.

Scale Description

These systems can exist as small to large linear features in the landscape. In larger, low elevation riverine systems, this system may exist as mid-large patches, as a function of valley bottom width and gradient.

Issues/Problems

Comments

This model for MZ29 was adopted from MZ20 created by Linda Vance and Steve Barrett and reviewed by Mary Manning. Descriptive and quantitative changes were made - in order to represent MZ29, but also to better represent a picture of disturbance reality in general.

This model for MZ20 was adapted from the same BpS in MZ21, created by John Simons (john_simons@blm.gov) and an anonymous contributor and reviewed by Chris Baker (clbaker@fs.fed.us), Jim Ozenberger (Jozenberger@fs.fed.us), Andy Norman (anorman@fs.fed.us), Sarah Canham (scanham@fs.fed.us) and Brenda Fiddick (bfiddick@fs.fed.us). Quantitative and descriptive changes were made, and the model's FRI for MZ20 more closely resembles that for MZs 10 and 19.

The model for MZ21 is based on the LANDFIRE model for the same BpS 1159 for MZ10 created by Don Major (dmajor@tnc.org) and Mary Manning (mmanning@fs.fed.us) and reviewed by Carly Gibson (cgibson@fs.fed.us), Cathy Stewart (cstewart@fs.fed.us) and John DiBari (jndibari@yahoo.com). Many quantitative changes were made to the model for MZ21 so that fire and other disturbance intervals matched those in 211154 (Black Cottonwood). The disturbance model should be identical to that in 1154 (Black cottonwood).

Additional reviewer for MZ10 was Steve Barrett (sbarrett@mtdig.net). MZ10 model was adapted from a model for the same BpS in MZs 12 and 17. The VDDT model for this system for MZ10 was taken from BpS 1160 and modified to highlight the dominance of the hydrologic regime.

Vegetation Classes

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Class A 15 %

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 3

Indicator Species* and Canopy Position

POPUL	Upper
SALIX	Upper
COSE16	Middle
CAREX	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Shrub 0m	Shrub 3.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Immediate post-disturbance responses are dependent on pre-burn vegetation composition. This class is dominated by sprouting shrubs that respond favorably to fire. Species composition is highly variable. Silt, gravel, cobble and woody debris may be common.

Generally, this class is expected to occur 1-5yrs post-disturbance. Replacement fire (100yrs), will set this class back to the beginning. Flooding (0.05 probability) will maintain this class.

Beavers were originally modeled as a disturbance; however, for MZ29, it was questioned as to whether beavers would be interested in small shrubs and trees 1-5yrs old; therefore, they were removed from this early class.

Class B 60 %

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 3

Indicator Species* and Canopy Position

POPUL	Upper
SALIX	Mid-Upper
COSE16	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Shrub 3.1m	Shrub >3.1m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Highly dependent on the hydrologic regime. Vegetation composition includes tall shrubs and small trees (cottonwood, aspen and conifers). This class persists for approximately 20-25yrs.

Modeled disturbances include: 1) weather-related stress expressed as annual flooding events occuring every five years, which maintains vegetation in class B, and 2) periodic flooding events (weather-related stress) every 100yrs causing stand replacement, 3) replacement and mixed severity fire every 100yrs each, (mixed causing no transition) and 4) beaver (Castor canadensis) herbivory (Option1). Beaver herbivory occurs causing, respectively, a transition back to class A every 40yrs and maintenance in class B every 40yrs. Succession to class C after approximately 25yrs.

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Class C 25 %

Late Development 1 Closed

Indicator Species* and Canopy Position

POPUL	Upper
PINUS	Upper
SALIX	Mid-Upper
JUSC2	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Tree 0m	Tree 50m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 3

Description

This class represents the mature, large cottonwood, conifer, etc. woodlands. In MT, these closed late systems can also be dominated by Rocky Mountain juniper, or spruce at higher elevations, and green ash at lower elevations. Ponderosa pine is only one possible dominant. Red osier dogwood is an indicator in all of these, with a range of 10-60% cover depending on overstory species. Other dominant and indicator species are interior Douglas-fir in the upland areas, PICEA, FRAPEN and COSE16. For MZ29, spruce may have been just as common as pine in this class, and green ash is questionable.

Generally, this class persists until a replacement disturbance (beavers, flooding, replacement fire) cause a transition to class A.

Some flooding events (weather-related stress) cause a transition to class A every 200yrs, whereas other flood events cause a transition to class B every 200yrs, and some occur every five years but just maintain the class.

Replacement fire is caused by importation from surrounding systems. Replacement and mixed fire overall every 100yrs each (mixed causing no transition).

Beaver activity infrequently causes (0.001 probability) a thinning disturbance to class B, but some beaver activity is frequent (5-10yrs) and just maintains this class, and some is a replacement disturbance, causing a transition back to A (every 40yrs or 2.5% of class each year).

Beavers were modeled as a replacement disturbance in class C in MZ29, as beavers probably had a major impact on presettlement montane riparian forests. Many were trapped out before settlers got here. Therefore, the previous percentage of 40% in class C was thought to be too high. Where beaver are common, there are few large cottonwoods within 50m of the water, and most montane riparian zones wouldn't have been too much more than 100 yards wide. This is opinion based on the Marias River (north-central MT) and the fact that the Beaverhead River (southwest MT) had no cottonwood when Lewis & Clark came through (Lesica, pers comm). Therefore, replacement disturbance beaver impact was modeled as occurring every 40yrs (as in class B). This reduced the percentage of this class.

Ice scour was originally modeled; however, it was removed for MZ29, as little likelihood that it occurred east of the continental divide.

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Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg 100
Min 1
Max 1000

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	100	75	275	0.01	53
Mixed	115			0.0087	46
Surface					
All Fires	53			0.01871	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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**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 sev

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911600** **Rocky Mountain Subalpine/Upper Montane Riparian Systems**

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

General Information

Contributors (also see the Comments field **Date** 6/13/2006

Modeler 1	Linda Vance	livance@mt.gov	**Reviewer**	Peter Lesica	peter.lesica@mso.umt.edu
Modeler 2	Steve Barrett	sbarrett@mtdig.net	**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type

Wetlands/Riparian

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

SALIX ABLA
CAREX PIEN
PSEUD7 POPUL
PICO PICEA

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Higher elevations in the zone down to valley riverbottoms. In MZ20, this BpS is very limited in extent.

For MZ29, this type would occur only in section M331B.

Biophysical Site Description

This ecological system represents the combination of numerous riparian types occurring in the upper montane/subalpine zones. Found at 900-3000m (3000-10000ft), but range is probably more like 6000-8000ft in MZ20. This ecological system typically exists as relatively small linear stringers, but can occupy relatively wide and flat valleys. This is a widely dispersed type generally adjacent to live water.

Although reviewers recommended that the descriptions be made less broad so as to adhere more to high elevation, it was decided that this type includes montane and subalpine elevations and therefore descriptions were kept broad.

These wetlands typically are in small upper-elevation watersheds that periodically experience high rainfall in short periods from late season snowmelt and convective thunderstorms.

In MZ29, it probably occurs at 6000-11000ft in the Bighorn Mountains.

Vegetation Description

These systems are highly variable and generally consist of one or more of the following five basic vegetation forms: 1) cottonwoods (might not occur in this type in Bighorns in MZ29); 2) willows and

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other shrubs; 3) sedges and other herbaceous vegetation; 4) aspen; and 5) conifers (primarily spruce and subalpine fir).

This BpS encompasses a broad array of riparian species. It is composed of seasonally flooded forests, woodlands and shrublands found at montane to subalpine elevations.

For MZ29, trees include aspens, coniferous forests - Picea engelmannii, Vaccinium, Ledum, Phyllodoce and Calamagrostis canadensis. Dominant and indicator species would be Picea engelmannii, Ledum, Salix, Alnus, Carex and Deschampsia.

Shrubs include bog birch and willows (eg, Salix planifolia, S. wolfii, S. drummondii, S. geyeriana and S. bebbiana) among others. Shrubs for MZ29 include Salix boothii, S. geyeriana, S. bebbiana, S. planifolia, S. drummondiana, Alnus viridis and S. wolfii.

Graminoids include tufted hairgrass, bluejoint reedgrass, beaked sedge (Carex utriculata) and water sedge (Carex aquatilis), among others. Sedges and grasses for MZ29 include Deschampsia cespitosa, Carex aquatilis, Carex utriculata, Carex lenticularis, Juncus balticus and Calamagrostis canadensis.

Other Salix species for MZ20 may include Salix candida, S. lutea, S. planifolia, S. serissima, S. barclayi, S. exigua, S. lasiandra, S. psudomonticola, S. commutata and S. tweedyi.

At lower elevations in MZ20, some of this riparian type (eg the S. exigua community type) typically includes cottonwood species. At higher elevations, S. geyeriana communities often includes aspen. At the highest elevations, S. planifolia sometimes has a spruce-fir-lodgepole component. In MZ20, high elevation meadows have the spruce-fir component interspersed in the wetlands along with the addition of lodgepole pine. These occupy low-gradient alluvial settings.

Disturbance Description

Flooding events and availability of water during drier periods are the major influences to this system, as a function of slope. Frequent flood events maintain vegetation but do not scour it, whereas larger, infrequent flood events scour and deposit sediments, resetting succession to early development, depending on vegetation. The importance of flooding as a disturbance depends on the degree of slope. Meandering, low-gradient streams are probably little changed by flood events outside of some deposition. However, high-gradient streams can be scoured by flood events, although these kinds of streams usually have narrow floodplains.

Reviewers felt that this BpS 1160 is more consistently wet with deep root systems, deep fens, springs, and small streams; flooding events aren't the major influence. Short growing season, temperature, radiation, avalanches, snow events, ice and scouring, herbivory and possibly long-interval fire regimes are major disturbances, but more data are still needed (Ozenberger, personal communication).

These wetlands are in small upper-elevation watersheds that periodically experience high rainfall in short periods from convective thunderstorms, leading to rapid runoff and mobilization of the fine alluvium in willow-dominated areas and even some of the rocks in conifer-dominated riparian on steeper gradients. Floods in willow-dominated alluvium may not show up as rushing streams scouring banks, but more as a rising bathtub type of flood. Alluvium does get moved and willows get topkilled by inundation or by deposition or removal of alluvium (anonymous contributor, personal correspondence). In MZ20, at least, these watersheds are also common at lower elevations too.

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Sites are probably fairly lush, so fires may skip over them. This would be a patchy replacement fire, topkilling all the vegetation. Most of the species are fire-adapted and would respond favorably (Dwire et al. 2004). Fire would probably only have a significant, long-term impact only on the conifer and aspen-dominated riparian zones.

Fire intervals for MZ21 were modeled as 3x longer than those in MZs 10 and 19.

Beaver (Castor canadensis) crop cottonwoods (Populus spp) and willows (Salix spp) and frequently influence the hydrologic regime through construction of dams (ponding water and slow release). Beavers show movement along rivers as available trees are felled. Beavers were the main agent of disturbance in presettlement times. Beaver dams impounded large, low-gradient valleys, allowing wetland and meadow vegetation to dominate in what might have been forest or steppe.

Adjacency or Identification Concerns

This BpS includes narrow to moderately wide meadows, shrublands and woodlands of conifers and aspen. It is adjacent to conifer/deciduous forest.

Over-grazing and irrigation use have had major impacts on some of these systems. Exotics in this setting are primarily Kentucky bluegrass, smooth brome, quackgrass, redtop, timothy, orchardgrass and dandelion.

Domestic sheep may be an issue in the Wyoming and Wind River Ranges. Global warming and acid rain may affect vegetation.

Many low-gradient, middle to high-elevation streams have suffered from livestock grazing in the past 120yrs. Cattle and sheep destroy or weaken the streamside vegetation allowing the stream to downcut its banks which in turn causes drying of the riparian area. Plus the loss of beavers in many of these systems means that natural downcutting and drying are not reversed by the trapping of sediment in beaver impoundments. The result is that many montane riparian areas are narrower with smaller or more decadent shrubs.

Many moist to wet meadows have high canopy cover of Juncus balticus and unpalatable forbs instead of Deschampsia cespitosa as a result of livestock grazing.

Native Uncharacteristic Conditions

Many moist to wet meadows have high canopy cover of Juncus balticus and unpalatable forbs instead of Deschampsia cespitosa as a result of livestock grazing.

Scale Description

These systems are small linear or relatively wide features in the landscape.

Per NatureServe, stands are variable, occurring as narrow bands of trees and/or shrubs lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels to larger floodplains or terraces of rivers and streams, in V-shaped, narrow valleys and canyons.

When into the upper montane and subalpine zones the streams are too small to be thought of as rivers. These are more headwaters streams.

Issues/Problems

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Comments

This model for MZ29 was adopted as-is from the same model from MZ20 created by Linda Vance and Steve Barrett and reviewed by Mary Manning.

This model for MZ20 was adapted from the same BpS in MZ21 created by Tim Klukas (tim_klukas@nps.gov), John Simons (john_simons@blm.gov) and an anonymous contributor and reviewed by Jim Ozenberger (jozenberger@fs.fed.us), Andy Norman (anorman@fs.fed.us), Sarah Canham (scanham@fs.fed.us) and Brenda Fiddick (bfiddick@fs.fed.us). Descriptive and quantitative changes were made to better reflect MZ20 and to have the FRI resemble other mapzones' and other adjacent systems more closely. Descriptive and other quantitative changes were made upon further review, to more closely match the models from MZs 10, 19, 12 and 17.

The model for MZ21 was adapted from the LANDFIRE models for the same BpS 1160 from MZs 10, 19, 12, 17 and 16; models from MZs 10 and 19 were created by Don Major (dmajor@tnc.org) and Mary Manning (mmanning@fs.fed.us) and reviewed by Carly Gibson (cgibson@fs.fed.us), Cathy Stewart (cstewart@fs.fed.us), John DiBari (jndibari@yahoo.com) and Steve Barrett (sbarrett@mtdig.net). For MZ21, descriptions were modified, and fire intervals were changed/increased (less fire).

Vegetation Classes

Class A 55 %

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 3

Indicator Species* and Canopy Position

SALIX	Upper
CAREX	Upper
PSEUD7	Middle
POPUL	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Shrub 0m	Shrub 3.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Immediate post-fire responses in this ecological system are dependent on pre-burn vegetation form. Post-burn condition sensitive to scouring and blow-out from floods. Generally, this class is expected to occur 1-3yrs post-disturbance. This class is shrub or grass dominated. Composition varies both within/among reaches. This class succeeds to B in 20yrs. Succession is highly variable due to high moisture levels and high species variability.

This class could contain seedlings of Douglas-fir, lodgepole pine, cottonwood, aspen, spruce and subalpine fir.

This class could be thought of as the shrub-dominated version of this sytem. There would be little effect of fire after a couple of years, becaue nothing is killed, and everything sprouts right back. This class could also be thought of as a tree-dominated (aspen or spruce) version of the system where fire has killed or set the trees back to this class, class A, and then after 10yrs (aspen) or 30yrs (spruce), the stands return to a tree-dominated stage, class B.

Flooding disturbances (modeled as weather-related stress) include events that do not scour every two years and events that reset the vegetation to age zero every 100yrs (Option 2).

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Beaver (Option 1) reset succession every 10yrs by moving along the river with tree depletion.

Replacement and mixed fire were modeled with an overall FRI of 150yrs, split 50/50.

Native grazing occurs very infrequently (probability 0.001).

Class B **45 %**

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 3

Indicator Species* and Canopy Position

SALIX	Middle
CAREX	Middle
PSEUD7	Upper
POPUL	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 0m	Tree 50m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Highly dependent on the hydrologic regime. For example, could include any combination of the five vegetation forms described above in "Vegetation Description". Composition of adjacent uplands is the determining factor for future fire events.

This class contains grasses, shrubs and maturing trees of Douglas-fir, lodgepole pine, cottonwood, aspen, spruce and subalpine fir.

Replacement and mixed fire were modeled with an overall FRI of 150yrs, split 50/50.

100-yr flood events (option 2) reset vegetation to early class. Every 33yrs, beavers (option 1), and every 10yrs, non-scouring flooding occur but have no effect on succession classes.

Beavers would be most active in aspen-dominated systems and least active in spruce-dominated systems. Given a long enough time (probably 200-300yrs), aspen would be invaded and overrun by spruce.

Class C **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg 10
Min 1
Max 100

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	300	100	500	0.00333	50
Mixed	300			0.00333	50
Surface					
All Fires	150			0.00668	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

☐ Insects/Disease
☑ Wind/Weather/Stress
☑ Native Grazing
☐ Competition
☑ Other (optional 1) Beaver
☑ Other (optional 2) 100-year flood events

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LANDFIRE Biophysical Setting Model

***Biophysical Setting* 2911620 Western Great Plains Floodplain Systems**

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

General Information

Contributors (also see the Comments field **Date** 4/6/2006

Modeler 1	Peter Lesica	peter.lesica@mso.umt.edu	**Reviewer**	Carolyn Sieg	csieg@fs.fed.us
Modeler 2	Elena Contreras	econtreras@tnc.org	**Reviewer**	Jack Butler	jackbutler@fs.fed.us
Modeler 3			**Reviewer**	Peter Lesica (rvwd for 29/30)	peter.lesica@mso.umt.edu

Vegetation Type

Wetlands/Riparian

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

PODE3 CORNU
SALU2 ROSA5
SAEX FRPE
SAAM2 ARCA13

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Great Plains river systems from eastern MT west to the Rocky Mountain front. Such river systems include the Missouri, Mussell, Yellowstone, Teton, Marias and Sun Rivers. The major tributaries to these river systems would be in this BpS. Cheyenne River in MZ31 into MZ29. Belle Fourche in WY into SD. Little Missouri - ND/SD. Yellowstone River. In MZ30, it would be in section 331Md along the floodplain of the Little Missouri River. This would occur throughout MZ29 in MT, including Yellowstone and its major tributaries in Bighorn, Tongue, Powder and the Little Missouri. In MZ30 it would include the Yellowstone and Missouri rivers (331E, 331M).

See Adjacency/Identification Concerns box regarding smaller second and third order prairie streams and where they occur or what they're classified as. Also see Adj/ID box to describe how to distinguish this from Rocky Mountain riparian systems.

Biophysical Site Description

Alluvial surfaces, usually bare, within broad floodplains are present as low elevation shorelines and barforms. The slightly higher fluvial landform adjacent to the channel forms the first terrace for fluvial dependent species. Over time, laterally migrating point bars form bench platforms that may become late seral stage floodplain forests.

Great Plains riparian and floodplain will be lower elevations/in the plains matrix.

Vegetation Description

Dominant types are cottonwood and willow. Broadleaf deciduous forest dominated by cottonwood

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(primarily Populus deltoides), yellow willow, or peach leaf willow and sandbar willow. In the Milk River drainages, narrowleaf cottonwood (Populus angustifolia) is common (but rare or absent in MZ29 and 30). Narrowleaf cottonwood occurs in upper (intermountain valley) reaches of the Marias and Yellowstone Rivers. Black cottonwood (Populus trichocarpa) is found along the Milk and Yellowstone, but only occasionally along the Marias (and not in MZs 29 and 30). Early seral stage phreatophytic vegetation becomes established on low elevation flood deposits, however, long-term survival is possible only on bare, moist sites on slightly higher elevation (1-3m above lower limit of perennial vegetation) Other species found in the floodplain riparian zone include sandbar willow, boxelder, green ash typically associated with late seral stages. Boxelder is more common along the Milk than along some of the other drainages. Boxelder, however, is also seen today in the Musselshell/Little Missouri River, but it is questionable as to whether that would have occurred historically. Girard et al. (1989) do not report boxelder for cottonwood forests, and Hansen et al. do not report boxelder for plains cottonwood forests in MT.

P. deltoides and Fraxinus pennsylvanica are characteristic of Great Plains riparian forests. Fraxinus becomes a dominant in MZ30 riparian areas where it comes in after P. deltoides, grows much more slowly, but persists after P. deltoides because it can recruit into shaded, relatively undisturbed sites. Fraxinus pennsylvanica was therefore added as a dominant for MZ29 and 30, and PASM was removed.

Green ash commonly forms a subcanopy in older stands and can eventually dominate if stands persist for more than 150-200yrs without major flood disturbance.

PODE is a pioneer species along Missouri River, in central ND, in southeast SD and near Omaha, NE, and is replaced successionally by various combinations of Fraxinus, Ulmus, Acer and Celtis (Hansen et al. 1984). Undergrowth dominated by SYOC, RHAR and other shrubs. Among the grasses, Calamovilfa longifolia, Elymus canddensis and Muhlenbergia racemosa are important (Hansen et al. 1984).

In Theodore Roosevelt National Park in ND, Poa pratensis is the most important grass, and Melilotus officinalis is the most important forb (Hansen et al. 1984).

Silver sage is present in this system in the late successional stage.

Understory species in these later seral stages may include dogwood, currents, snowberry, wild rose and chokecherry.

Disturbance Description

The development and maintenance of this system is dependent on fluvial geomorphic processes such as channel meandering/erosional processes of river flooding, sedimentation, erosion, channel avulsion and barform accretion driven by hydrologic variability. This variability incorporates the features of timing, duration, frequency, magnitude and intensity. Regeneration of the dominant species (cottonwood and willow) is dependent on flooding and movement of river channels, which creates bare, moist soil needed for seedling establishment. Oxbow and slough development also influence the floodplain system and create variability in plant community composition. Upper terraces have infrequent flooding and scouring events, while the lower terraces nearest the river flood frequently.

Early seral stage development stands are produced on point bars via channel meandering, which occurs most often during moderately frequent high flows. Also produced in other ways - ie: two kinds of rivers - meandering and as well as occurring on areas of sediment deposition - if river has large flood and bare area created, then system established; or via silt deposit that assists establishment (Scott et al 1996).

Scouring caused by ice jams during the winter, channel meandering, oxbows and slough development greatly influence this system. Ice jams and ice scouring were not modeled.

Changes in hydrology due to the activities of beaver are also an important ecological process in the Great Plains Floodplain, particularly on the tributaries (Little Missouri) to the Missouri River, as well as tributaries of the Yellowstone River (Powder, Tongue and Bighorn). Beavers are present on the main stem Yellowstone River, but are not critically important because bank dens are frequently flooded and destroyed. Beaver impoundments kill trees (sometimes over large areas) and may create open water habitat, willow stands or contribute to channel meandering. The effects of beaver ponds on forest dynamics in this system are also poorly understood at the landscape level, especially in the presettlement context. Note that beaver populations might have been maintained at artificially low levels on the Great Plains due to constant harvesting by humans. Beaver activity could have been a large influence in this sytem historically. It could have contributed to the system going from the mid seral stage to the silver stagebrush stage. However, this would happen if they were old stands on higher terraces close to the channel, but not if they were younger stands on lower, moister terraces. Cottonwoods on lower moister terraces would resprout and there would be a willow-cottonwood, beaver-induced disclimax. Beaver damage could be highly extensive in areas in this system (Lesica and Miles 2004; 1999). The effects of beaver activity on forest dynamics in this system are also not well understood at the landscape level, especially in the presettlement context.

Traveling ungulate herds and Native American activities locally impacted seral stage development. However, not enough is known about about such disturbance to attempt modeling. Native Americans likely camped along rivers and used fire to attract game - low severity fires in early spring probably more frequent than 50-75yrs (Butler, pers comm).

This seral community is most affected by fluvial geomorphic processes such as flooding, avulsion and deposition, and channel movement. The floodplain valley was modeled up to the last high terrace that rarely floods to reset to an early successional seral stage. The model does include shallow wetlands, sloughs or oxbows. Deep water habitat and the wetted width of the active river were not included in the model. Different flooding regimes were used in the model. The rivers flood to some extent almost every year. This annual, spring, snowmelt flooding is the primary driver of point bar formation. 50-yr or 100-yr floods can wipe out point bars, but they form lots of habitat for cottonwood and willow establishment through scouring and deposition. Minor, point-bar forming floods occur almost every year, while serious, scouring, high-terrace depositing events may be 20-50yrs. Flood frequency is also based on location on the floodplain, with higher terraces being subject to longer flood cycles.

Fire was a disturbance mechanism within portions of floodplain, however, the frequency and intensity is unknown. We can, however infer mixed severity fires in general, given the highly variable species and varying fuel amounts and spatial arrangements. The role of fire was less important, with relatively infrequent and patchy, low to mixed severity fires. A reviewer (Barrett, personal correspondence) commented that the overall FRI was probably approximately 50-75yrs given the presumably abundant ignition opportunities in the neighborhood (ie: occassional fires spreading into this BpS from adjacent frequently burned grasslands). The overall FRI was thus modeled as such. However, Butler commented that Native Americans likely camped along rivers and used fire to attract game - low severity fires in early spring probably more frequent than 50-75yrs (Butler, pers comm).

Adjacency or Identification Concerns

This system is easily identified by using flood plain which is covered by a 10yr event. Surrounding vegetation could vary from forested to grass prairie transition. In the western part of MZ20, could have narrowleaf cottonwood and could have hybrids between this system and narrowleaf.

Russian olive and tamarisk may be invaders. Tamarisk comes in with cottonwood and willow in earliest post-disturbance stage. Russian olive might affect later successional stages - after 10yrs, usually at approximately the time that green ash and Rocky Mountain juniper come in. Rocky mountain juniper also invades along the Little Missouri River in MZ29.

Leafy spruce, Smooth brome, Canada thistle and Russian knapweed might invade also.

The natural flooding frequencies have been changed by the modern water control structures (dam and irrigation projects). Flooding intensity has been altered by construction of small impoundments on tributaries as well as larger impoundments on the main-stem rivers. Decreased flood frequency along the Little Missouri River, decreased cottonwood abundance and increased distribution of silver sage in MZ29 currently. However, this trend has just started - ie: increase of silver stage today vs historically.

Agriculturial activities have change seral development and introduced invasive plant species to the BpS.

Woodcutters along the system operated from the earliest days (1860s) to supply wood to the paddlewheelers plying the river. They cut many of the early stands along the river and perhaps threw the balance to POPDEL regeneration as opposed to ACENEG. It is very difficult to model the presettlement conditions of these river systems, not knowing their original composition.

Currently, there would be higher cover and taller shrubs on the landscape today, versus historically - in MZs 29 and 30.

Johnson (1992), in a study of Missouri River floodplain forests in central North Dakota, determined that the presettlement forest was, in fact, dominated by early successional stages. He reports that young pioneer stands (<40yrs) comprised 47% of the forest, while older pioneer stands (40-80yrs) comprised 25% of the forest; that transitional forest (80-150yrs) comprised 21% of the forested acreage and that equilibrium stands (dominated by green ash, elm, oak, etc.) (>150yrs) comprised only seven percent of the forested acreage. Johnson (1992) also demonstrated that with construction of Garrison Dam and subsequent cessation of flooding, there is a continuing shift to older forest stages and very little recruitment of new, early successional forest; the very types that once dominated the Missouri River floodplain and provided habitat for its varied native wildlife.(from Ode 2004).

Over the past 37yrs much has changed in the cottonwood forest of LaFramboise Island in SD. As the density of cottonwoods has declined (at a rate of about two per acre per year), the number of junipers and, to some extent, green ash have dramatically increased. In cottonwood forests throughout much of the upper Missouri River Valley, green ash is one of the most important tree species to colonize cottonwood forests and, over time, becomes the dominant forest tree (Ode 2004). Whatever the dominance of green ash in the future forest, it will likely be overwhelmed if not over-shadowedvby the massive number of junipers which are now developing in the LaFramboise Island forest understory (Ode 2004). Cottonwood is declining.

Junipers are notoriously vulnerable to fire. On the presettlement landscape of the northern plains, where

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prairie fires were frequent events, juniper woodlands were restricted to fire-protected environments like river breaks, badland escarpments, buttes and islands (Ode 2004).

This system to be distinguished from 1159 by geographic range/ecoregions. The Great Plains Floodplain systems are in the Northwestern Glaciated Plains and the Northern Great Plains; the Rocky Mountain Montane Riparian systems are in the lower elevations (ie, not alpine) of the Northern and Middle Rockies, some of which occur as isolated mountain ranges in the Great Plains. Broadly generalized, the Great Plains Floodplain systems typically have broader floodplains and more terrace development.

Also - montane riparian systems of central MT and probably the Black Hills too will have steeper gradients, narrower floodplain, and be dominated by Populus angustifolia or P. balsamifera as opposed to P. deltoides for Great Plains floodplains. Rivers like the Powder, Tongue and probably Little Missouri start as montane rivers and become Great Plains rivers.

There might be some difficulty distinguishing the Floodplain Systems from the Riparian from the Wooded Draw/Ravines - and where to assign smaller, second and third order prairie streams. The second and third order prairie streams can sometimes have cottonwood and be like small rivers (Riparian, Floodplain); sometimes they are dominated by other woodies such as water birch, boxelder, green ash (Wooded Draw/Ravine) and willows, depending on how far east you go; sometimes they have very few woody plants other than silver sagebrush (Floodplain box E). Streams in the eastern half of MT (east of the Big Snowies) could probably be modeled as either a cottonwood successional sequence or a woody draw successional sequence, depending on the size of the drainage basin. If the basin is big enough there will eventually be a flood big enough to result in cottonwood regeneration. This may not happen very often naturally, so these types of drainages would be in class E Floodplains (silver sagebrush) a lot of the time. This is especially true now that we have all the impoundments in the headwaters of these prairie streams. Drainages that just don't have the area to get a serious flood would probably have been some sort of woody draw, dominated by green ash in the eastern third of the state or other woodies like hawthorn or chokecherry in the more western part of the Great Plains. In terms of assigning the drainage to one or the other type of system, it would depend on basin size.

The Rocky Mountain riparian systems will occur in the mountains, while Great Plains riparian and floodplain 1162 will be lower elevations/in the plains matrix of eastern WY and east MT plains grasslands and better described by 1162. The exception to this is the strings of narrow-leaf cottonwood (P. angustifolia) found along the Laramie river and other rivers in the Wyoming portions of MZ29, which are Rocky Mountain in character despite being surrounded by grasslands and sage-steppe. These riparian zones in the middle of sage-steppe are really Rocky Mountain systems, not Great Plains.

Rivers and streams that have had impoundments (current conditions) for 50yrs or more probably have more class D and E than presettlement but less class A and B. Class A and B currently has tamarisk. Class C and D have Russian olive currently. Several exotics, such as Canada thistle, Kentucky bluegrass and quackgrass are ubiquitous in classes B through E currently.

Native Uncharacteristic Conditions

Native uncharacteristic conditions- Rivers such as the Missouri below Fort Peck Dam and the Bighorn and Tongue below their dams probably have more late-seral and less early-seral vegetation because of the reduced flooding frequency and severity.

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Scale Description

Landscape adequate in size to contain natural variation in vegetation and disturbance regime. This BpS occurred in a linear dimension along the Missouri River floodplain and Little Missouri River (MZ30), with smaller areas covered in tributary rivers and streams. Wetland complexes include oxbow lakes, slough and marshes.

Issues/Problems

Assumptions: Rapid Assessment model developed with the recognition that the Great Plains Floodplain forest (cottonwood-willow community) is a seral community. This seral community is most affected by fluvial geomorphic processes such as flooding, avulsion and deposition, and channel movement. The floodplain valley was modeled up to the last high terrace that rarely floods to reset to an early successional seral stage. The model does include shallow wetlands, sloughs or oxbows. Deep water habitat and the wetted width of the active river were not included in the model. Flood frequency for a class is based on location on the floodplain, with higher terraces being subject to longer flood cycles.

Woodcutters along the system operated from the earliest days (1860s) to supply wood to the paddlewheelers plying the river. They cut many of the early stands along the river and perhaps threw the balance to POPDEL regeneration as opposed to ACENEG. It is very difficult to model the presettlement conditions of these river systems, not knowing their original composition.

Comments

This model for MZs 29 and 30 was adopted as-is from the same BpS from MZ20 created by Peter Lesica and Vinita Shea and reviewed by Brian Martin, Steve Cooper and Linda Vance. Slight model changes made.

This model for MZ20 was adapted from the Rapid Assessment model R4NOFP Great Plains Floodplain created by George Cunningham (gcunningham@mail.unomaha.edu) and reviewed by John Ortmann (jortmann@tnc.org). The model for MZ20 was modified greatly descriptively and quantitatively by Vinita Shea (vshea@blm.gov) and Ben Pratt (ben_pratt@fws.gov). The model is also reflective of the Upper Missouri River region. Upon review for MZ20 by Peter Lesica, Brian Martin and Steve Cooper, other major quantitative changes were made and successional classes were changed to encompass the silver sagebrush component of class E instead of a green ash community, which was thought to not exist in MZ20. Other reviewers for MZ20 were Steve Barrett.

Vegetation Classes

Class A **15%**

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Description

Indicator Species* and Canopy Position

PODE3	Upper
SAEX	Upper
SALU2	Upper
SCHOE6	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

The upper layer lifeform is comprised of a seedling and sapling shrub (willows) and tree component. Trees might be more abundant/frequent. Shrubs of any cover and 0-1m are in this class.

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Created by deposition, stream meander changes, point bar formation and scouring.

This model was originally made with two early classes, A and B. One reviewer for MZs 29 and 30 suggested combining classes A and B. They were combined for MZs 29 and 30 in order to accommodate another late successional stage with green ash and boxelder. This class is now ages from 0-15yrs.

The upper layer lifeform is comprised of a seedling and sapling shrub (willows) and tree component and dominated by a young canopy of tree saplings and shrubs after a few years. Trees might be more abundant/frequent.

Sandbar willow, Salix interior is invariably the first species to make its appearance on the newly made lands on the borders of the Mississippi and Missouri, and seems to contribute much towards facilitating the operation of raising this ground still higher; they grow remarkably close and, in some instances, so much so that they form a thicket almost impenetrable (from Meriwether Lewis during the Lewis & Clark expedition in 1804 to 1806, from Ode 2004).

Pioneer tree and shrub species of cottonwoods and willows. The understory is highly variable and consists of bare sand, annuals or perennial hydrophytes. Species would include various grass, sedges and rushes. Annuals become less and less common after 10yrs as the rhizomatous perennials take hold. Herbaceous understory of sedges (bulrushes) and native annuals in wet areas. In the early few years of this stage, most of the area is bare sand. Age 0-4yrs for the first part of this class, then 5-14yrs for the second part of this class.

Most of area is seasonally flooded. Much bare, wet-alluvium habitat for cottonwood establishment is created each year during spring floods. However, most all of these will be swept away by the next year's flood in the early part of this class. It is probably only every 10-20yrs that flooding occurs up high enough on point bars and low terraces to establish cottonwoods and then allow them to escape flooding until they are large enough to persist - in the early part of this class.

During the 2nd part of this class, at age 5-14yrs, minor flooding occurs every 20yrs, advancing this stage to the next; deposition causes the terrace to build and become higher and drier. This was modeled as alternate succession. Lack of flooding actually maintains the stage.

Major flooding occurs every 50yrs, bringing it back to the beginning of this stage. This was modeled as wind/weather stress.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. It was modeled as "optional 1". Beavers, however, do not have as much of an impact in stands less than 10yrs old unless there is nothing else in the area. Beaver activity is quite variable. It was modeled as occuring on one percent of this class on the landscape each year, maintaining this class.

After 15yrs, this class succeeds to the mid-development closed stage.

Johnson (1992) states that young pioneer stands (<40yrs) comprised 47% of the forest historically.

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Class B **30 %**

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PODE3	Upper
SAAM2	Mid-Upper
SALU2	Middle
FRPE	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	70 %
Height	Tree 5.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This stage develops as the stand starts to mature. This community tends to be partially opened, with scattered cottonwoods and willows. Stands of cottonwoods 20-50yrs old can be fairly dense, although there are usually some openings. The shrub layer is highly variable and may include species such as rose, snowberry, chockecherry or dogwood. Glycyrrhiza lepidota might also occur. Elymus canadensis might also occur.

Green ash begins to establish in cottonwood stands when they are approximately 20yrs old (Lesica and Miles 1999).

The understory vegetation is highly variable. Age is 15-50yrs, succeeding to class C, a late closed stage.

Flooding occurs every 50yrs, and advances it to the next stage; it promotes it to the next stage by raising the level of the terrace. Minor flooding leads to deposition. This was therefore modeled as alternate succession. Major flooding occurs every 50yrs, bringing this class back to the early class A stage. This was modeled as wind/weather stress.

Replacement fires were modeled at occurring every 150yrs. However, it has been suggested that stand replacing fires might not occur in this class because it might be too wet for fire. However, due to lack of data, replacement fires were kept in the model. It is questionable as to whether replacement fire would set this stage back to the beginning of class A, as the terrace would be too high and dry to provide conditions for successful establishment of cottonwood and willow from seed. If the cottonwoods resprouted, it would be more like the middle of class A because the understory would be more mature than the beginning of class A; if the cottonwoods didn't resprout, it would probably just be a willow stand. Replacement fire was however modeled as taking this class to class A.

Low severity and mixed fire also occur every 100yrs, combined, and does not transition to another stage.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. It was modeled as "optional 1". Beaver activity is quite variable. It was modeled as occuring on one percent of this class on the landscape each year, maintaining this class.

One reviewer suggested combining classes B and C; however, they were left intact due to their species and ecological differences.

It has been suggested that Native Americans likely burned (low severity fires) these areas more often than every 100yrs. Also, some sites were likely heavily grazed by bison (low severity fire sites) and horses near camps. However, the model was retained as-is, as no further feedback was received.

Johnson (1992) states that young pioneer stands (<40yrs) comprised 47% of the forest historically.

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Class C **25 %**

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PODE3	Upper
PASM	Low-Mid
SYOC	Middle
FRPE	Low-Mid

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	61 %	80 %
Height	Tree 25.1m	Tree 50m
Tree Size Class	Very Large >33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

This class is a mature, late seral closed canopy cottonwood floodplain forest. Overstory is dominated by cottonwood and green ash. (Original MZ20 modelers included boxelder ACENEG in this class; however, all other reviewers disagreed and said that ACENEG was a minor component historically. It might be present, but in small amounts; chokecherry is more common; Boxelder, however, is seen today in the Musselshell/Missouri River, but it is questionable as to whether that would have occurred historically.) System becoming drier, so western wheatgrass coming in.

At least four studies along the Missouri River in southeastern SD have described aspects of a successional sequence that begins with colonization by cattails or sandbar willow, develops through transitional phases to a plains cottonwood dominated forest, and finally, in the absence of stand replacing floods, develops into a mixed deciduous forest that may contain the following tree species (in addition to aging cottonwoods): green ash, American elm, boxelder, bur oak, slippery elm, hackberry, American basswood, black walnut and eastern redcedar (Johnson 1950, Heckel 1963, Wilson 1965 & 1970, Lawry 1973). Ecological studies along the Missouri River in central ND have documented a similar successional pattern ultimately resulting in a forest dominated by green ash, boxelder, bur oak, and American elm (Johnson, et al. 1976). (from Ode 2004). This was therefore modeled as an alternate successional pathway to class D. Some cottonwood stands follow the successional pathway and proceed to E. Others have enough green ash that the next class, in this case Class D, is dominated by green ash and Symphoricarpos occidentalis. Of course some stands would be a mosaic of these two late-seral types.

Age 51-200yrs and can then succeed to E.

Minor flooding occurs every 10-20yrs. Minor flooding raises the level of the terrace. Because this is the last stage in this cottonwood portion of the system, this minor flooding was modeled as wind/weather stress, causing no transition. Major flooding occurs every 50-100yrs, bringing this class back to class A. This was modeled as wind/weather stress.

Replacement fire occurs every 150yrs (this interval is speculative, as not much data is available.) and takes this class to E, the silver sagebrush class. It is thought, however, that before it gets to silver sagebrush, there might be an intermediate stage dominated by western wheatgrass and snowberry before silver sagebrush establishes in significant amounts. However, due to the limitations of the five-box model, this intermediate stage was not modeled.

Low severity fire was also modeled as it was in class B, causing no transition. Mixed severity fire was also included with the same probability as low severity, every 100yrs. It is thought that mixed severity fire would cause a more open, drier stand that would allow invasion of silver sagebrush earlier, bringing it to E earlier; however, because that type of transition was captured in replacement fire, mixed severity fire was modeled as removing some of the overstory and thus causing a transition to B.

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Optional 2 in this class represents erosional processes of river meandering that would bring this class eventually back to class A. The class/system will first be part of the river, but then will succeed to class A or a point bar state. This occurs with a frequency of several hundredyrs and was modeled at a frequency of 400yrs.

River meanders cut away at the banks where mature or old-growth stands of POPDEL exist and these living trees are slowly undercut and ultimately fall into the stream.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. It was modeled as "optional 1". Beaver activity is quite variable. It was modeled as occuring on one percent of this class on the landscape each year, maintaining this class.

One reviewer suggested combining classes B and C; however, they were left intact due to their species and ecological differences.

Johnson (1992) states that older pioneer stands (40-80yrs) comprised 25% of the forest; that transitional forest (80-150yrs) comprised 21% of the forested acreage and that equilibrium stands (dominated by green ash, elm, oak, etc.) (>150yrs) comprised only seven percent of the forested acreage historically.

Class D **5 %**

Late Development 2 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

FRPE	Middle
ACNE2	Middle
PODE3	Middle
SYOC	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	71 %	100 %
Height	Tree 5.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class was based on R4NOFP class E. Found along the upper terrace that has been protected from most flood events, except for rare high intensity flooding. Species composition increases towards south and east within the region. Overstory species include hackberry, green ash, sycamore, black walnut and elm. Understory species include vines and poison ivy.

In the absence of stand replacing floods, this class is what has developed - a mixed deciduous forest that may contain the following tree species (in addition to aging cottonwoods): green ash, American elm, boxelder, bur oak, slippery elm, hackberry, American basswood, black walnut, and eastern redcedar (Johnson 1950, Heckel 1963, Wilson 1965 & 1970, Lawry 1973). Ecological studies along the Missouri River in central ND have documented a similar successional pattern ultimately resulting in a forest dominated by green ash, boxelder, bur oak and American elm (Johnson, et al. 1976). (from Ode 2004).

In class D, hackberry, sycamore, slippery elm, basswood, burr oak and black walnut would be rare or absent in eastern MT and (presumably) western ND. These species occur in central to eastern ND. I think the only trees you can count on in class D in eastern MT and western ND (and probably much of western SD too) are green ash, American elm, boxelder and eastern redcedar (Juniperus scopulorum).

Hansen et al. (1984) state that other dominants are Toxicodendron rydbergii and Elymus canadensis.

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The FRPE/SYOC association is an edaphic climax on the floodplain adjacent to the Little Missouri River and its major tributaries. PODE currently dominates many stands but is no longer reproducing. It will be replaced by FRPE. The larger trees, some 6-7dm DBH are PODE, but the young trees establishing in the stands are FRPE. JUSC is tallied with the tree species, although it's an understory species in the closed forest. Its current abundance is attributed to adequate light penetrating to the shrub and herb layers of the community as a result of wide spaceing of the old Populus. Along the Missouri River, in central ND, southeast SD, and near Omaha, NE, PODE is a pioneer species and is replaced successionally by various combos of Fraxinus, Ulmus, Acer and Celtis. Among the grasses, CALO, ELCA and MURA are important (Hansen et al 1984).

The disturbances are those from R4NOFP: Major flooding events can bring this class back to A (0.004 probability - every 250yrs), modeled as wind/weather stress. Flooding events can also cause a transition back to C (0.005 probability - every 200yrs), modeled as wind/weather stress.

Mixed fire occurs every 50yrs but causes no transition.

Dominants of the green ash/western snowberry stands can resprout after fire. However, a very hot fire can kill the green ash (Lesica 2003), in which case it would probably become a stand of western snowberry-silver sagebrush-western wheatgrass (not modeled here).

Class E **25 %**

Late Development 3 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

ARCA13	Upper
SYOC	Upper
PASM	Middle

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	11 %	40 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This is a silver sagebrush climax community on river terraces and larger streams. It has been noted (Cooper, personal correspondence) that the usual case in this system is for plains cottonwood to die out and for the stand to go to silver sagebrush domination with western wheatgrass in the undergrowth or western snowberry and rose (Rosa spp) with grasses (mostly PASSMI). That is what is therefore modeled here. It is thought that before this stage gets to silver sagebrush, there might be an intermediate stage dominated by western wheatgrass and snowberry before silver sagebrush establishes in significant amounts. However, due to the limitations of the five-box model, this intermediate stage was not modeled.

This class also represents the post-replacement fire community from C. If a replacement fire were to occur in C, it would come to this stage - which is why this stage therefore starts at age 50yrs. This is a stable community. It persists. Silver sagebrush resprouts after fire.

This class is less likely to have depositional flooding than other stages. It was therefore not modeled here.

Major flooding events were modeled as wind/weather stress occurring every 250yrs, bringing this class back to A.

Optional 2 in this class represents erosional processes of river meandering that would bring this class eventually back to class A. The class/system will first be part of the river, but then will succeed to class A or a point bar state. This occurs with a frequency of several hundred years and was modeled at a frequency of

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400yrs.

Replacement fire was modeled at every 50yrs, similar to other silver sagebrush communities, but maintaining this stage, as this class is stable, as stated above - and the silver sagebrush resprouts and thus maintains this stage.

Note for mappers: although height and cover overlap with class A, species are completely different. This is no longer a PODE3 community.

It is thought that this stage might be more prevalent currently vs historically due to impoundments increasing the silver sage distribution.

It has been suggested that this class not occupy 25% of the landscape but rather a lesser portion historically. However, upon further consideration from modelers and experts, 25% seeemd reasonable for big rivers, but may be a little low for smaller streams that don't flood with the same frequency; in other words, there might be more than 25% historically for smaller streams.

Johnson (1992) states that older pioneer stands (40-80yrs) comprised 25% of the forest; that transitional forest (80-150yrs) comprised 21% of the forested acreage and that equilibrium stands (dominated by green ash, elm, oak, etc.) (>150yrs) comprised only seven percent of the forested acreage historically.

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	115			0.0087	45
Mixed	150			0.00667	35
Surface	260			0.00385	20
All Fires	52			0.01921	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- ☐ Insects/Disease
- ☑ Wind/Weather/Stress
- ☐ Native Grazing
- ☐ Competition
- ☑ Other (optional 1) beaver
- ☑ Other (optional 2) erosional processes of river meandering

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911660** **Middle Rocky Mountain Montane Douglas-fir Forest and Woodland**

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

General Information

Contributors (also see the Comments field **Date** 6/12/2006

Modeler 1	Chris Thomas	cthomas@fs.fed.us	**Reviewer**	Bill Schaupp	bschaupp@fs.fed.us
Modeler 2	Dennis Sandbak	dsandbak@fs.fed.us	**Reviewer**		
Modeler 3	Paul Mock	pmock@fs.fed.us	**Reviewer**		

Vegetation Type

Forest and Woodland

Dominant Species*

PSEUD7
ARTRV
FEID

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Geographic Range

East of the Continental Divide in MT and WY. NatureServe states that this is the predominant montane conifer system in these zones, particularly where it is Douglas-fir without true fir or spruce. This is in the Bighorns, Yellowstone region and isolated ranges of central WY.

Biophysical Site Description

The xeric Douglas-fir type primarily exists on lower foothills immediately above grasslands/shrublands in elevation. Slopes range from gentle to steep, but aspect is primarily north-facing.

Vegetation Description

Generally dominated by Douglas-fir with an understory of bunchgrasses and sparse shrubs. Stands are typically open and dominated by moderate to large diameter Douglas-fir.

Disturbance Description

Fire regime is predominantly (70%) frequent, low severity fires with a MFRI of approximately 30yrs. Mixed-severity fires occur with a typical frequency of 30-50yrs primarily in dense stands (classes B and E). (The model, however, varies the FRI in class C, however, to account for more surface versus mixed fire.)

Native American burning was likely significant in many of these low-elevation forests.

Wind/weather stress and insect/disease are modeled as disturbances.

Adjacency or Identification Concerns

This BpS corresponds with cool, dry Douglas-fir habitat types (Pfister et al. 1977). Ecotone with mountain

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grasslands/sagebrush. This BpS is a transitional phase between the sagebrush-graminoid prairie at lower elevations and the 291050 BpS above.

Much of this setting has seen epidemic bark beetle infestation recently.

There have been missed fire cycles recently. Much of the Douglas-fir is dead from MT down to Lander - on the eastside. There is currently an epidemic of Douglas-fir beetle. Trees start failing, then they die. Also found on bottom fringes of Bighorns = on western edge of MZ29.

During the reference period, there was a mosaic of Douglas-fir in terms of succession classes. Now insects killing all stages. Under reference conditions, the beetle would only knock the system back to the late open stage. However, now, due to fire suppression, the beetle causes the system to get thrown back to the early A stage.

For MZ29, 1166 was originally described as 1051; however upon NatureServe recommendation, this description was imported and used for 1166 instead, as it matches it better. The Bighorn spruce, Douglas-fir and limber pine concept of 1051 occurs in the Laramie Range and the Bighorns.

Native Uncharacteristic Conditions

Scale Description

Since this type is dominated by surface fires and because this type represents an ecotone, patches tended to be smaller in size. Consequently, fire sizes were also relatively small. Analysis areas of several thousand acres would probably be adequate.

Issues/Problems

Comments

This model for MZ29 was adapted from the Rapid Assessment (RA) model R0PSMEdy created by Jeff Jones and reviewed by Steve Barrett and Cathy Stewart. Additional modeler for MZ29 was David Overcast. This description was originally for 1051 for MZ29; however, upon NatureServe recommendation, this description was imported and used for 1166 instead, as it matches it better. 1051 only occurs in the Laramie Range of southern Wyoming and now has another model/description.

RA workshop code was DFIR3. RA review comments incorporated, resulting in clarification in description and slightly more surface fires and higher MFRI overall.

Vegetation Classes

Class A **10 %**

Early Development 1 All Structure

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Description

Indicator Species* and Canopy Position

PSEUD7	Upper
FEID	Lower
ARTRV	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Tree 0m	Tree 5m
Tree Size Class	Seedling <4.5ft	

☐ Upper layer lifeform differs from dominant lifeform.

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Dominated by bunchgrasses, and seed/sapling sized Douglas-fir. These are seedling/sapling trees, less than one inch DBH and 10ft tall.

This class succeeds to a mid-development open stage in approximately 30yrs, although without fire for 25yrs, it will succeed to a mid-development closed stage.

Wind/weather stress events can occur every 30yrs and set this stage back to the beginning.

Replacement and mixed fires can occur every 20yrs, each.

Class B **5 %**

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PSEUD7 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Relatively dense pole sized Douglas-fir. Sagebrush has largely dropped out of the stand. This class succeeds to a late closed stage after approximately 60yrs.

Wind/weather stress events can occur every 30yrs and cause a transition to a mid-open stage. Insect/disease can also cause a transition to a mid-open stage every 200yrs.

Mixed severity fire may open up the canopy, every 200yrs, bringing this class to C, and low severity fire may occur every 25yrs also bringing this class to C, the mid-open stage.

Class C **25 %**

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PSEUD7 Upper
FEID Lower
ARTRV Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Open poles with bunchgrass and sagebrush understory. Surface fires maintain the open condition.

This class succeeds to a late-development open stage in approximately 60yrs. In the absence of fire for 45yrs, however, this stage may transition to a mid closed stage.

Insect/disease occur with a probability of 0.001 but cause no transition. Wind/weather stress events occur every 30yrs but cause no transition.

Low severity fire occurs every 20yrs and mixed severity every 1000yrs, though neither cause a transition to another stage.

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Class D **50 %**

Late Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PSEUD7 Upper
FEID Lower
ARTRV Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Very Large >33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Open canopy of medium to large diameter trees with bunchgrass and sagebrush understory.

Without fire for 45yrs, this class may transition to a late closed stage.

Surface fires maintain the open condition and occur every 20yrs, while mixed fires occur every 200yrs and bring this stage back to a mid-development open stage, C.

Insect/disease occur with a probability of 0.001 but cause no transition. Wind/weather stress events occur every 30yrs but cause no transition.

Class E **10 %**

Late Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PSEUD7 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Very Large >33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Multi-storied Douglas-fir with sparse understory. Mixed severity fire may open up the canopy.

Insect/disease occur with a probability of 0.01 and bring this stage back to a late open stage. Wind/weather stress events occur every 30yrs and also bring this class to a late open stage.

Replacement fire occurs every 100yrs, and mixed fire occurs every 40yrs, bringing this class to a late open stage.

Disturbances

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Fire Regime Group:** I

Historical Fire Size (acres)

Avg 1000
Min 1
Max 10000

Sources of Fire Regime Data

- [x] Literature
- [ ] Local Data
- [x] Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	215	100	300	0.00465	9
Mixed	110	30	110	0.00909	17
Surface	25	15	40	0.04	74
All Fires	19			0.05374	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- [x] Insects/Disease
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911670** **Rocky Mountain Poor-Site Lodgepole Pine Forest**

☑ *This BPS is lumped with: 1055, 1050*

☐ *This BPS is split into multiple models:* *This model incorporates some facets of 1050, 1055 and poor site lodgepole 1167. Development of this type is thought to be different from the others in structure and pre-European fire regime.*

General Information

Contributors (also see the Comments field **Date** 6/13/2006

Modeler 1 Chris Thomas	cthomas@fs.fed.us	**Reviewer**	Elena Contreras	econtreras@tnc.org
Modeler 2 Dennis Sandbak	dsandbak@fs.fed.us	**Reviewer**		
Modeler 3 Paul Mock	pmock@fs.fed.us	**Reviewer**		

Vegetation Type

Forest and Woodland

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

PICO
PIEN
ABLA
VASC

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Common in the mountains of WY and minor portion of the Pryor Mountains in the upper montane and lower subalpine zones. This would occur in ECOMAP sections M331B and M331I. This type occurs in the Bighorn Mountains of WY as well as the Laramie Peak Range.

Biophysical Site Description

This BpS occurs between approximately 7000ft (above foothill forests dominated by ponderosa pine and Douglas-fir) to 9500ft. This type is restricted to north slopes at lower elevations. Slopes may be gentle to moderately steep (eg, 0-60% slope).

Vegetation Description

Lodgepole pine, Engelmann spruce, and subalpine fir are the dominants of this BpS. Lodgepole pine is more common on drier sites and spruce and fir are more common on more mesic sites (such as north-facing slopes). Common associated species include aspen, grouse whortleberry, common juniper, heartleaf arnica, russet buffaloberry, elk sedge and various grasses.

Because of its relative intolerance for the forest understory environment, lodgepole pine traditionally has been considered a pioneer or seral species to forests dominated by Engelmann spruce and subalpine fir. However, some of the Bighorn National Forest (MZ29) is too dry to support spruce-fir forests and lodgepole pine perpetuates itself in some areas (Despain 1973 in Meyer et al. 2005).

Disturbance Description

Fire Regime Group V or IV, but primarily moderately long to long-interval stand replacement fires.

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Mixed-severity and surface fires may occur rarely in small patch sizes (ie, <1000s of acres) for this group, but are not modeled here.

Insects (mountain pine beetle) affect approximately 0.1% of the landscape every year and will either open the canopy, (maintaining or causing a transition to classes C and D), or replace the vegetation, causing a transition to early-development conditions (class A). Stand replacing insect outbreaks typically only occur in closed-canopy forests (classes B and E).

Blister rust might have occured during the HRV period - at relatively low levels during cool periods and at higher levels during warm, moist periods such as the early 1500s early 1700s (Meyer et al. 2005).

Blowdown events occur rarely (once every 500-1000yrs), and are replacement events, causing a transition to early-development conditions (class A).

For MZ29, changed replacement fire - higher and more frequent to get correct percentages in classes.

The HRV for succession and processes during the reference period for both individual stands and the landscape in the Bighorn Mtns would have been broad. Different sites on any specific burn can experience different successional trajectories, resulting in doghair stands of lodgepole in some areas, stands of average or below average tree density elsewhere and a full variety of combinations of invading aspen, spruce, fir and lodgepole pine across the landscape (in Meyer et al 2005).

Meyer et al. (2005) suggest that the MFRI of stand-replacing fires in the last 100yrs in high elevation types within the Bighorns is still within the range of means during the HRV period, despite fire suppression efforts. Recent fire records for the Bighorn National Forest suggest that fires still play an important role on the Bighorn National Forest, but fire suppression efforts have lengthened the MFRI during the last 50yrs (Meyer et al. 2005).

Surface fires in lodgepole pine have been observed in the Bighorns, and because of the thin bark, some trees are killed. Surface fires may have burned through lodgepole pine forests in the Bighorn National Forest at intervals as short as 40-80yrs (Meyer et al. 2005). They were not modeled here.

Adjacency or Identification Concerns

In WY, this group is adjacent to lodgepole pine and upper subalpine groups, and will be found above Douglas-fir and ponderosa types in elevation. Vegetation classes may vary significantly.

Secondary succession initiated today could have quite different trajectories than 200-300yrs ago because of the warmer and wetter climatic conditions of the last century (in Meyer et al. 2005).

This type might be confused with the Subalpine Spruce Fir Forests 1056. This system, however, incorporates more of the lodgepole and is at somewhat lower elevations and might be drier. Note that some of the Englemann spruce/subalpine fir should be keyed to 1056 as well as 1050/1055 in MZ29.

Blister rust ncreased in 1900s. At present time, dwarf mistletoe occurs at higher levels than in the HRV (Meyer et al. 2005).

In the Bighorns, a full range of size and age class structures probably existed during the HRV period, ranging from young to older even-aged stands of lodgepole, many having developed after fires in the

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1600s and 1700s to uneven-aged stands that hadn't burned for centuries and were dominated primarily by Engelmann spruce and subalpine fir. The fires would have killed many of the big trees from time to time, and they probably burned over large areas. Consequently, tree size would have ranged from uniformly small trees after the stand was recently burned to very large trees with small trees when the stand hadn't been disturbed for long periods. Since the late 1800s, both human-caused fire and timber harvest have converted areas with large, old trees to stands of younger, smaller trees, with the exception that timber harvesting could extend into areas that hadn't burned for centuries, such as on leeward slopes or in ravines. When timber harvesting in those areas doesn't provide sufficient time to allow regrowth of old trees, age and size class structure is outside of the HRV. Across the rest of the landscape where disturbances were more common historically, the variety of age and size class structures with and without clearcutting is probably within the HRV - -as both clearcutting and intense fires would create the kind of size class structure characteristic of even-aged stands, and currently, the forest stands have not been cut more frequently than the rate at which fires have burned stands. However, because planned rotation times are shorter than natural FRIs, the average harvested stand won't be able to achieve old-growth characteristics and thus stand age and size structure may eventually exceed the the HRV (Meyer et al. 2005).

In the Bighorns, due to thinning and selective harvesting, percent canopy cover is probably lower than that of the HRV (Meyer et al. 2005).

In the Bighorns, under existing conditions, tree densities might still fall within the moderately broad HRV, because even though trees have been partially or completely removed on about 20% of the landscape, fires may have removed half of that anyway if fire suppression had not been practiced. Canopy gap density and cover may be slightly below the HRV, but after 20yrs, these variables return to more natural conditions (Meyer et al. 2005). Stand variables averaged at the landscape scale could go beyond the HRV because of the abundance of older forests, mineral soil disruption or compaction, snag density and abundance of coarse woody debris (Meyer et al. 2005).

Native Uncharacteristic Conditions

There might be lower canopy cover and less old-growth today in parts of the Bighorns.

Scale Description

Patch sizes are generally 1000s to 10000s acres in variable mosaics, including forest land and meadows. Landscape are never in equilibrium, except possibly considering very large scales that exceed 300000ac.

Issues/Problems

This system will be highly heterogeneous and dynamic; this system has a very wide range of variability.

Comments

This model for MZ29 was adapted from the Rapid Assessment (RA) model R0LPSFcr Lower Subalpine, Wyoming and Central Rockies, created by Chris Thomas, Dennis Knight, Kathy Roche, and reviewed by Bill Romme and Bill Baker. Other modeler for MZ29 was David Overcast. Model changed descriptively, structurally, and quantitatively.

Laramie RA workshop code was LSAL2.

Additional edits from Dennis Knight and peer review incorporated on 4/11/2005. Peer review resulted in no changes to the model.

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Vegetation Classes

Class A 15 %

Early Development 1 All Structure

Indicator Species* and Canopy Position

PICO	Upper
PIEN	Upper

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Tree 0m	Tree 5m
Tree Size Class	Seedling <4.5ft	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

These are seedling/sapling trees less than one inch DBH, and genrally less than six feet in height

Range of 3-50% of a landscape, depending on climatic conditions and size of landscape. Early succession after moderately long to long interval replacement fires. Buttery and Gillam's (1987) HSS 1, 2. Time in class is dependent on scale and intensity of disturbance, but generally moves out within 20yrs and goes to a mid-closed stage, B. Alternatively, succession, under the right conditions, can move to a closed stage. This was modeled as alternate succession with a probability of 0.002.

Replacement fire occurs every 300yrs.

Class B 35 %

Mid Development 1 Closed

Indicator Species* and Canopy Position

PICO	Upper
PIEN	Lower

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This is dog hair lodgepole less than five inches DBH and 25ft tall.

Range of 5-50% of a landscape, depending on climatic conditions and size of landscape. Saplings to poles in size. Buttery and Gillam's (1987) HSS 3B, 3C. Includes classic "dog hair" stands. Ages run from 20-80yrs, then succeeds to a late closed stage, class E.

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) (0.0015 probability) and blowdowns (0.001 probability), cause a transition to a mid-open stage. Insects can also cause a transition very rarely (0.0001 probability) to the early stage, A.

There is probably more of this class in current versus historical conditions, at least in the Bighorns (Meyer et al. 2005).

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Class C **10 %**

Mid Development 1 Open

Indicator Species* and Canopy Position

PICO	Upper
PIEN	Mid-Upper
ABLA	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Description

This is open grown pole sized lodgepole less than nine inches DBH and 35ft in height.

Range of 3-50% of a landscape, depending on climatic conditions and size of landscape. Saplings to poles. Buttery and Gillam's (1987) HSS 3A. Ages run from 20-80yrs, then succeed to a late open stage. Alternately, under the right conditions, succession can also occur toward a late closed stage - with a probability of 0.001.

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) (0.0015 probability) and blowdowns (0.001 probability), cause a transition to a mid-open stage.

There is probably more of this class in current versus historical conditions, at least in the Bighorns (Meyer et al. 2005).

Class D **10 %**

Late Development 1 Open

Indicator Species* and Canopy Position

PICO	Upper
PIEN	Upper
ABLA	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Description

Range of 2-15% of a landscape, depending on climatic conditions and size of landscape. Edaphic conditions control the density of this class. Moderate to large-diameter mixed conifer, generally on south aspects and shallow, intermittent rocky soils. Ages run from 80-300yrs, then succeeds to the late closed stage.

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) and blowdowns (0.001 probability for both), can cause a transition to a mid-open stage or can maintain this late open stage. Competition/maintenance can also maintain this stage with a probability of 0.001.

There is probably less old growth in current versus historical conditions (Meyer et al. 2005).

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Class E **30 %**

Late Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PICO	Upper
PIEN	Mid-Upper
ABLA	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Range of 15-50% of a landscape, depending on climatic conditions and size of landscape. Moderate to large-diameter trees largely on mesic sites (eg, north slopes). This is closed lodgepole stands less than nine inches DBH and <50ft tall. Ages run from 80-300yrs (LANDSUM requires that this class lasts through 999yrs).

Replacement fire occurs every 100yrs.

Insects (mountain pine beetle) (0.0015 probability) can cause a transition to a mid-open stage or an early stage (0.0001 probability). Blowdowns (0.001 probability), cause a transition to a late-open stage.

There is probably less old growth in current versus historical conditions (Meyer et al. 2005).

Disturbances

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 1000
Min 1
Max 100000

Sources of Fire Regime Data

- [x] Literature
- [x] Local Data
- [x] Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	120	30	300	0.00833	100
Mixed					
Surface					
All Fires	120			0.00835	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- [x] Insects/Disease
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [x] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911690** **Northern Rocky Mountain Subalpine Deciduous Shrubland**

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

General Information

Contributors (also see the Comments field **Date** 11/18/2005

Modeler 1	Kelly Pohl	kpohl@tnc.org	**Reviewer**
Modeler 2			**Reviewer**
Modeler 3			**Reviewer**

Vegetation Type

Upland Shrubland

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

ACGL	RUPA
MEFE	ALVI5
RHAL	VAME
RILA	SASC

General Model Sources

☑ Literature
☐ Local Data
☐ Expert Estimate

Geographic Range

This shrubland ecological system is found in the upper montane and subalpine zones in the northern Rocky Mountains. For MZ29, this is thought to be very infrequent, with some occurring in the Bighorns and Black Hills.

Biophysical Site Description

This BpS occurs within the continuous forest zone in the upper montane and lower subalpine. This BpS is maintained by recurring disturbances, including fire and downslope movement of soil, water, snow and rock. It can occur on all aspects and soils, but is generally found on well-drained sites.

Vegetation Description

Persistent shrubfields dominated by Acer glabrum, Menziesia ferruginea, Rhamnus alnifolia, Ribes lacustre, Rubus parviflorus, Alnus viridis, Salix scouleriana, Holidiscus discolor, Sorbus spp, Prunus emarginata, Sampucus spp and/or Vaccinium membranaceum. Xerophyllum tenax, Chamerion angustifolium and Pteridium aquilinum are important forbs, reflecting the mesic nature of many of these shrublands.

Disturbance Description

This BpS is typically initiated and maintained by fires and will persist on sites for long periods because of repeated burns and vigorous stump sprouting. Fire frequencies in these shrubfields are generally the result of anomalous reburns with relatively short fire return intervals as compared to the surrounding vegetation types with longer fire return intervals. Most of the shrub species resprout vigorously following fire, often within the first growing season. Severe fires may delay resrpouting and/or reduce survival, depending on species and microsite characteristics. Fire frequencies will be highly dependent on surrounding vegetation, but typically range from 50-75yrs (Barrett 1982, Barrett 2004).

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Regional lead for MZ29 questioned why this BpS 1169 would have a shorter fire return interval, 50yrs MFRI, than the lower elevation 1106 Northern Rocky Mountain Lower Montane Deciduous Shrubland, which has an interval of 80yrs MFRI. However, because multiple mapzones have used this 50yrs MFRI for 1169, it was retained. An approximate 80yrs MFRI for 1106 was also used in other mapzones, though there was some variation btwn 66-90yrs MFRI for 1106 in adjacent mapzones.

Mass movement of snow, rock and soil, especially on steeper slopes in the lower subalpine zone, can cause occasional, but generally small disturbances in this BpS, typically causing resprouting of the shrub species (though these disturbances are not modeled here).

The shrub species in this BpS are important browsing and cover species for wildlife (although this disturbance is not modeled here).

Adjacency or Identification Concerns

Conifer systems may re-establish in these shrublands with fire exclusion, but these shrub communities are typically aggressive competitors. In climatic climax classifications (sensu Daubenmire and Daubenmire 1968), these psersistent shrubfield BpS would be considered forested habitat types.

Many of these shrub species are common understory and/or early seral associates in conifer BpS. The persistent shrubfields represented by this BpS may be distinguished by the lack of tree cover and coniferous seedlings.

Avalanche chutes may have some similar species present, but are distinguished by their relatively narrow, linear nature across steep elevation gradients. Avalanche chute systems correspond to BpS 1168 (Northern Rocky Mountain Avalanche Chute).

Native Uncharacteristic Conditions

Scale Description

Issues/Problems

This system represents geographic and biophysical outliers within the subalpine and upper montane zone and exist because of anomalous reburn events. This may not actually be a result of environmental or biophysical site potential, but rather of fire regimes.

Comments

This model for MZ29 was adopted from the same BpS in MZs 10 and 19, created by Kelly Pohl and reviewed by Steve Barrett and Mary Manning. This model received no review for MZ29 because regional lead was informed by NatureServe of this system at a late date and because NatureServe stated it did not occur frequently.

Peer review of this model for MZs 10 and 19 resulted in slight modifications to the description and a slight change in the proportion of mixed severity fire to replacement fire.

Vegetation Classes

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Class A **10 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 0

Indicator Species* and Canopy Position

ACGL	Upper
MEFE	Upper
RHAL	Upper
RILA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Resprouting mixture of shrubs immediately following disturbance. This class lasts for only a few years (less than six years), as shrubs typically resprout vigorously following disturbance. However, following replacement fires (approx 55yrs), resprouting may be delayed (modeled as "competition/maintenance" at 200yr interval, setting succession back to A). Mixed severity fires (infrequent - every 500yrs) may cause very small patchy openings in this class, but not complete top-kill.

Class B **90 %**

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Fuel Model 0

Indicator Species* and Canopy Position

ACGL	Upper
MEFE	Upper
RHAL	Upper
RILA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Shrub 1.1m	Shrub >3.1m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Mid and late-development shrubs of typically dense canopy cover and tall heights. Rocky Mountain maple can reach heights of three meters within 10yrs post-disturbance, and will typically reach maximum heights (>10m) by 20-40yrs post-disturbance (Anderson 2001).

Replacement fires (55yr frequency) cause top-kill of shrubs and transition to class A. Mixed severity fires (500yrs) may cause very small, patchy openings in this class, but not complete top-kill.

Class C **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	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

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	55	50	75	0.01818	90
Mixed	500	35	1000	0.002	10
Surface					
All Fires	50			0.02019	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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**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 sev

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**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 seve

LANDFIRE Biophysical Setting Model

Biophysical Setting **2911791** **Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna - Low Elevation Woodland**

☑ *This BPS is lumped with: 1013*

☑ *This BPS is split into multiple models:* *Bur oak is being lumped into several systems as an inclusion within these systems, because it occurs in a variety of settings/communities - 1054, 1117, 1385, riparian and transitioning from aspen in north in ND. It is in transition zones in MZs 29 and 30. Therefore, we can tell you where to map it (Dakotas), but it won't have its own model, because each model would encompass pieces of the aforementioned models.*

Querceus macrocarpa/Prunus virginiana habitat type forms relatively extensive communities on backslopes of intermittent streams and drainageways. This habitat type was limited to glaciated areas. The Populus tremuloides/QUMA2 community type occupied erosive slopes. Once these areas become stabiliized, the QUMA2/PRVI habitat type will probably result because QUMA2 reproduces in the understory. The QUMA2/Corylus species habitat type is found in the Killdeer Mountains and adjacent areas. This habitat type is on gentle slopes and the soils are more leached than many of the other types. The Betula papyrifera Corylus Cornuta community type occupies similar sites and is seral to QUMA2/Corylus species habitat type (Girard et al. 1989).

This system is split into Low Elevation PIPO, and PIPO Savanna.

General Information

Contributors (also see the Comments field **Date** 6/13/2006

Modeler 1	Cody Wienk	cody_wienk@nps.gov	**Reviewer**	Peter Brown	pmb@rmtrr.org
Modeler 2	Jeff DiBenedetto	jdibenedetto@fs.fed.us	**Reviewer**	Deanna Reyher	dreyher@fs.fed.us
Modeler 3	Chris Thomas	cthomas@fs.fed.us	**Reviewer**	Bill Schaupp	bschaupp@fs.fed.us

Vegetation Type

Forest and Woodland

Map Zone

29

Model Zone

- ☐ Alaska
- ☐ California
- ☐ Great Basin
- ☐ Great Lakes
- ☐ Northeast
- ☐ Northern Plains
- ☑ N-Cent.Rockies
- ☐ Pacific Northwest
- ☐ South Central
- ☐ Southeast
- ☐ S. Appalachians
- ☐ Southwest

Dominant Species*

PIPO	JUCO6
PRVI	MARE11
QUMA2	TORY
ORAS	ARUV

General Model Sources

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Geographic Range

Black Hills region, eastern MT, northeastern WY and western SD. Includes Bull Mountains and Missouri Breaks, north of Billings - northeastern quadrant of MZ29. This type would be in MZs 29, 30 and 20. In MZ29, specifically in subsections 331Mi, 331Md and 334Ab.

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This type occurs in central and eastern MT, ND and SD, Black Hills and a portion of eastern WY, including the Rochelle Hills of the Thunder Basin National Grassland. It also occurs along the Missouri River Breaks, and in 331G, 331K and east of Bighorns.

This is the PIPO Woodland, Low Elevation, that is not in the mountains of the Rockies.

Biophysical Site Description

North and northeast aspect slopes outside of the Black Hills and Laramie Peak (section M331I). Soils range from sandy loams to loams (Hansen and Hoffman 1988). The underlying substrate would be predominantly sedimentary. Elevation would be at approximately 3000-4000ft.

This BpS is found on all aspects of the Black Hills, below Ponderosa Pine Black Hills high elevation (BpS 1048) and above Ponderosa Pine savanna (BpS 11792) (generally 4000-6000 ft), predominately on the lower limestone plateau and material weathered from metamorphic rocks. This type is generally on sites with sandy loam to clayey loam soils.

Vegetation Description

Ponderosa pine, bur oak (in northern Hills and Bear Lodge Mountains), chokecherry, Saskatoon serviceberry, aspen, Ribes species, rose species, ironwood (Black Hills), hawthorn, Oregon-grape, raspberry, roughleaf ricegrass (Black Hills), littleseed ricegrass, Canada wildrye, needlegrasses, sideoats grama, sedges, common juniper and poison ivy.

BpS Code 1013 Bur Oak included in this model. 1013 occurs primarily in the North Western Black Hills and Bearlodge although can occur in scattered areas throught the BpS. For more information on this site can see Marriott et al 2000.

Disturbance Description

Generally frequent fire return interval with surface fire. The presence of abundant fire-scarred trees in multi-aged stands supports a prevailing historical model for ponderosa pine forests in which recurrent surface fires affected heterogeneous forest structure (Brown 2006). Mixed severity fire occurs if fire return intervals are missed, and stand replacement fire is infrequent. Some speculate that stand replacing fire in the Black Hills is less frequent than outside. The Black Hills stand replacement frequency is thought to be approximately 300yrs+. Some speculate that the stand replacement frequency outside the Black Hills is thought to be approximately 150-200yrs (and is thought to be as such for the Laramie Peak area). With the Native American influence outside of the Black Hills, the replacement fire interval could be even more frequent than the 300yr interval. However, due to lack of evidence for a different interval outside of the Black Hills, the 300-yr interval was chosen for this model and based on review.

There is considerable debate over the role of mixed severity and surface fires in the historical range of variability in this and other ponderosa pine forests in the northern and central Rockies (Baker and Ehle 2001, 2003; Barrett 2004; Veblen et al. 2000).

Brown (in press) argues that surface fire was dominant mode of disturbance.

Snead (2005) reported a MFRI of 4-42yrs on northern side of Ashland Ranger District; on southern side, 4-63yrs.

Fire intervals found at Wind Cave National Park are among the shortest documented for northern ponderosa pine forests. Fire frequencies at Wind Cave sites are comparable to those found in southwestern

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US ponderosa pine forests and some lower elevation ponderosa pine sites in the northern Rocky Mountains (Brown and Sieg 1999).

In the Rochelle Hills, the mean fire-free interval (WMPI) of the non-suppression period is not statistically different from the mean fire-free interval of the suppression period. Although suppression period sample size is limited, our estimates of minimum frequencies should limit the power (lowering the chance of not detecting a difference when there is a difference) that greater sample numbers (fire years) would generate (Perryman and Laycock 2000).

Most of southern and southwestern forested areas of the Rochelle Hills have somewhat closed canopies, substantial amounts of litter accumulations, and relatively high tree densities. This set of circumstances will most likely lead to a future catastrophic fire, but it is unclear if fire suppression activities have given rise to this condition or if this condition is a part of the natural cycle in the ecology of this system (Perryman and Laycock 2000).

Bragg (1985) calculated a MFRI of 3.5yrs before 1900 increasing to 8.5yrs between 1900 and 1958 in ponderosa pine areas of the Nebraska Sandhills.

The Little Missouri Grasslands are thought to also have a very short fire return interval.

Precipitation is concentrated in April through June, but occurs throughout the growing season, resulting in good pine regeneration and dense patches of saplings. Elk, and to a lesser extent, bison, were important ungulates. Windthrow, storm damage and mountain pine beetles were important disturbances in this type, especially when stands reached high densities, as evidenced in mountain pine beetle outbreaks occuring from 2000 through present and still increasing (USDA Forest Service 2006 map).

Insect/disease disturbance occurs, but unsure of frequency. It was modeled at a very infrequent rate. Frequency could be related to density; therefore, modeled in the late closed and open stages. For additional information on insects in the Black Hills see the Phase II Amendment (USDA Forest Service 2005).

Disturbance from mountain pine beetles (MPB) was frequent locally and rare area-wide. Current research indicates highest probability of infestation occurs in areas greater than 120 sq ft per acre (possibly 100) of trees averaging seven inches DBH or greater.

The occurrence of area wide MPB epidemics is dependent on favorable weather and abundant food supplies in the form of adjacent susceptible areas.

In ponderosa pine, bur oak occurs with fire adapted species. When a stand replacing fire occurs, system will get big patches of bur oak that will persist until the pine comes in. It is shade intolerant. (The Laramie Peak area does not have bur oak.)

In the northern Black Hills, there is a separate bur oak type with a long FRI. However, because bur oak is an inclusion within many systems in this mapzone, it was not modeled separately and is rather included in many of the systems.

Adjacency or Identification Concerns

This type occurs at elevations above Ponderosa Pine Savanna and at elevations below Ponderosa Pine Black Hills High Elevation. This type differs from Northwestern Great Plains Highland Spruce Woodland

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and Ponderosa Pine-Black Hills (BpS 2910480) because it has been documented to have more frequent surface fires, less frequent replacement fires, and less closed canopy forest. (Brown 2003)

This system could be difficult to distinguish from 1117 Ponderosa Pine Savanna. They will be adjacent to each other. It could also be adjacent to grassland and shrubland systems/associated with prairie systems. It might also be adjacent to and intermingled with green ash/woody draw systems. And at the lowest margins with grasslands invasion has occurred. Distinguishing features can be found by aspect (see Biophysical Site Description).

As this system model and description is a copy of 1054, this system will be difficult to distinguish from that one, and is only distinguished by geography.

Currently, there have probably been at least five fire cycles that have been missed due to suppression, grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 70-90% canopy closure. Increased ladder fuel as a result of missed fire cycles increases the probability of a stand replacement fire.

Expansion into grasslands both at prairie margins and into interior meadows; timber harvest and removal of larger size classes from all areas; stand infilling and thickening due to fire exclusion.

The absence of dwarf mistletoe distinguishes this PIPO system from most others in the country.

This model for 11791 for MZ29 seems to differ slightly from 1054 in MZ20 (adjacent mapzone), due to distinctness of Black Hills ponderosa pine. However, in general, overall FRI similar with mostly low severity fires. And general amounts in the successional classes are similar, with similar cover/height distinctions. Some of the other disturbance probabilities differ, due to more information provided in literature for MZ29.

In this system, as in many others, non-native grass species may be providing different surface fire effects. For example, litter produced by Kentucky bluegrass, Japanese brome, and downy brome is much finer and has different characteristics for burning, insulation and moisture retention. This would change the effects of fires, even if they occurred at historic frequencies. The most likely change is in composition of surface vegetation, although longer term effects to the soil may also occur.

Native Uncharacteristic Conditions

Currently, there have probably been at least five fire cycles that have been missed due to suppression, grazing, etc. in the Black Hills. Therefore, the system today would look much more like the late closed stage with approximately 70-90% canopy closure, at least in the Black Hills area.

Scale Description

Disturbance patch size probably ranged from 10s-10000s of acres.

In the Black Hills and Missouri Breaks, system would have been 100s010000s of acres. Outside of the Black Hills and Missouri Breaks, this BpS would have been 10s-1000 of acres.

Issues/Problems

Comments

This BpS was originally modeled as MZs 29 and 30 BpS 1054 which included the Black Hills. However,

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post-model-review-and-delivery, the new Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna - Low Elevation Woodland BpS was created by NatureServe. Therefore, this model is a copy of MZs 29 and 30 1054, only different from the current 1054 by defined geography.

The 1054 model for MZs 29 and 30 was adapted from the model from the Rapid Assessment (RA) R0PIPObl Ponderosa Pine woodlands and BH low elevation developed by Kelly Pohl, Cody Wienk and Carolyn Sieg. Other modelers for MZs 29 and 30 were Paul Mock, Dave Overcast and Kim Reid. Other reviewers for MZs 29 and 30 were Carolyn Sieg and Gwen Sanchez-Lipp, Kathy Roche and Mary Lata.

RA quantitative model was developed post-workshop by Kelly Pohl with input from Cody Wienk and Carolyn Sieg. Additional input was provided during the workshop by Deanna Reyher, Blaine Cook and Bill Baker and factored into the model development. Because of the model's late development it received no peer review.

Vegetation Classes

Class A 5 %

Early Development 1 All Structure

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

PRVI	Mid-Upper
AMAL	Mid-Upper
PIPO	Middle
QUMA	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	60 %
Height	Shrub 0m	Shrub 3.0m
Tree Size Class	Seedling <4.5ft	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Herbaceous/shrubby post-replacement class, persists 0-15yrs.

In Bear Lodge this stage dominated by bur oak. In the Black Hills proper, lower limestone, it is dominated by grass/forb, with chokecherry, serviceberry, leadplant (not present on Laramie Peak), raspberry, rose and currant present. Bur oak is an indicator for the Black Hills, not other areas.

Outside of the Black Hills, associated with grass/forb, chokecherry, serviceberry, leadplant, raspberry, rose, Oregon grape, snowberry and currant.

Shrubs are typically greater than one meter but chokecherry can reach heights of over three meters.

This class is generally expected to succeed to a mid-open stage in approximately 15yrs, although without fire for 13yrs or other distubances, it may succeed to a mid closed stage.

Replacement fire occurs every 300yrs, and low severity fire every 20yrs. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30yrs; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.)

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**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 seve

Class B 15 %

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Pole ponderosa pine (dog hair), generally persists 15-50yrs. Very few understory species present due to canopy closure. This class may succeed to a late closed stage if not affected by fire or insect outbreaks.

Replacement fire occurs every 300yrs, and low severity fire every 20yrs, but causes no transition. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30yrs; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.)

Class C 15 %

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PRVI	Middle
AMAL	Middle
QUMA	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class persists 15-50yrs. Surrounding this class are other trees/stands that are over 100yrs old. In Bear Lodge Mountains, bur oak persists, particularly in open canopy stands.

Understory species would be similar to those in class A. Snowberry will also become more prevalent. Grasses could include roughleaf ricegrass in Black Hills.

This class succeeds to a late open stage, although without fire for 25yrs, this class can move to a mid closed stage.

Replacement fire occurs every 300yrs, and low severity fire every 20yrs, and mixed fire every 200yrs, but low and mixed do not cause a transition. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30yrs; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.)

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Class D **55 %**

Late Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PRVI	Middle
AMAL	Middle
QUMA	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Open canopy stand; persists 50yrs+. Patches of dense doghair and 200yr+ old trees persist. Bur oak mostly restricted to northern Black Hills and Bear Lodge. Common juniper and rough leaf ricegrass common in Black Hills.

Other understory species same as in class C and A.

In the absence of fire, drought or insect outbreaks for 60yrs, this class may be expected to succeed to a late development closed stage.

Insect/disease outbreaks functioning as minor mortality incidents not causing a transition to another class, can occur every 20yrs (reviewers speculated between 15-25yrs and 30-50yrs). Moderate mortality incidents can cause a transition to a mid-open stage every 100-200yrs (modeled every 250yrs), and catastrophic mortality which causes a change back to an early stage occurs every 200-300yrs (modeled as every 333yrs).

It is thought that class D should occupy approximately 60% of the historical landscape (see figure 3 in Brown and Cook (2006) for some rough numbers, which found that ~60% of the reconstructed historical stands had <~20 m^2/ha basal area which would probably be late open.)

Replacement fire occurs every 300yrs. Low severity fire occurs every 20yrs but does not cause a transition. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30yrs; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.). Mixed severity fire occurs approximately every 200yrs overall, half the time causing a transition to a mid stage and half the time causing no transition. Mixed severity fires are patchy.

Class E **10 %**

Late Development 1 Closed

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
JUCO	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Closed canopy, multi-layer stand, persists 50yrs+. At >70% canopy closure, mountain pine beetle outbreaks occur, opening up the canopy. Insect/disease outbreaks functioning as minor mortality incidents not causing a transition to another class, can occur every 40yrs (reviewers speculated between 15-25yrs and 30-50yrs). Moderate mortality incidents can cause a transition to a late-open stage every 100-200yrs (modeled every 100yrs), and catastrophic mortality which causes a change back to an early stage occurs every 200-300yrs

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**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 sev

(modeled as every 333yrs).

Ironwood and bur oak in northern Black Hills and Bear Lodge Mountains.

Understory species the same but fewer numbers. Common or Rocky Mountain juniper might be present with lack of disturbance. Outside of Black Hills, sun sedge and littleseed ricegrass may be present.

Mixed fire occurs approximately every 200yrs, half the time causing a transition to a mid development stage (75% open, 25% closed), and half the time staying within the late development stage (75% open, 25% closed).

Replacement fire occurs every 300yrs, and low severity fire every 20yrs and brings this class to a late open stage. (This class was originally modeled with replacement fire occurring every 200yrs and low severity every 30yrs; however, upon review, it was decided and confirmed that those intervals should be changed - based on Brown 2006 and other studies.)

See figure 5 in Brown (2006); closed canopy conditions were probably transient due to regional synchronous recruitment forced by climate (ie, the distinction between fire history and fire regime).

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg
Min 1
Max 100000

Sources of Fire Regime Data

- [x] Literature
- [ ] Local Data
- [ ] Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	300	100	400	0.00333	6
Mixed	270	50	400	0.00370	6
Surface	20	5	50	0.05	88
All Fires	18			0.05704	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- [x] Insects/Disease
- [ ] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [ ] Other (optional 1)
- [ ] Other (optional 2)

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**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 seve

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2911792** **Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna - Savanna**

☑ *This BPS is lumped with: 1013*

☑ *This BPS is split into multiple models:* *Bur Oak is being lumped into several systems as an inclusion within the system, because it occurs in a variety of settings/communities - 1054, 1117, 1385, riparian, and transitioning from aspen in north in ND. It's in transition zones in MZs 29 amd 30. Therefore, we can tell you where to map it (Dakotas), but it won't have its own model, because each model would encompass pieces of the aforementioned models.*

Querceus macrocarpal/Prunus virginiana habitat type forms relatively extensive communities on backslopes of intermittent streams and drainageways. This habitat type was limited to glaciated areas. The Populus tremuloides/QUMA2 community type occupied erosive slopes. Once these areas become stabiliized, the QUMA2/PRVI habitat type will probably result because QUMA2 reproduces in the understory. The QUMA2/Corylus species habitat type is found in the Killdeer Mountains and adjacent areas. This habitat type is on gentle slopes and the soils are more leached than many of the other types. The Betula papyrifera Corylus Cornuta community type occupies similar sites and is seral to QUMA2/Corylus species habitat type (Girard et al. 1989).

This system is split into Low Elevation PIPO, and PIPO Savanna.

General Information

Contributors (also see the Comments field **Date** 6/12/2006

Modeler 1	Cody Wienk	cody_wienk@nps.gov	**Reviewer**	Peter Brown	pmb@rmtrr.org
Modeler 2	Jeff DiBenedetto	jdibenedetto@fs.fed.us	**Reviewer**	Bill Schaupp	bschaupp@fs.fed.us
Modeler 3	Chris Thomas	cthomas@fs.fed.us	**Reviewer**	Ken Marchand	kmarchand@fs.fed.us

Vegetation Type

Forest and Woodland

Dominant Species*

PIPO	PASM
JUSC2	CAREX
RHAR4	SCSC
PSSP6	QUMA2

General Model Sources

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Map Zone

29

Model Zone

☐ Alaska	☑ N-Cent.Rockies
☐ California	☐ Pacific Northwest
☐ Great Basin	☐ South Central
☐ Great Lakes	☐ Southeast
☐ Northeast	☐ S. Appalachians
☐ Northern Plains	☐ Southwest

Geographic Range

This BpS is located in the lower elevations of the Black Hills, western ND and SD, eastern MT, the Missouri River Breaks of northern MT and from the High Plains of eastern WY (including the Rochelle Hills of the Thunder Basin National Grassland) eastward to western NE (in NE, the Pine Ridge escarpment would be included in this, but not the Sandhills. The Pine Ridge escarpment reaches to the

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edge of the Sandhills, but not really into them). This might describe areas in MZ29, 30, 20 and 31. In MZ29, it could occur generally east of the Bighorn and Laramie Ranges (including sections 331G, 331K and 331F; subsections M334Aa, 331Mi and 331Md).

This is the PIPO Savanna that is not in the mountains of the Rockies.

Biophysical Site Description

The geology is typically sedimentary in origin. Often found on buttes, hogbacks, rocky outcrops and steep, rocky slopes. Elevations range from 3200-4400ft, but in the southern Black Hills may be found up to 5700ft on southern aspects. In eastern MT and northeast WY, it is also found on southern aspects.

Vegetation Description

This type is dominated by interior ponderosa pine and is often the only tree present. Understory composition varies but Rocky Mountain juniper, skunkbush sumac, mountain mahogany (in southern Black Hills and the eastern Pine Ridge), snowberry, and yucca are common woody species (one reviewer noted that under the historic fire regime, the occurrence of yucca would have been a bit lower than at present). Bur oak might occur in this system as well. Currant and chokecherry are found in the Montana portion of the BpS's range. These also occur on the Pine Ridge, but neither is significant except in draws. Poison ivy is also common in the Pine Ridge.

Regional lead asked about Rocky Mountain juniper (JUSC2) as an indicator for the Black Hills: JUSC2 really is a component and indicator of many of the ponderosa pine savanna areas. The species generally becomes more prominent in the pine savanna as the soils become more skeletal, or the soil profile and surface contain more rock fragments. There may be some sites where it is a very limited component. JUSC2 can also be considered an indicator for Thunder Basin. In the Pine Ridge in NE, JUSC2 is never hard to find in the PIPO areas, but you sometimes have to actively look for it - so it might not be an indicator on the Pine Ridge; this may be one of the differences between this side of the range and the NW side of the range. Rocky Mountain juniper is listed as present in late successional communities for ponderosa pine/Idaho fescue, ponderosa pine/sun sedge, and ponderosa pine/bluebunch wheatgrass habitat types by Hanson and Hoffman (1988) for southeastern MT. But it's not mentioned as present in the other ponderosa pine habitat types (ponderosa pine/common juniper, ponderosa pine/chokecherry). RM Juniper is not an indicator for ponderosa pine habitat types in southeastern MT or western ND.

Herbaceous species include needlegrasses, grama grasses, little bluestem, western wheatgrass, sedges and bluebunch wheatgrass. There is Idaho fescue as far east as Ashland, MT.

Disturbance Description

Generally frequent fires of low severity (Fire Regime Group I). Mixed severity fire occurs in the closed canopy conditions, and stand replacement fire is very infrequent (300yrs+). Low-severity fires are frequent and range from <10yrs to more than 20yrs (Brown and Sieg 1999, Fisher et al. 1987), but probably not more than 40yrs at the high end (3-70yrs range). The MFRI is approximately 12-15yrs for low severity fires.

There is considerable debate over the role of mixed severity and surface fires in the historical range of variability in this and other ponderosa pine forests in the northern and central Rockies (Baker and Ehle 2001, 2003; Barrett 2004; Veblen et al. 2000). However, Brown (2006) argues that surface fire was the dominant mode of fire disturbance and that the role of mixed-severity fires is overstated.

The surgeon's log at Fort Robinson in 1893 states that the White River face has steep asclivities that are

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black with the pines that have given their name to the ridge. The forest growth is limited by the creek and beyond are grass-grown prairies whose annual fires have destroyed the seedling pines. A drive of twelve miles would take us to the summit and bring to view a rolling fertile land that sinks by gentle slopes to the level of the Niobrara on Running Waters. Things would have changed some by 1893, but this area didn't settle heavily until at least two decades after that. Additionally, a form he had to fill out stated that the trees were mostly up on the ridges. So – this documents a very high frequency fire regime, at least at that time (the last armed conflict with Native Americans was in 1890, so Native American influences on the fire regime were already tremendously affected – probably shorter. Higgens suggested that with the coming of the railroads, fire frequencies increased significantly (Lata, pers comm).

In the Rapid Assessment (RA) workshop, review indicated more mixed fire should occur in the early stage and surface fire should be modeled in all structural stages. Peer review comments during the RA disagreed on the role of mixed and surface fire in this type. The majority of review agreed with the original model's parameters for mixed fire, but thought surface fire could be slightly less frequent. One review contended that there is no evidence of mixed severity fire in this type at all, and that the overall MFRI should be around 25yrs.

For MZs 29 and 30, it was suggested that mixed fire be removed from this model; reviewers agreed, and therefore mixed fire is not in the model.

Variation in precipitation and temperature interacting with fire, tip moths and ungulate grazing affects pine regeneration. Windthrow, storm damage and mountain pine beetles were minor disturbances in this type unless stands reach high densities. The interactions among drought, insects and disease are not well understood.

Ips spp of bark beetles can cause significant mortality among pole-sized and larger diameter pines, especially those weakened by drought, fire injury and the hail-related native disease diplodia. This serves to maintain the late-development open stage (class D) and move the late-development closed stage (class E) to the late-development open stage (class D).

In ponderosa pine, bur oak occurs with fire adapted species. When a stand replacing fire occurs, system will get big patches of bur oak that will persist until the pine comes in. It's shade intolerant.

In the northern Black Hills, there is a separate bur oak type with a long FRI.

Ponderosa pine - Juniperus scopulorum savanna in the southern Black Hills has lots of rock exposure or sparsely grassed soils, which probably protected some of the juniper seed trees from being wiped out by fire.

Adjacency or Identification Concerns

This type is either surrounded by Northern Plains grasslands and shrublands or is a transition between Northern Plains grasslands and shrublands and higher-elevation coniferous forests. Ponderosa pine in this BpS has encroached into the Northern Plains grassland and shrubland types in many areas due to fire suppression and grazing.

As this system model and description is a copy of 1117, this system will be difficult to distinguish from that one, and is only distinguished by geography.

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Invasive species in this system include cheatgrass, Japanese brome, crested wheatgrass, Kentucky bluegrass and intermediate wheatgrass. Crested wheatgrass and cheatgrass are at lower elevations mostly. Cheatgrass has altered the fire frequency and extent (although not on the Pine Ridge).

Currently, there have probably been at least 5-10 fire cycles that have been missed due to suppression, grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 50-80% canopy closure - uncharacteristic. Also- encroachment into prairies by pine and juniper is an issue today (Juniper becomes more of an issue further east; it's primarily ponderosa pine that is encroaching in the NE area), although JUSC2 is an indicator at least in the Black Hills. Generally. the juniper that is an issue with the prairies east of the Black Hills is the eastern redcedar. As it continues to be incorporated into windbreaks, it is continuing to increase into new areas.

Hardwoods exist in drainages, which encompasses a separate BpS. In NE, there is green ash, chokecherry, hackberry and American elm, which get crowded out by the ponderosa pine.

Currently expanding into grasslands and shrublands because of fire suppression, grazing and natural expansion from Holocene rebound (Norris 2006).

Native Uncharacteristic Conditions

Currently, there have probably been at least 5-10 fire cycles that have been missed due to suppression, grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 50-80% canopy closure - uncharacteristic. Some areas have been thinned to "even spacing," rather than the "clumpier" arrangement that is shown in early photos.

Scale Description

Disturbance patch size probably ranged from 10s-10000s of acres. On the Pine Ridge in NE, fires could have at least been 75-100000ac, as evidenced by current fires that have burned there (approx 60K acres), that would have continued to burn if they weren't suppressed.

System would be a patchy mosaic of 10s-1000 acres. It could be a range of patches, such as in Missouri Breaks where it could be up to 10000ac patches.

Issues/Problems

Comments

This BpS was originally modeled as MZ29 and MZ30 BpS 1117 which included the Black Hills. However, post-model-review-and-delivery, the new Northwestern Great Plains-Black Hills Ponderosa Pine BpS was created by NatureServe. Therefore, this model is a copy of MZs 29 and 30 1117, only different from the current 1117 by defined geography.

The 1117 model for MZ29 and 30 was adapted from the Rapid Assessment model R0PIPOnp developed by Breck Hudson and reviewed by Bill Baker, Dennis Knight, and Brad Sauer. Other modelers for MZs 29 and 30 were Paul Mock, David Overcast and Kim Reid. Other reviewers for MZs 29 and 30 were Carolyn Sieg and Mary Lata.

RA Workshop code was PPIN11.

Additional authors for the RA include Deanna Reyher, Carolyn Sieg, Breck Hudson, Cody Wienk, Peter Brown and Blaine Cook. This type was modeled based on earlier work done by an expert panel (Morgan

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and Parsons 2001). Collapsing of stages were necessary to fit the five-box model used for this process.

Vegetation Classes

Class A 5 %

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

NAVI4	Mid-Upper
PASM	Mid-Upper
PSSP6	Mid-Upper
CAREX	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	90 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	Seedling <4.5ft	

- [ ] Upper layer lifeform differs from dominant lifeform.

Shrubs are the upper layer, perhaps, but cover is <20%.

Description

This community is dominated by herbaceous and woody species, including the graminoids needlegrasses, western wheatgrass, bluebunch wheatgrass, sedges, Idaho fescue and little bluestem in moister areas, and various shrubs including skunkbush and snowberry. Ponderosa pine seedlings are scattered and found in small clumps.

Little bluestem will also be indicator species.

Number of years in this class is variable depending on climatic patterns and fire disturbances. This class typically ends at 30yrs in this model. Without fire for 25yrs, this class can move to a mid-closed stage.

Needlegrasses can be tall up to one meter, but other graminoids are typically less than 0.5 meters.

Low severity surface fires occur every 30yrs. Replacement fires (since this is mostly grassland in this class) occur every 50yrs.

Class B 2 %

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Multi-story stand of small and medium trees with saplings and seedlings coming in as clumps. Understory is sparse. Some juniper might be present - could be an outlier. Grasses and shrubs are shaded out.

This class lasts approximately 70yrs, then moves to a late closed stage.

Low severity surface fires occur every 15yrs and move this stage to a mid open stage. Replacement fires occur infrequently approximately every 300yrs.

Insect/disease was modeled at approximately occurring every 50yrs, not causing a transition.

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Class C **8 %**

Mid Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
NAVI4	Lower
PASM	Lower
PSSP6	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Graminoids could have up to 60-80% cover (Hansen and Hoffmann 1988). Grasses co-dominate.

Description

Predominantly single-story stands with a few pockets of regeneration. Low shrubs such as snowberry and skunkbush and poison ivy are dominant as well as grass and forbs. Graminoids could have up to 70-80% cover. Rocky Mountain juniper present in patches (Rocky Mountain juniper is not common on the Pine Ridge in NE).

Carex spp and little bluestem will also be indicator species.

This class lasts approximately 50yrs then goes to a late open stage. Without fire for 40yrs, this could transition back to a mid closed stage.

Low severity surface fires occur every 15yrs, maintaining this class. Replacement fires occur very infrequently (modeled at 0.0015 probability).

Class D **80 %**

Late Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
NAVI4	Lower
PASM	Lower
PSSP6	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Graminoids could have up to 60-80% cover. Grasses co-dominate.

Description

Predominantly single-story stands of large ponderosa pine with pockets of smaller size classes (replacement). Snowberry, skunkbush and patches of Rocky Mountain juniper. Understory is dominated by shrub species and grasses and poison ivy. Graminoids could have up to 70-80% cover.

Carex spp and little bluestem will also be indicator species.

It is thought that class D, the late open stage, should occupy approximately 80% of the historical landscape.

Low severity fires occur every 15yrs and maintain this stage. Replacement fires occur very infrequently (0.0015 probability). If no fire occurs after 40yrs, this class could transition to the late closed stage.

Insect/disease occurs every 50yrs and maintains this stage.

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Class E **5 %**

Late Development 1 Closed

Indicator Species* and Canopy Position

PIPO Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	51 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Description

This is a somewhat uniform late-development stage, multi-story stands of large, medium, small and seedling ponderosa pine. Shrubs and grasses are sparse. This type generally exceeds 70% canopy cover. DBH is less in this class than late-open.

Low severity surface fires occur every 15yrs and cause a transition back to the late open stage. Replacment fires occur every 300yrs.

Insect/disease occurs every 250yrs, causing a transition back to the late open stage. Drought can also occur - every 500yrs, causing a transition to the late open stage.

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg
Min 1
Max 50000

Sources of Fire Regime Data

☑ Literature
☑ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	380			0.00263	4
Mixed					
Surface	15	3	70	0.06667	96
All Fires	14			0.06931	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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**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 sev

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LANDFIRE Biophysical Setting Model

***Biophysical Setting* 2913850** **Western Great Plains Wooded Draw and Ravine**

☑ *This BPS is lumped with: 1013*

☐ *This BPS is split into multiple models:* *Bur Oak is being lumped into several systems as an inclusion within the system, because it occurs in a variety of settings/communities - 1054, 1117, 1385, riparian, and transitioning from aspen in north in ND. It's in transition zones in MZs 29 and 30. Therefore, we can tell you where to map it (Dakotas), but it won't have its own model, because each model would encompass pieces of the aforementioned models.*

Quercus macrocarpa/Prunus virginiana habitat type forms relatively extensive communities on backslopes of intermittent streams and drainageways. This habitat type was limited to glaciated areas. The Populus tremuloides/QUMA2 community type occupied erosive slopes. Once these areas become stabiliized, the QUMA2/PRVI habitat type will probably result because QUMA2 reproduces in the understory. The QUMA2/Corylus species habitat type is found in the Killdeer Mountains and adjacent areas. This habitat type is on gentle slopes and the soils are more leached than many of the other types. The Betula papyrifera Corylus Cornuta community type occupies similar sites and is seral to QUMA2/Corylus species habitat type (Girard et al. 1989).

General Information

Contributors (also see the Comments field **Date** 9/11/2006

Modeler 1	Jack Butler	jackbutler@fs.fed.us	**Reviewer**	Carolyn Hull-Sieg	csieg@fs.fed.us
Modeler 2	Lee Blaschke	lblaschke@fs.fed.us	**Reviewer**	Mary Lata	mlata@fs.fed.us
Modeler 3			**Reviewer**	Linda Vance	livance@mt.gov

Vegetation Type

Forest and Woodland

Map Zone

29

Model Zone

☐ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☑ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

FRPE	SYOC
ULAM	CASP7
ACNE2	ELYMU
PRVI	QUMA2

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Predominately west of the Missouri River in ND and SD, with minor extensions east of the Missouri River and south into NE. (also extends into WY and MT.) It occurs in upland draws and ravines scattered throughout the Northern Mixed Grass Prairie and Northern Great Plains Steppe. This BpS is probably best developed in the Little Missouri Badlands of western ND (MZ30, Section 331Md). This BpS also extends along drainages east to the Missouri River into MZ30 Section 331Mc, and west and north into section 331Me and 331Ea (possibly all way west to MZ20, although this is speculation), and likely into MZ29, Section 331Mi.

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The bur oak component is also by Sturgis, East of Black Hills, where grass meets the Black Hills.

See Adjacency/Identification Concerns box regarding smaller second and third order prairie streams and where they occur or what they're classified as.

Biophysical Site Description

This BpS occurs in major tributaries and upland drainages with extensions onto steep north-facing slope. The vegetation type is best developed in topographic conditions that favor snow trapment and protection from fires in the adjacent grasslands. This BpS is heavily influenced by topographic situations that produce a combination of deeper soils, supplemental moisture from run-off and snow catchment. Soils on toeslopes and north facing backslopes are deep and well developed, while slopes on south facing backslopes tend to be dry, coarse textured and not well developed.

Bur oak occurs on sideslopes.

In Theodore Roosevelt National Park, it occurs in ravines or draws or on moderately steep north-facing slopes throughout much of the Park (Hansen et al. 1984).

Note from E. Contreras: The POTR/BEOC (aspen/paper birch) habitat type in Theodore Roosevelt National Park in ND, occurs on upper slopes facing northwest to east. Stands of the Fraxinus/Prunus habitat type are lower on the same slopes (Hansen et al. 1984).

Vegetation Description

Intricate mix of western grassland and shrubland species, with elements of eastern deciduous woodlands. Northern extent occasionally supports quaking aspen, while southern extent supports Juniper species and western extent includes ponderosa pine.

Green ash, chokecherry are dominant species, as well as buffaloberry, snowberry and American elm. On north end into ND, would start seeing aspen and bur oak, and paper birch (in Theodore Roosevelt NP; also tend to be small, incidental communities in the Little Missouri NG). In southern extent, would not see those as much. Rocky Mountain juniper also occurs in places, but tends to be an understory shrub in MT. Should also have Canada wildrye and woods rose. Variable across distribution. Muhlenbergia racemosa also common.

The bur oak type (even though lumped into this BpS and others) occurs within here. Green ash on bottom, and backslopes could have oak within it - in higher elevation areas such as Black Hills and Missouri River Badlands (in these MZs 29 and 30) . On eastern edge of Black Hills, bur oak is predominant species in drainages extending into prairie. Bur oak extends west into extreme southeastern corner of MT.

Quercus macrocarpa/Prunus virginiana habitat type forms relatively extensive communities on backslopes of intermittent streams and drainageways. This habitat type was limited to glaciated areas. The Populus tremuloides/QUMA2 community type occupied erosive slopes. Once these areas become stabiliized, the QUMA2/PRVI habitat type will probably result because QUMA2 reproduces in the understory. The QUMA2/Corylus species habitat type is found in the Killdeer Mountains and adjacent areas. This habitat type is on gentle slopes and the soils are more leached than many of the other types. The Betula papyrifera Corylus Cornuta community type occupies similar sites and is seral to QUMA2/Corylus species habitat type (Girard et al. 1989).

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Other dominant species: poison ivy

Disturbance Description

The wooded draw BpS forms an intimate association with adjacent mixed grass prairie and shrublands where non-typical-replacement fires are relatively frequent because of productive grass fuel and cycles of moisture and drought. Fires could go through the tree stands without topkill. Most years, the fires occur and meander but they're not intense enough to crown.

In drought periods, especially in late fall/summer, conditions were dry enough for stand replacing fires.

In areas where Rocky Mountain juniper or ponderosa pine invade woody draws, enhance flammability of system; fire carries through system. Juniper would then be lost, and smaller pines would be lost.

Bur oak is in some of the woody draws. Since it is fire-tolerant, a strong sprouter and shade intolerant, it will be enhanced by stand replacing fire, especially in times with higher moisture.

Many of trees could be killed by drought and fire together - weak sprouters for example, such as green ash and American elm could be killed.

Fraxinus is even more tolerant than bur oak - so it would sprout up too after high intensity fire. Periods with more fires - bur oak dominates. Without fire - elm and ash dominate.

Less frequent stand replacement fires were generally associated with periods of exceptionally high moisture conditions immediately followed by severe dry conditions.

Native ungulates play a role in stand regeneration on sites where deer and elk (and less so - bison, which don't congregate in the woody draws) concentrate for food, cover and shelter.

Drought and moist cycles are major factors that interact with both fire and native grazing.

Low and mixed severity fire probably occurs on average every 10yrs.

Replacement fire: green ash trees are over 50yrs old. Replacement fires occurring every 60yrs.

Deciduous trees in the Badlands of the Dakotas in woody draws are reported to be no older than 50yrs and juniper no older than 100yrs (Warner 1983). The fire return intervals of 15-30yrs were estimated for more broken topography at Scotts Bluff National Monument, NE (Wendtland and Dodd 1992). This return interval would have interacted with long term wet and dry periods for the area. The edges of these draws would have been impacted by the return intervals and fire frequencies of the surrounding prairie. The more mesic areas of the draws would have only been likely to burn in dry periods. The community, when maintained by fire, will have a mosaic of different age classes within a watershed. Browse for ungulates will increase. Sheltering cover will remain within 25% of current levels. Canada thistle and associated non-native species related to homesteading will be reduced. The structural complexity of the community will be maintained. (from Badlands National Park Fire Management Plan).

Heart rot can occur with Fraxinus spp.

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Adjacency or Identification Concerns

Occurs in upland draws and ravines scattered throughout the Northern Mixed Grass prairie. There may be intermediates of this type of green ash communites and cottonwood stands, especially in the eastern portion of the map zone along the larger, primary drainages associated with the Missouri River, and also in southern edge of Black Hills. In some cases, the type merges with north-facing Rocky Mountain juniper stands, especially at the top of draws.

This could also grade into the Floodplains or riparian areas. There might be some difficulty distinguishing the Floodplain Systems from the Riparian from the Wooded Draw/Ravines - and where to assign smaller, second and third order prairie streams. The second and third order prairie streams can sometimes have cottonwood and be like small rivers (Riparian, Floodplain); sometimes they are dominated by other woody species such as water birch, boxelder, green ash (Wooded Draw/Ravine) and willows, depending on how far east you go; sometimes they have very few woody plants other than silver sagebrush (Floodplain box E). Streams in the eastern half of MT (east of the Big Snowies) could probably be modeled as either a cottonwood successional sequence or a woody draw successional sequence, depending on the size of the drainage basin. If the basin is big enough there will eventually be a flood big enough to result in cottonwood regeneration. This may not happen very often naturally, so these types of drainages would be in class E Floodplains (silver sagebrush) a lot of the time. This is especially true now that we have all the impoundments in the headwaters of these prairie streams. Drainages that just don't have the area to get a serious flood would probably have been some sort of woody draw, dominated by green ash in the eastern third of the state or other woody species like hawthorn or chokecherry in the more western part of the Great Plains. In terms of assigning the drainage to one or the other type of system, it would depend on basin size.

The bur oak type (even though lumped into this BpS and others) occurs within here. Green ash on bottom, and backslopes could have oak within it - in higher elevation areas such as Black Hills and Missouri River Badlands (in these MZs 29 and 30). On eastern edge of Black Hills, bur oak occurs in drainages extending into prairie.

Aspen in this system could be confused for the Northwestern Great Plains Aspen Woodland and Parklands. However Aspen Parklands are not more extensive in this part of the US. The range of aspen parklands just gets to the ND-MB border. There could be some plots that trickle into ND but we wouldn't expect many. The aspen parkland system is really in Canada, Alberta in particular (Menard, pers comm). There is a aspen/paper birch habitat type described for Theodore Roosevelt NP.

Understory is currently often dominated by Kentucky bluegrass throughout its extent in these mapzones, and leafy spurge is dominant in the Little Missouri grasslands.

Grazing by domestic livestock has reduced regeneration (increased mortality). On heavily grazed sites, stands are much more open than historically, with an understory of Kentucky bluegrass. There's also more compaction. Mid-story and regeneration is "missing." When the trees become decadent the whole stand can be lost. Combo of drought and grazing/trampling could also cause loss of stand.

In ND, system more likely to withstand grazing effects due to higher precipitation.

There's probably less of this system currently versus historically. Due to grazing, this system probably appears departed from its reference condition.

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In many of the woody draws on Buffalo Gap and Oglala NGs, cattle will hang out in the draws and prevent almost all surface vegetation from growing. This increases erosion, compacts soil, and affects flammability for those fires that do occur. This leads to an overabundance of Rocky Mountain juniper in some draws. Fires burning up these draws with good burning conditions would be high severity (everything aboveground killed).

Native Uncharacteristic Conditions

Scale Description

Landscape adequate in size to contain natural variation in vegetation and disturbance regime. Western stands are usually relatively small (<50ac). Larger areas, 50-100ac, occur infrequently on the eastern and northern edge of distribution. Long, linear corridors could be <50m wide but snake through the landscape for many miles, although it is not necessarily a continuious system (dendritic scale similar to riparian scale).

Most fires meander from adjacent system - grasslands. If a drier year, fire will burn through system.

Issues/Problems

Long, linear nature of distribution makes these systems difficult to map. Consequently, they are often listed as a complex in relatively small-scale mapping efforts.

Comments

This model for MZs 29 and 30 was adapted from the model from Rapid Assessment R4WODR created by Jack Butler and Stefanie Wacker and reviewed by John Ortmann; however, portions of the MZs 29 and 30 model were also taken from MZ20 model for this BpS created by Peter Lesica. The VDDT model and descriptions used were those from MZ20.

This model for MZ20 was adapted from the Rapid Assessment model R4WODR Northern Great Plains Wooded Draws and Ravines created by Jack Butler and Stefanie Wacker and reviewed by John Ortmann. For MZ20, major descriptive and quantitative changes were made in order to represent MT better. The MZ20 model was changed to a three-box model.

Vegetation Classes

Class A **20 %**

Early Development 1 All Structure

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

CASP7	Lower
SYOC	Upper
PRVI	Upper
	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	80 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

This class is dominated by shrubs. Cover averages approximately 50%, and the minimum cover would never be as low as zero percent. In the first year, herbaceous species might dominate. The herbaceous cover is high underneath the shrubs. The herbaceous cover would probably be 25-50% cover. This class succeeds to B after approximately 10yrs.

This class is similar to a snowberry rose coulee type. It contains chokecherry and snowberry, with a mesic

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understory of CASP7 and various woodland forbs and poison ivy.

The transition from A to B could be retarded by native ungulate browsing. Grazing would set this stage back to its beginning state. Grazing, however, is dependent on weather cycles, as well. However, deer select green ash. There is also elk browsing.

The combined effect of drought and grazing was modeled as Optional 1. It was modeled to occur on 10% of this class on the landscape each year, setting succession back to zero.

Grazing alone was modeled as occurring on 25% of the landscape each year, but maintaining the class and not causing a transition.

The FRIs are similar to grassland systems, but we're not in a grassland system here the entire 10yrs or throughout the system - it is partly shrubs, so there aren't replacement fires occurring all of the time. Occassionally, there are replacement fires if going through the grass. There are also mixed severity fires - 25-75% topkill - since the shrubs aren't completely topkilled. Fires were modeled at an overall interval of 15yrs, half replacement and half mixed severity.

Class B **15 %**

Mid Development 1 All Structures

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model

Indicator Species* and Canopy Position

PRVI	Mid-Upper
SYOC	Low-Mid
FRPE	Lower
CASP7	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	50 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class is dominated by shrubs and trees and is a mid-development stage. It is 10-29yrs old. Trees are coming in and getting taller in this stage. Trees are growing approximately 2/3 of a foot each year. A 30% canopy cover of trees would be the average (Lesica 2001). This stage reaches approximately 30yrs of age. It is similar to class A, but the shrubs are taller, and the trees that are coming in, are beginning to overtop the shrubs. A true tree canopy has not yet developed.

The FRI is similar to that in a grassland system, although this system might experience somewhat less frequent intervals, as occassionally fires might not burn through this stage. Some will be replacement fires (100yrs) and take out all of the stand, although this would be less frequent and would also depend on the year and drought. Some fires might maintain the stand. Most of the fires would be mixed (40yrs) and low severity (65yrs), although the frequency of types would be similar. There would be less mortality on larger trees. During episodes of drought and grazing, there would be no fuel present for fire. Fire was therefore modeled at an overall frequency of 20yrs, but split 30/50/20 percent between low, mixed and replacement fires. The low and mixed fires do not cause a transition to another stage.

The combined effect of drought and grazing was modeled to occur on 10% of this class on the landscape each year, but not causing a transition, and rather maintaining this class.

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Class C 65 %

Late Development 1 All Structures

Indicator Species* and Canopy Position

FRPE	Upper
PRVI	Mid-Upper
SYOC	Middle
CASP7	Lower

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

This class begins at approximatelly 30yrs old and persists. This includes both open and closed stages of this system in this age range. An average canopy closure would be approximately 50%. Height can be between 40-70ft and DBH approximately 45in (USDA Forest Service 2002), although most old-mature ash trees in this type in MT are 20-40ft high with a basal diameter of 20-30in. Tree canopy in this stage is now formed. It takes on aspects of a woodland instead of a shrubland (the first two classes are more shrub communities).

The FRI is similar to that in a grassland system, although this system might experience somewhat less frequent intervals, as occassionally fires might not burn through this stage. Some will be replacement fires and take out all of the stand, although this would be less frequent and would also depend on the year and drought. Some fires might maintain the stand. Most of the fires would be mixed and low severity, although the frequency of types would be the same. There would be less mortality on larger trees. Fire was therefore modeled at an overall frequency of 20yrs, but split 30/50/20 percent between low, mixed and replacement fires. The low and mixed fires do not cause a transition to another stage.

The combined effect of drought and grazing was modeled to occur on 10% of this class on the landscape each year, but not causing a transition, and rather maintaining this class.

Disease might occur in this stage, which opens the stand (Lesica et al. 2003). In MT, this is more prominent than in the Dakotas. In the Dakotas, canopy closure could be 90%. In MT, open canopy would be about 40-45%, and the relatively open nature of stands is probably due, in large part, to high rates of heart-rot disease. Disease is not as common further east, in the Dakotas, NE, etc, and as one gets further east into higher precipitation zones. In the east, canopy cover would be higher and more closed (therefore, canopy cover increased to 100% for MZs 29 and 30). Disease was modeled as occuring on 20% of this class each year and causing no transition - just keeping it a more open stand. It does not cause a transition to another stage (ie: B), however, because it was questionable as to whether the disease-caused, open, mature stand would be the same as the 9-30yrs old stand.

Class D 0 %

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

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**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 seve

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg 50
Min 5
Max 100

Sources of Fire Regime Data

- ☐ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	75	30	100	0.01333	26
Mixed	40			0.025	49
Surface	80	10	100	0.0125	25
All Fires	20			0.05083	

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

- ☑ Insects/Disease
- ☑ Native Grazing
- ☑ Other (optional 1) grazing and drought together
- ☐ Wind/Weather/Stress
- ☐ Competition
- ☐ Other (optional 2)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **2914950** **Western Great Plains Depressional Wetland Systems**

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

General Information

Contributors (also see the Comments field **Date** 5/5/2006

Modeler 1	Kathy Roche	kroche@fs.fed.us	**Reviewer**	Peter Lesica	peter.lesica@mso.umt.edu
Modeler 2	Carolyn Meyer	meyerc@uwyo.edu	**Reviewer**	Kathy Roche (rvw'd again)	kroche@fs.fed.us
Modeler 3			**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

29

Model Zone

☐ Alaska ☑ N-Cent.Rockies
☐ California ☐ Pacific Northwest
☐ Great Basin ☐ South Central
☐ Great Lakes ☐ Southeast
☐ Northeast ☐ S. Appalachians
☐ Northern Plains ☐ Southwest

Dominant Species*

PASM ELPA3
DISP JUBA
HOJU PUCCI
ELAC

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This occurs throughout lowland low elevation areas of MZ22. These are wetlands that are saline playas. This model might also be used for MZ29. This system is very uncommon in MZ20.

Saline playas are not common in the MT part of MZ29. However, this habitat does occur both north and west of Billings probably in 331k. There may be more playas in the Bighorn basin of WY. For MZ30, there is probably not any playa-type vegetation in northeastern MT. However, there are some large areas on the Fort Peck Indian Reservation west of Froid that could be this type. These probably do also occur in the Dakotas.

Biophysical Site Description

The closed depression wetland has communities associated with the playa lakes in the southern areas of this province an the rainwater basins in NE characterize this system. They are primarily upland depressional basins. This hydric system is typified by the presence of an impermeable layer such as a dense clay, hydric soil and is usually recharged by rainwater and nearby runoff. They are rarely linked to outside groundwater sources and do not have an extensive watershed. These closed depression wetland sites on the unglaciated great plains (ie: not prairie potholes) that are not Western Great Plains Saline Depressions CES303.669 are few and far between in MZ20.

In the open freshwater depression wetland, the system is composed of lowland depressions and also occurs along lake borders that have more open basins and a permanent water source through most of the year except during exceptional drought years. These areas are distinct from Western Great Plains Closed

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Depression Wetland (CES303.666) by having a large watershed and/or significant connection to the groundwater table. The system includes submergent and emergent marshes, and associated wet meadows and wet prairies. These types can also drift into stream margins that are more permanently wet and linked directly to basin via groundwater flow from/into the pond or lake.

Depressional wetlands in MZ29 WY have formed from other means –sometimes wind scour with a low permeability substrate.

Vegetation Description

In MZ20, vegetation is dominated by sparse to dense cover of graminoids, up to one meter tall, although typically 0.6m or shorter. Pascopyrum smithii usually dominates, with Distichlis spicata, Hordeum jubatum, Eleocharis acicularis or Eleocharis palustris almost co-dominant. Juncus balticus will be present in areas where water stands for longer after a storm or where flooding occurs. Other graminoids include Puccinellia nuttalliana, Bouteloua gracilis, Koeleria macrantha and Hesperostipa comata (HECO is questionable, since it prefers sandy soils, and this type is developed on clay soils). Spartina gracilis has been documented in MZ20 but only in limited areas. Woody plants are rare, except for occassional Gutierrezia sarothrae, Artemisia frigida, Artemisia cana or Symphoricarpos occidentalis. Sarcobatus vermiculatus and Basin wildrye (Elymus cinereus) can also be associated with saline playa vegetation in MT, although they are probably not nearly as common as the listed dominants.

For MZ22, there is inland saltgrass, alkali sacaton, alkali cordgrass and Rocky Mountain glasswort. Vegetation is in zones radiating from the center of the depression and is dependent on the gradient of the depression. Other dominant species could be SPGR, SARU and SPAI.

Disturbance Description

Plant communities providing saltgrass habitat are diverse and exhibit a wide range of fire frequencies. Saltgrass is found in desert shrub communities that have fire return intervals of <35yrs to 100yrs+ (Hauser 2006).

Prior to land use changes, grassland communities where saltgrass occurs burned regularly. While there is relatively little fire frequency information available on the time prior to the 1880s, it is estimated that fire occurred every 7-10yrs (Hauser 2006). However, the saltgrass in this BpS is in a wetland system and is therefore thought to burn much less frequently. Also, some of the wet clay and salt acts as a fire retardant. There is also little litter in these systems (Roche, pers comm).

Historical fire size is very dependent upon the surrounding vegetation.
The minimum size would be one acre. The maximum would be around 200ac. The average would be eight or nine. Logic is that if the average playa is about 10ac, the whole thing would rarely burn because of the wetness at the center --so say 80-90% of the playa would burn. Because the surrounding grasslands have an FRI of 10-20yrs, it was thought that small playas or depressional wetland systems would have similar FRIs, because the fire would just move over them. However, if the playa/system is larger - ie: over an acre, then it would be less likely to burn. Therefore, an overall FRI, considering both scenarios, was chosen to be 50yrs. This rationale was questioned by a reviewer who thought that the FRI would be the same as the surrounding grassland or steppe because fire would occur when the playa and grass was dry and would be just as flammable as the uplands. However, many of the plants in these playas aren't grass and just don't dry out or don't burn like grass (Collins and Uno 1983). And also because the FRI was originally modeled at 100yrs, the lesser 50yrs was retained and not made it even more frequent. Because fire rotation is being considered, the longer interval was retained.

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Return interval for fire could be extended by ungulate grazing.

Spartina gracilis, when present, can withstand fire because of deep rhizomes. Sarcobatus might be the only species that might be killed by fire.

Episodic disturbance is caused by insect infestation (grasshoppers, range caterpillars and Mormon crickets). This was not modeled.

Grazing by native ungulates such as buffalo and antelope can occur. During droughts, ungulates congregate in these areas.

Adjacency or Identification Concerns

Adjacent to western great plains shortgrass and mixedgrass prairies, saltgrass meadow, greasewood shrubland, mixed desert shrubland and big sagebrush steppe (Knight 1994).

It would be difficult to confuse this system with others in MZ29, as it is so rarely found in MZ29. Using aerial photography it might be possible to confuse an irrigated pasture for this type. Otherwise there are few wetlands not closely associated with rivers or streams.

Large concentrations of ungulates could increase the percent of the landscape dominated by shrubs and forbs compared with reference conditions. Fire return intervals are now in the range of 30yrs plus.

Since the early 1900s, fire has been excluded and nonnative species such as Japanese brome (Bromus japonicus), smooth brome, Kentucky bluegrass, crested wheatgrass (Agropyron cristatum) and Canada thistle (Cirsium arvense) have taken a strong hold in the Great Plains mixed-grass prairies where saltgrass occurs (Hauser 2006).

Bromus japonicus is the most likely exotic to become common in this type. Halogeton could be common in WY.

Shallow wetlands have sometimes been plowed and planted to crested wheatgrass in other parts of MT.

Native Uncharacteristic Conditions

Scale Description

Documentation from outside of MZ22 says playas range from two acres to 800ac with an average of 17ac. For MZ22, big playas are non-existent --so the average would probably be smaller --maybe about 10ac. For MZ20, calling them playas is stretching the definition. We see these little semi-saline playa-type wetlands here and there but they are rarely much more than two acres. However, there are large alkali lakes in parts of the state, although these are much more saline. MZ20 also contains War Horse Lake, a large playa-type lake, Alakalai Lake south of Browning as well as some large playas south of Fort Benton (White Lake, Big Lake, Shonkin Lake); all of these are on the order of ca. 1000ac.

Historical fire size is very dependent upon the surrounding vegetation.
The minimum would be one acre. The maximum would be around 200ac. The average would be eight or nine. Logic is that if the average playa is about 10ac, the whole thing would rarely burn because of the wetness at the center --so say 80-90% of the playa would burn.

Issues/Problems

Concentrations of ungulates could increase the percent of the landscape dominated by shrubs and forbs compared with reference conditions.

Comments

This model for MZs 29 and 30 was adopted as-is from the same BpS from MZ20 which was reviewed by Linda Vance.

This model for MZ20 was adapted from the draft model for the same BpS from MZ22. Descriptive changes were made to reflect the system within MZ20 and to more fully describe the system.

This model for MZ22 was adapted from the model from BpS 1149 in MZ28, which was an adjacent western Great Plains shortgrass prairie model. Quantitative and descriptive changes were made, and this is in essence a new model. Therefore, comments and modeler and reviewer names from 281149 have been removed.

Vegetation Classes

Class A **35 %**

Early Development 1 All Structure

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

PASM	Upper
DISP	Upper
HOJU	Upper
ELAC	Upper

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	0 %	20 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Dominated by resprouts and seedlings of grasses and post-fire associated forbs. Low to medium height with variable canopy cover. For MZ22, indicator species could also be PUCCI and SPAI.

Persists for 20yrs and then succeeds to class B, a mid-development closed stage. This long span in class A was questioned by a reviewer. It was stated that the only way this would happen is if there was some pretty heavy livestock grazing. Class B would be back in just a few years following a fire. Fire would cause little change in species composition except possible a temporary decline in Puccinellia and Hordeum (bunch grasses). However, in the southern end of MZ29, the dry cycles severely limit vegetation establishment; the southern part of MZ29 is drier and saltier, and gets different precipitation patterns, which slows down vegetation recovery compared to other parts of MT. It takes a long time to get enough cover to move to class B. It might be warranted that there be a different model for a more northern version, with the model cycling to B more quickly. This would cause less percentage to be in A and more to be in B.

Also - the periodic wet and dry periods are the reason for the long time in class A and the slow recovery of cover. Perhaps as you go further south and more outside the glaciation effects, the recovery of the system is slower (Kathy Roche, USFS, pers comm). In the southern end of the mapzone, the dry periods are longer and slow the vegetation recovery.

Native grazing and herbivory could be heavy (10% of this class each year).

Replacement fire occurs every 50yrs, which is somewhat longer than the FRI of an adjacent grassland

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community. Since this is a wetland community, it is thought that fire would impact the landscape much less frequently.

Class B 65 %

Mid Development 1 Closed

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Indicator Species* and Canopy Position

PASM	Upper
DISP	Upper
PUCCI	Upper
HOJU	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	30 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	None	

- [x] Upper layer lifeform differs from dominant lifeform.

Scattered shrubs may be present.

Description

Greater than 30% herb and shrub cover combined. For MZ22, indicator species could also be SPAI and SARU.

Native grazing and herbivory could be heavy (20% of this class each year).

Replacement fire occurs every 50yrs, which is somewhat longer than the FRI of an adjacent grassland community. Since this is a wetland community, it is thought that fire would impact the landscape much less frequently.

Class C 0 %

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Class D 0 %

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model

- [x] Upper layer lifeform differs from dominant lifeform.

Description

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Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	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 10
Min 1
Max 200

Sources of Fire Regime Data

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Fire Intervals

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	50	10	100	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 fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver 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.

Additional Disturbances Modeled

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

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