LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110110 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** 2/26/2006

Modeler 1	Roy Renkin	roy_renkin@nps.gov	**Reviewer**	Liz Davy	edavy@fs.fed.us
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Vegetation Type

Forest and Woodland

Map Zone

21

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 PIEN
PSME GRASS
PICO
ARTR2

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This ecological system is widely distributed in MZ21 within a mosaic of other communities in the Northern US Rockies. Communities are usually small 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 and 342Dd have communities in patches ranging from 25-100ac (10-40ha) in size.

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 between sagebrush steppe and the subalpine forest zone, 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. Generally, aspen stands that have low amounts of conifer cover are associated with mollisols. 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 sagebrush, so there is likely some overlapping with those BpS's.

Vegetation Description

These are upland forests and woodlands 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, dominated by graminoids or forbs. Common shrubs include Acer glabrum, Amelanchier alnifolia, Artemisia tridentata, Juniperus communis, Prunus virginiana, Rosa woodsii, Shepherdia canadensis, Potentilla gracilis, Symphoricarpos albus and

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Vaccinium spp.

Native grasses could include Calamagrostis canadensis, Calamoagrostis ubescens, Carex geyeri, Carex rossii, Elymus glaucus, Elymus trachycaulus, Festuca idahoensis 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 MFI 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. They occurred approximately every 40yrs in the montane aspen-conifer mix. When adjacent to subalpine zone lodgepole pine or closed-canopy Douglas-fir, fires occurred least frequently, 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 their experience in modern landscapes and literature review (Barrett 2004).

For MZ21, modelers considered fire 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 disturbance regime that could influence successional pathways.

After initial review, another reviewer commented that there should be mixed and surface fires in this system, and that conifer encroachment should be considered and modeled separately (Tart, personal correspondence). However, this was not modeled as original modelers did not respond. It is also thought by another reviewer that this system might have had a more frequent return interval, not based on lightning strikes but rather adjacent types and Native American burning. The return interval in this system is in question.

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 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

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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.

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.

Currently, most of this class is probably in the E or C classes - late development closed stages. This system is probably in FRCC 3 - due to fire suppression and elk browsing and livestock grazing.

Type conversion to conifers in some areas. Very small amounts of aspen left in some areas.

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) in size.

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 1800's. 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 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

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

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Additional reviewers for MZ21 were: Spencer Johnston (sdjohnston@fs.fed.us), Candi Eighme (ceighme@fs.fed.us), Lisa Heiser (lheiser@fs.fed.us) and Heidi Whitlatch.

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. The model and description for MZs 12 and 17 is a compromise between VDDT model R2ASPN from the rapid assessment and the model for MZ16. One class (D) representing moderate conifer encroachment to stable aspen (as per NatureServe description of ecological system 1011) was added to the Rapid Assessment model R2ASPN and the mean annual FRIs and insect/disease probabilities of BpS 1011 for MZ16 were adopted. 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). 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.

Vegetation Classes

Class A 10%

Indicator Species* and Canopy Position

Early Development 1 All Structures POTR5 Upper

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 2

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

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 10yrs.

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. A reviewer suggested 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. This condition does not represent site establishment via sexual reproduction that would revert to grass three years after seedling establishment. Also, although aspen suppression by herbivores is important in the Greater Yellowstone Ecosystem (which would more likely be a current condition, not the 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 although it certainly can be extirpated, it is believed that this occurs far less frequently.

Native grazing occurs with a probability of 0.01, which returns the class to the beginning of the state.

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Class B 25 %

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 2-10m 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 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 MFI was originally used for the model and results generally in overstory mortality. Reviewers recommended a 100yr MFI, 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, 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

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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 replacemnt fire will stimulate the suckering response. Reviewers recommended adding mixed severity fire at 100yrs and replacement fire at 100yrs. However, because mixed and high severity fires are functionally the same in terms of suckering response, and since no data exists to split these disturbances, they were lumped for simplicity.

Subalpine fir might be comining 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 2 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 and 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 MFI of 60yrs was originally used for the model, but changed to 100yrs as per reviews.

In the absense 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.

Reviewers state that in the southern portion of this mapzone, this would transition to ABLA instead of PSME. PICO and ABLA would occur in the lower, middle 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.

Outside reviewer commented that 25% in class D historically seemed too high, and that it should rather be approx 10-15%.

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Class E **15 %**

Late Development 3 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	110	4	200	0.00909	100
Mixed					
Surface					
All Fires	110			0.00911	

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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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110120 Rocky Mountain Bigtooth Maple Ravine Woodland

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

General Information

Contributors (also see the Comments field) **Date** 4/10/2005

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Modeler 2			**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type
Forest and Woodland

Map Zone
21

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

Dominant Species*
ACGR3
CAGE2
SYOR2

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Northern and central Wasatch Mountains. Scattered occurrences in SW UT, central AZ and NM. BpS 1012 is believed to be rare to absent in MZ17 and completely absent from MZ12 (NV).

Biophysical Site Description
Rocky colluvial or alluvial soils with favorable soil moisture, from flat or gentle to steep slopes. Generally deep soils. Found on all aspects, but more commonly on south-facing slopes in MZ18, and more on lower slopes than exposed slopes or ridges. Elevations range from about 5000-8000ft.

Vegetation Description
Generally dominated by Acer grandidentatum, but may be mixed with Quercus gambelii or scattered conifers on drier sites, or with Acer negundo or Populus tremuloides on moister sites. Understory may include elk sedge, snowberry and various herbs. Maple stands are generally dense and often continuous, although may be patchy with various grass or herbs between clones. Open maple stands (of any seral stage) are uncommon. Mature stands are generally tall shrub to low tree height.

Disturbance Description
Fire is the primary disturbance factor in this system, probably originating from the outside landscape. Fires are generally moderately infrequent and mixed severity, with a fair component of stand-replacement. (No fire modeled in class A; class B and C modeled 75yr mixed and 125yr replacement.) Bigtooth maple sprouts readily after fire, and recovery is generally rapid.

Insect and disease impacts are rare and were not modeled. Occasional avalanche, mud or rock slides will have minor, localized effects on seral stages (also not modeled). Floods will occasionally create conditions

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for seedling establishment (modeled at 400yr return interval for big floods which return conditions to early seral.

Adjacency or Identification Concerns

This BpS is mappable in MZ18, however BpS 1012 is probably not mappable in MZ17 as experts do not think that bigtooth maple is found in MZs 12 and 17.

Often adjacent to and grading into the Rocky Mountain Gambel Oak - Mixed Montane Shrubland, which will occur on slightly drier and more southern sites. May be just below the Rocky Mountain Montane Mixed Conifer or Rocky Mountain Subalpine Spruce-fir or Aspen types. This type is generally continuous maple patches; landscapes with scattered maple patches would be a different type.

Maple may be susceptible to non-native gypsy moth in today's ecology.

Literature suggests that bigtooth maple is replacing Gambel oak in the absence of fire, although personal observation suggests that both sprout equally well where they occur. Rather than replacing Gambel oak, bigtooth maple may be becoming a component within the oak system. Maple is more shade-tolerant than Gambel oak and can replace oaks during long fire-free intervals.

Native Uncharacteristic Conditions

Scale Description

This type is found on fairly large elevation bands between the valley grasslands and montane aspen/conifer or sagebrush stands. Disturbance patch sizes within this type are generally small, from a few acres to hundreds of acres, and are influenced by topography and geology.

Issues/Problems

Comments

For MZ21, this BpS was adopted as-is by MFSL from 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. BpS 1012 from MZ17 was accepted with only minor revisions for MZ18 (S. Heide 5/19/05). Some changes were made to the database record including plant species additions and changes to fuel models.
BpS 1012 for MZ17 was adopted as-is from MZ16. Gary Medlyn (gary_medlyn@nv.blm.gov), Jack Sheffey (Jack_Sheffey@blm.gov), Bryan Bracken (bryan_bracken@blm.gov) and Sandy Gregory (s50gergo@nv.blm.gov) examined description of BpS for MZs 12 and 17 and did not believe that bigtooth maple ravine woodlands are found in MZs 12 and 17 as they have never observed the species in these zones.
BpS 1012 for MZ16 was developed by Beth Corbin (ecorbin@fs.fed.us) and Stanley Kitchen (skitchen@fs.fed.us) and reviewed by Doug Page (doug_page@blm.gov) and Mark Loewen (mloewen@fs.fed.us).

Vegetation Classes

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Class A **10 %**

Early Development 1 All Structures

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model 5

Indicator Species* and Canopy Position

ACGR3	Upper
CAGE2	Lower
MARE11	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0.6m	Shrub 1.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Post-replacement stage dominated by a mix of various herbs and grasses and low maple sprouts. Since bigtooth maple sprouts rapidly, the early seral stage will last less than eight years (commonly from 0-8yrs in age). This vegetation not likely to carry fire (fire was not modeled in this class). Large floods are stand-replacing events and occur with a frequency of approximately 400yrs.

Class B **20 %**

Mid Development 1 Closed

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model 9

Indicator Species* and Canopy Position

ACGR3	Upper
SYOR2	Lower
CAGE2	Lower
MARE11	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	70 %
Height	Shrub 1.1m	Shrub 3.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Mid-seral, closed stands of maple (sometimes associated with Gambel oak or other shrubs). Mid-seral stages generally start at about nine years of age and become late seral at about 30yrs of age. Sprout sizes generally are about 1-3m high, with high canopy cover. Stem diameters are generally less than three inches. Understory herb and grass cover can range from very low (when shrub and litter cover is high) to fairly high. Replacement fire (mean 125yrs FRI) and flooding (return interval of 400yrs) are stand replacing events, whereas mixed severity fire (mean 75yrs FRI) maintains vegetation structure.

Class C **70 %**

Late Development 1 Closed

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model 9

Indicator Species* and Canopy Position

ACGR3	Upper
SYOR2	Low-Mid
CAGE2	Lower
MARE11	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	80 %
Height	Shrub 3.1m	Shrub >3.1m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Late seral, generally closed stands of maple. Stand stem ages are generally greater than 30yrs, and greater than three inches diameter in size. Stand heights are generally greater than three meters. Overstory canopy cover is generally 30-80%; understory cover is similar to mid-seral. Scattered conifers can occur at this stage. Disturbance dynamics as in class B.

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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 40
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	135			0.00741	38
Mixed	82			0.0122	62
Surface					
All Fires	51			0.01961	

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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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110450 Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest

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

General Information

Contributors (also see the Comments field) **Date** 2/14/2006

Modeler 1	Steve Cooper	scooper@mt.gov	**Reviewer**	anonymous	
Modeler 2	Lee Clark	lwclark@fs.fed.us	**Reviewer**	LaWen Hollingsworth	lhollingsworth@fs.fed.us
Modeler 3	Jim Roessler	roessler@direcway.com	**Reviewer**	Reggie Clark	rmclark@fs.fed.us

Vegetation Type
Forest and Woodland

Map Zone
21

Model Zone

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

Dominant Species*

PIPO	CAGE
PSME	PHMA5
PICO	SYAL
CARU	MARE11

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Northern Rocky Mountains in western, north and central MT, eastern WA and northern ID, extending south to the Great Basin. In MZ20 tree islands throughout the zone.

Modelers and reviewers for MZ21 feel strongly that this BpS is not in MZ21, and that the Douglas-fir stands in MZ21 are BpS 1166. The only place this might occur is near Livingston and at lower elevations in the very northern portion of the zone. Ponderosa pine, western larch and grand fir are not thought to occur in MZ21 in this form. There is no naturally occurring ponderosa pine/Douglas-fir types in the forested area from Bozeman to west Yellowstone. There is some ponderosa pine south of Big Timber and more to the east once you leave MZ21. There is also none in Yellowstone or the Island Park area. There is no Abies grandis or Larix in this area either.

Biophysical Site Description
Modelers and reviewers for MZ21 feel strongly that this BpS is not in MZ21, and that the Douglas-fir stands in MZ21 are BpS 1166. The only place this might occur is near Livingston and at lower elevations in the very northern portion of the zone. Ponderosa pine, western larch and grand fir are not thought to occur in MZ21 in this form. There is no naturally occurring ponderosa pine/Douglas-fir types in the forested area from Bozeman to west Yellowstone. There is some ponderosa pine south of Big Timber and more to the east once you leave MZ21. There is also none in Yellowstone or the Island Park area. There is no Abies grandis or Larix in this area either.

Generally found in the montane zone on well-drained, thin soils, generally on relatively warm, steep settings in the non-maritime influenced portion of the mapping zones. Elevation ranges from >4000ft in the southern

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area and >2500ft in the northern extent. In MZ20, elevations can range from 2500ft to up to 6900ft in Bear Paw Mountains. Sites can range from nearly flat to steep on all aspects.

This can also occur along benches - with Linnea Borealis.

Common habitat types include: PSME/CARU - all phases, PSME/PHMA, PSME/SYAL, ABGR/LIBO and ABGR/XETE. In MZ20, not necessarily ABGR. Other common habitat types are also: PSME/ARUV and PSME/COCA-LIBO in Bear Paw Mtns. In the Snowy Mts, PIEN/LIBO is found.

Vegetation Description

Ponderosa pine is generally the dominant species on southerly aspects and drier sites, with Douglas-fir dominating on northerly aspects. Southerly aspects support relatively open stands. Northerly aspects support more closed stands. On mesic sites with longer fire return intervals, Douglas-fir often co-dominates the upper canopy layers. In the absence of fire, Douglas-fir and grand fir dominate stand understories. Western larch and lodgepole pine may also be present and becomes more abundant throughout the northern range of the BpS.

In MZ20, Douglas-fir codominates in the canopy and dominates stand understories; PICO can be present in the understory of open stands. At lower elevations in the Snowy Range, hybrids can occur of Englemann and white spruce. Western larch and grand fir are absent.

Understory can be dominated by shrubs such as ceanothus, ninebark and spiraea, willow and ocean spray, or open grass dominated by carex and pinegrass. Ninebark can have high cover (>30%) in some stands.

In MZ20, snowberry (SYAL) and Mahonia repens (MARE11) are also present in the shrub layer.

Most of the indicator species for 1045 do not occur in the NW part of the Greater Yellowstone Ecosystem and thus MZ21.

Disturbance Description

Consists of Fire Regime Groups I, II, III and IV with surface and mixed severity fires at varying intervals. Replacement fires may also occur. Mixed severity fire increases and surface fires decrease further north and higher elevations.

Lodgepole pine can dominate the understories in open canopy stands with the influence of low severity surface fires.

Insects and disease play an important role, especially in the absence of fire. Bark beetles such as mountain pine beetle, western pine beetle and Douglas-fir beetle are active in the mid and late structural stage, especially in closed canopies. Weather related disturbances, including drought, tend to affect the late closed structure more than other structural stages. Windthrow disturbance can also affect stands of this type.

Root rot is a minor concern in the northern extent of this BpS.

Mistletoe is present in the southern portion of this BpS and increases in occurrence with a lack of fire.

Adjacency or Identification Concerns

The mixed conifer zone in the Northern Rockies is broad, and represents a moisture gradient that affects fire regimes and species dominance.

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At lower elevations or southerly aspects, this type generally borders dry ponderosa pine, shrub or grassland systems. At higher elevations or northerly aspects, it borders spruce and subalpine fir. At ecotones, it may be very difficult to distinguish between this BpS and 1053 (Northern Rocky Mountain Ponderosa Pine Woodland) in mid and late-closed seral states.

This BpS corresponds to Pfister et al. (1977) and Steele et al. (1981) warm dry Douglas-fir (PSME/AGSP, PSME/ARUV PSME/FESC, PSME/SPBE, PSME/SYAL and PSME/LIBO).

Because of fire suppression, xeric ponderosa pine types may be invaded by Douglas-fir today. It may be especially difficult in fire suppressed areas to distinguish between ponderosa pine and ponderosa pine/Douglas-fir BpS units.

Modelers and reviewers for MZ21 feel strongly that this BpS is not in MZ21, and that the Douglas-fir stands in MZ21 are BpS 1166. The only place this might occur is near Livingston and at lower elevations in the very northern portion of the zone. Ponderosa pine, western larch and grand fir are not thought to occur in MZ21 in this form. There is no naturally occurring ponderosa pine/Douglas-fir types in the forested area from Bozeman to west Yellowstone. There is some ponderosa pine south of Big Timber and more to the east once you leave MZ21. There is also none in Yellowstone or the Island Park area. There is no Abies grandis or Larix in this area either.

Native Uncharacteristic Conditions

Canopy closure of >80% is considered to be uncharacteristic for this BpS.

Scale Description

Patch sizes were probably highly variable. Surface and mixed severity fires may have been variable in size, and potentially achieve large sizes due to wind influence (10s-1000s of acres).

Issues/Problems

In the northern range of this BpS, the younger age/size classes (class A, B and C) may be more extensive owing to larger and more frequent mixed or stand-replacement fires (relative to surface fires).

Modelers and reviewers for MZ21 feel strongly that this BpS is not in MZ21, and that the Douglas-fir stands in MZ21 are BpS 1166. The only place this might occur is near Livingston and at lower elevations in the very northern portion of the zone. Ponderosa pine, western larch and grand fir are not thought to occur in MZ21 in this form.

Comments

This model for MZ21 was adopted as-is from the MZ20 draft model for this same BpS with additions to the descriptions. The MZ20 draft model was, however, subsequently modified greatly for MZ20 by MZ20 modelers from this draft MZ20 model, which is why the mapzones listed for this BpS only include MZ21 and not MZ20 - since currently, the MZ20 model is not this one any longer. Additional reviewers for MZ21 included Nathan Korb, Eric Miller, LaWen Hollingsworth, Mark Novak, Liz Davy and one anonymous reviewer. Modelers and reviewers for MZ21 feel strongly that this BpS is not in MZ21, and that the Douglas-fir stands in MZ21 are BpS 1166. The only place this might occur is near Livingston and at lower elevations in the very northern portion of the zone. Ponderosa pine, western larch and grand fir are not thought to occur in MZ21 in this form.

For MZ20, model adapted from model for 1910451 created by Steve Rust, Larry Kaiser and Kathy Geier-Hayes and reviewed by Rolan Becker (rolanb@cskt.org), Den Leavell (dleavell@fs.fed.us) and Ed Leiser

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(eleiser@fs.fed.us). Changes to description and species were made as well as significant changes to model and fire intervals. Model was unsplit for MZ20. Additional modelers for MZ20 were Dan Rasmussen and Shannon Downey Iverson. Again, it should be noted that this draft model for MZ20 was completely changed subsequent to MZ21 model development.

For MZ19, additional reviewers included Cathy Stewart (cstewart@fs.fed.us), Pat Green (pgreen@fs.fed.us), Steve Rawlings (srawlings@fs.fed.us), Catherine Phillips (cgphillips@fs.fed.us), Lyn Morelan (lmorlan@fs.fed.us), Susan Miller (smiller03@fs.fed.us) and Steve Barrett (sbarrett@mtdig.net).

Peer review for MZ19 resulted in changes to the description and a slight reduction in the overall fire frequency (from 15yrs to 20yrs).

For MZ19, this BpS was adapted from RA PNVG R0PPDF by Lynette Morelan and Jane Kapler Smith, which was reviewed by Pat Green, Cathy Stewart and Steve Barrett. Modifications to the Rapid Assessment model included a slightly increased fire frequency (from approximately 20yrs to 15yrs). Relative proportions of surface, mixed and replacement fire were unchanged. The resulting percentages in classes C and D changed slightly.

The Rapid Assessment included two additional grand fir types. There was some disagreement among modelers and reviewers about whether two or three types should be developed from this BpS to capture slight differences in fire regimes. The BpS was not split.

Vegetation Classes

Class A 30 %

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PSME	Upper
PICO	Upper
	Upper

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.

Some sites exhibit resprouting shrubs (Physocarpus malvaceus) as the dominant lifeform. Other sites may be dominated by pine grass (Calamagrostis rubescens).

Description

Openings of grass and forbs that are created by infrequent, stand replacement fire. Seedlings and saplings of ponderosa pine, Douglas-fir and lodgepole pine may be present; on the drier end ponderosa pine will be dominant. Following very severe replacement fires, this class may be dominated by lodgepole pine.

Additional dominant species (low in the canopy) will include ninebark (PHMA5; Physocarpus malvaceus) and ceanothus (CESA; Ceanothus sanguineus). Spiraea may also be present. Elk sedge, tussock grass, Idaho fescue and pine grass are also present.

After 40yrs, this class succeeds to C (mid-development open) unless a replacement or mixed severity fire occurs. Alternate succession to B has a probability of 0.01.

Mixed fire occurs every 125yrs, and replacement fire every 55yrs.

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Class B 20 %

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PSME	Upper
PICO	Middle
	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	61 %	80 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Pole and medium sized Douglas-fir and ponderosa pine.

Succession to a late closed state will occur after approximately 110yrs.

Replacement fire will return this class to A, with a frequency of 75yrs. Mixed fire can open the stand and convert this class to class C (mid-development open), with a frequency of 90yrs. Surface fires are rare, but would maintain the class; they were not modeled. Pathogens can create gaps and cause a transition to class C (mid-development open) with a frequency of 50yrs.

Class C 30 %

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PSME	Upper
PICO	Upper
	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	60 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Pole and medium sized ponderosa pine or Douglas-fir are the dominant trees.

Additional dominant species (low in the canopy) will include ninebark (PHMA5; Physocarpus malvaceus) and ceanothus (CESA; Ceanothus sanguineus). Spiraea may also be present in the shrub layer. Elk sedge and pinegrass are also major components of the understory.

Replacement fire, though rare, will cause a transition to class A (early development), every 100yrs. Surface fires (188yrs), mixed fires (90yrs) and insects (80yrs) will maintain the open condition. If this class escapes fire for 60yrs, it will succeed to class B (mid-development closed). If fires do occur, it will succeed at 115yrs to class D (late-development open).

Class D 15 %

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PSME	Upper
	Upper
	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

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Large and very large sized ponderosa pine and Douglas-fir are the dominant trees. Structure may be patchy depending on fire severities in previous class. Ceanothus will be decreasing and willow, spiraea, ninebark, elk sedge and pine grass will still be present.

Replacement fire, though rare, will cause a transition to class A (early development) every 190yrs. Surface fires (65yrs), mixed fires (200yrs) and insects (100yrs) will maintain the open condition. If this class escapes fire for 60yrs, it will succeed to class E (late-development closed).

Class E 5%

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PSME	Upper
	Middle
	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	61 %	80 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Large and very large diameter ponderosa pine and Douglas-fir. Ninebark and spiraea will be present, but ceanothus will be absent. Some pinegrass and elk sedge will be present.

Replacement fire will return this class to A every 75yrs. Mixed fire (90yrs) can open the stand and convert this class to class D (late-development open). Surface fires are rare, but would maintain the class every 370yrs, and some would move it to a late open stage every 1400yrs. Pathogens can create gaps and cause a transition to class D (mid-development open) every 50yrs.

Weather disturbance was modeled at .015 probability, taking the class back to a late open state.

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	75			0.01333	51
Mixed	110			0.00909	35
Surface	275			0.00364	14
All Fires	38			0.02606	

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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LANDFIRE Biophysical Setting Model

Biophysical Setting: **2110460** **Northern Rocky Mountain Subalpine Woodland and Parkland**

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

General Information

Contributors (also see the Comments field) **Date** 1/27/2006

Modeler 1	Vicki Edwards	vedwards@fs.fed.us	**Reviewer**	Bill Romme	romme@warnercnr.colostate.edu
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Vegetation Type
Forest and Woodland

Map Zone
21

Model Zone

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

Dominant Species*
PIAL
ABLA
PIEN

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
The geographic range for MZ21 includes southwest MT, southeast ID and northwest WY.

Biophysical Site Description
Upper subalpine zone (7000-11000ft) on moderate to steep terrain (eg, 40-70% slope). Landforms include ridgetops, mountain slopes, glacial trough walls and moraines, talus slopes, land and rock slides, and cirque headwalls and basins. Some sites have little snow accumulation because of high winds and sublimation, which increases summer drought.

Patchy distribution of this type may be controlled by edaphic conditions, including soil depth and susceptibility to summer drought.

Vegetation Description
This is a subalpine parkland setting with tree clumps or discontinuous forest mixed with meadow. Forest communities range from nearly homogeneous stands of whitebark pine on harshest, highest elevation sites to mixed species including shade tolerant subalpine fir or Engelmann spruce. Vegetation can be stunted with short, dwarfed trees, including krummholz vegetation on the harshest sites. Historically, whitebark pine dominated on southerly aspects, while northerly aspects were dominated by subalpine fir and Engelmann spruce. Rarely, limber pine may be present in eastern ID, but in these mapping zones it is not typically a subalpine species (it favors lower treeline habitat). In this harsh windswept environment trees are often stunted and flagged from wind damage.

Undergrowth on these sites is usually sparse and at timberline is highly variable. Shrubs that may occur

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include Vaccinium spp, Juniperus communis, Shepherdia canadensis and Paxistima myrsinites. Ledum glandulosum may also be present. Grasses include Carex geyeri, Carex rossii, Festuca idahoensis, Bromus carinatus, Elymus trachycaulus and Trisetum spicatum. Herbs include yarrow, prairie smoke, mountain dandelion and Ribes montigenum. These understory species listed apply to MZ21 (Fischer and Clayton 1983, Bradley et al 1992, USDA, Targhee National Forest Subsections and Landtype Associations 1998). Other common forbs include Arnica cordifolia, Claytonia lanccolata, Lupinus argenteus and Erythronium grandiflorum.

This type is a mixture of whitebark pine dominated clumps and stringers mixed with the Idaho fescue-bearded wheatgrass habitat type in Yellowstone.

Whitebark pine is a keystone species in many of these forests. Mature whitebark pine trees ameliorate local conditions on harsh sites and facilitate the establishment of less hardy subalpine species. The seeds of whitebark pine provide an important food source for grizzly bears and Clark's nutcrackers. Whitebark pine also depends exclusively upon Clark's nutcrackers for seed dispersal and subsequent tree establishment. The Clark's nutcracker may distribute seeds eight kilometers from the source tree. Reproduction following disturbance is slow; trees may not produce cones until they are 50yrs or older.

Disturbance Description

Fire Regime Groups III and IV, primarily long-interval (eg, 100-200yrs+) mixed severity (25-75% top kill) and stand replacement fires. Ignitions are frequent due to lightning, though fires seldom carry due to lack of fuel from the slow-growing vegetation and cool, moist conditions. Tree clumps may burn out without carrying through intervening meadow, or spot from one clump to the next. Individual tree torching is common. Non-lethal surface fires may dominate where continuous light fuel loading (ie, grasses) exists (Kapler-Smith and Fischer 1997), but would typically be small in extent and are not modeled here. Recent dendroecological data collected in whitebark pine forests near Missoula, in western MT, found numerous small fires (MFIs <50yrs) punctuated by less frequent, larger fires (MFIs 75-100yrs) and implicated large-scale climate variability (eg, the Little Ice Age) as a driver of temporal changes in the fire regimes of these forest systems (Larson 2005). While this may be more common in the northern Rockies, there has been little evidence of frequent fires in this forest type in MZ21 (Walsh 2005).

Fire frequency is largely controlled by climate in this system (Romme, personal correspondence, Veblen et al. 1994) and there is a relatively long MFI in the Greater Yellowstone Ecosystem, maybe longer than elsewhere (Walsh 2005).

The mountain pine beetle is an important disturbance agent in whitebark pine and lodgepole pine forests, and past outbreaks have caused widespread mortality in these forest types throughout the region. Spruce budworm may be present on higher density spruce sites. Snow, wind and other weather events may cause damage and cause transitions between classes.

Mountain pine beetle is a natural agent of mortality affecting five-needle pines. Infestations occur periodically and are a natural agent of disturbance in these systems. The mountain pine beetle has become increasingly more important (versus historically) in the last five years due to warm temperatures.

Adjacency or Identification Concerns

This BpS corresponds to cold upper subalpine and timberline habitat types (Pfister et al. 1977, Steele et al. 1983, and Cooper et al. 1991), including ABLA/LUHI, PIAL/ABLA and ABLA/XETE. Lower subalpine forests border at lower elevations, including lodgepole pine, Douglas-fir, Engelmann spruce and subalpine fir types. Thre is a successional trajectory towards more shade tolerant species in absence of fire in many

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locations.

Whitebark pine blister rust has affected whitebark pine in moist ranges of this BpS, but blister rust mortality is not as severe in MZ21 as in MZ19. Whitepine blister rust might preferentially affect older trees, possibly retarding succession to older seres; however, that is unconfirmed, as others state that it does not preferentially attack older individuals and that the rust will actually kill younger and smaller trees faster than the larger, older ones.

The Shoshone Forest and Yellowstone NP have some climax stands of whitebark pine with no or little evidence of blister rust present. Blister rust is, however, becoming more prominent in the Teton Range, Mount Leidy Highlands, and there is a high mortality from a variety of insects and diseases on all conifer species on the Bridger-Teton.

Reviewers for MZ21 felt that this BpS could be a solution to BpS 1070 Alpine Mountain Dwarf-Shrubland not encompassing krummholz features.

In some locations, early grazing, fire suppression and climate change may have altered natural fire frequency. Live and dead trees are potential dendro-climatic resources.

On Mount Washburn in Yellowstone National Park, one of the whitebark pine plots that burned in a crown fire is regenerating entirely to Engelmann spruce. However, this is an occurrence that might be happening on a small scale and is not necessarily happening everywhere.

Native Uncharacteristic Conditions

On Mount Washburn in Yellowstone National Park, an anomaly is occurring in that one of our whitebark pine plots that burned in a crown fire is regenerating entirely to Engelmann spruce. However, this is an occurrence that might be happening on a small scale and is not necessarily happening everywhere.

Scale Description

Fire sizes range from individual trees, tree clumps and groups. Occassionally, larger patches of fire occur, as in Yellowstone National Park in 1988. Insects and whitepine blister rust may affect whole drainages.

Issues/Problems

Empirical data for the upper subalpine forest is generally sparse; quantifying fire regimes, succession and other disturbances continues.

Comments

This model for MZ21 is based on the LANDFIRE model for the same BpS 1046 in MZ19 created by Larry Kaiser, Katie Phillips and Randall Walker. For MZ21, modifications to the fire return interval in class E were made by Randy Walsh. Changes to the description were made by Vicki Edwards (vedwards@fs.fed.us), Don Despain (don_despain@usgs.gov), Tim Brickell (tbrickell@fs.fed.us) and Eric Miller. Bill Romme reviewed this MZ21 model on 1/30/06. Another anonymous reviewer also reviewed the model on 2/06. Additional reviewers for the MZ21 model were: Randy Walsh (jwalsh@ensr.aecom.com) on 3/12/06 and Sarah Canham (scanham@fs.fed.us) on 3/8/06. Changes were made in descriptions.

For MZ19, reviewers included Dana Perkins (dana_perkins@blm.gov), Carly Gibson (cgibson@fs.fed.us), John DiBari (jdibari@email.wcu.edu), Steve Barrett (sbarrett@mtdig.net), Evan Larson (lars2859@umn.edu), Susan Miller (smiller03@fs.fed.us), Steve Rawlings (srawlings@fs.fed.us) and Cathy Stewart (cstewart@fs.fed.us).

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Peer review for MZ19 resulted in changes to the description, but no changes to the model. Two reviewers disagreed about the fire frequency-- one suggesting it be changed to 150yrs MFI, another suggesting it be changed to ~100yrs. No changes were made to the MFI.

Original model was based on Rapid Assessment model R0WBLP by Steve Barrett and reviewed by Cathy Stewart. Adjustments for MZs 10 and 19 resulted in additions to the description and an increased fire frequency (from 155yrs to 133yrs MFI).

Vegetation Classes

Class A 25%

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PIAL	Upper
PICO	Upper
PIEN	Upper
PIFL2	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	40%
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

☑ Upper layer lifeform differs from dominant lifeform.

Higher elevation sites will be dominated by herbaceous species.

Description

Early succession after moderately long to long interval replacement fires, and highly variable interval mixed severity fires. Whitebark pine, Engelmann spruce and rarely lodgepole pine will typically be early pioneers.

In some areas in MZ21, PIEN and PIAL may colonize a site in close temporal proximity. It is possible that some areas are characterized by spruce first colonizing a site with whitebark coming in soon thereafter. PIFL2, although an indicator in other mapzones, might be rare in MZ21.

As an anomaly, in Yellowstone National Park a whitebark pine site is regenerating post-fire entirely by Engelmann spruce.

Wind, weather (0.005 probability), insects (0.005 probability) and replacement fire from all succession classes cause a transition to back to the beginning of class A. This class will transition to class B, mid-closed stage, after approximately 50-100yrs, although limited resources (0.005 probability) may cause this class to persist longer. An alternate successional pathway might also take this class to a mid-open state, with a probability of 0.01.

Replacement fire occurs infrequently at 0.001 probability.

Class B 35%

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PIAL	Upper
ABLA	Upper
PIEN	Mid-Upper
PICO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31%	100%
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

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Stands dominated by small-diameter with a mix of shade tolerant and intolerant species. High elevation or harsh sites may exhibit krummholz growth form. Whitebark pine, Engelmann spruce or lodgepole pine will typically be early pioneers on harsh sites.

Replacement fire occurs every 500yrs, while mixed occurs every 250yrs.

Wind, weather (0.005 probability), insects (0.003 probability) and mixed fire in this class can cause a transition to an open class. (Insects/disease can also cause a transition to an earlier state at 0.003 probability.) Limited resources may keep (0.002 probability) this class in its current state for a longer period of time.

This class succeeds to E at 130yrs.

Class C **10%**

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIAL	Upper
LALY	Upper
PICO	Upper
PIFL2	Upper

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	11 %	30 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Stands dominated by small-diameter with a mix of shade tolerant and intolerant species. High elevation or harsh sites may exhibit krummholz growth form.

Whitebark pine (especially on southerly aspects) and subalpine larch (especially on northerly aspects) will typically be early pioneers on harsh sites. Limber pine may also occur on these sites. Subalpine larch is uncommon in the Greater Yellowstone Ecosystem. And although limber pine is rare, some PIFL2 individuals were found intermixed in a nearly pure PIAL forest in the Wind River Range, but that has not been seen often in the Greater Yellowstone Ecosystem.

Replacement fire occurs every 300yrs+, while mixed fire occurs approximately every 150yrs.

Wind/weather (0.003 probability) and insect/disease (0.002 probability) can sometimes cause a transition back to an early seral state. Some insect/disease outbreaks just occur (0.002 probability) without causing a transition to another class.

This class succeeds to D at 130yrs. An alternate successional pathway might also take this class to a mid-closed state, with a probability of 0.05.

Class D **5%**

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PIAL	Upper
PICO	Upper
PIFL2	Upper
	Upper

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.

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Description

Mid to large diameter mixed conifer species in small to moderate size patches generally on southerly aspects. Open canopy conditions occur on sites where soil is less developed or on wind-exposed, south-facing aspects. Whitebark pine, subalpine fir, Engelmann spruce and lodgepole pine will typically dominate.
This class will persist until a disturbance causes a transition. Although, five percent will transition to a late development closed class.

Insect/disease outbreaks occassionally occur, causing a transition to an earlier mid-seral state (0.001 probability) or an early seral state (0.002 probability).

Replacement fire occurs every 300yrs+, while mixed fires can occur every 150yrs.

Wind/weather events occur with a probability of 0.007, but maintain this class in its current state.

Class E 25 %

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PIAL	Upper
ABLA	Upper
PIEN	Upper
PIFL2	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.

Description

Mid to larger diameter mixed conifer species in small to moderate size patches generally on southerly aspects. Subalpine fir is likely to be initiating in the understory on these sites. Closed canopy conditions occur on sites that are more protected (ie, northerly aspects) or have better soil development. This class will persist until a disturbance causes a transition.

Replacement and mixed fires were originally modeled at occurences of every 200yrs. However, it was then suggested that they may operate at extremely long timescales (500yrs+) in some areas, per Walsh (personal correspondence). This change in interval altered only two of the class percentages by less than five percent. The change was therefore adopted.

Wind, weather (0.006 probability), insects and disease (0.002 probability) can cause a transition from this class to an open late seral class, while occassionally, insects/disease can cause a transition back to a mid open state (0.002 probability) or an early seral state (0.003 probability).

Disturbances

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Fire Regime Group:** III

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

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

Additional Disturbances Modeled

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

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	500	100	1000	0.002	37
Mixed	300	55	1000	0.00333	62
Surface					
All Fires	187			0.00534	

Fire Intervals (FI):

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

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*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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110490 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

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Modeler 2	LaWen Hollingsworth	lhollingsworth@fs.fed.us	**Reviewer**	Liz Davy	edavy@fs.fed.us
Modeler 3			**Reviewer**	Tim Belton	tbelton@fs.fed.us

Vegetation Type
Forest and Woodland

Map Zone
21

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

Dominant Species*
PIFL2 ARTR2
JUSC2 BOGR2
JUOS LEKI2
ARNO4 POSE

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range
Northern MT to central CO east of the continental divide, on escarpments across WY into the Black Hills. This is thought to occur in subsections M331Dm as well.

Biophysical Site Description
Occurs in foothill and lower montane zones into the western Great Plains. Elevation ranges from 1000-2400m (3300-7900ft). 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.

Vegetation Description
Open canopy dominated by Pinus flexilis, Juniperus scopulorum, to a lesser extent Juniperus osteosperma. Pinus edulis is not present. The shrubs layer is sparse to moderately dense. Shrubs may include Artemisia nova, Artemisia tridentata, Cercocarpus ledifolius, Cercocarpus montanus, Ericaneria nauseosa, Purshia tridentata, Rhus trilobata, Rosa woodsii and Ribes montigenum. Herbaceous layers are sparse, often significantly different than surrounding community. These may include Bouteloua gracilis, Leucopoa kingii, Hesperostipa comata, Koeleria macrantha, Pipatherum micranthum, Poa secunda and Pseudoroegneria spicata.

Disturbance Description
Limber pine bark at the base of older trees may be two inches (five cm) thick, therefore these trees can withstand stem scorch from low-severity fires. Terminal buds are somewhat protected from the heat

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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 loading and 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 occured 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).

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. It is also susceptible to mountain pine beetle outbreaks.

Native Uncharacteristic Conditions

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

Scale Description

Tens to 100's 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.

Outside reviewer for MZ21 commented, after models were already delivered, that there is disagreement with the model developed and that there should be lots of mixed severity fire in various areas, and that perhaps the model should have been split between dominant versus infrequent fire.

Comments

This model 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.

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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 severity.

For MZs 10 and 19, this model was adopted as-is from 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 MZ28 4/19/2005. Model was also reviewed in workshop by Chuck Kostecka (Colo State Forest Service, ret.).

Vegetation Classes

Class A 15%

Early Development 1 All Structures

Indicator Species* and Canopy Position

PIFL2	Upper
JUSC2	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.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 2

Description

Seedlings can be slow to establish. Competition from grasses and shrubs is variable depending on moisture availability. Adjacent grasslands, shrublands and Douglas-fir ecosystems can influence the fire regime. Trees <70yrs in this class; succession to an open late-development state occurs after 70yrs, although succession can occur bringing the class to a closed state with a probability of 0.01.

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

The data from Yellowstone shows that ~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 10%

Late Development 1 Open

Indicator Species* and Canopy Position

PIFL2	Upper
JUSC2	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.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 2

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.

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 ~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.

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Class C **75%**

Late Development 1 Closed

Indicator Species* and Canopy Position

PIFL2 Upper
JUSC2 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31%	50%
Height	Tree 5.1m	Tree 10m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 2

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; greater than 70% would be uncharacteristic.

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

The data from Yellowstone shows that ~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]

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:** III

Historical Fire Size (acres)

Avg 25
Min 1
Max 200

Sources of Fire Regime Data

- ☐ Literature
- ☐ Local Data
- ☑ Expert Estimate

Additional Disturbances Modeled

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

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

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

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110500 Rocky Mountain Lodgepole Pine Forest

☑ *This BPS is lumped with: 1055*

☐ *This BPS is split into multiple models: 1050 and 1055 are lumped/identical. 1050 is seral to 1055 and should probably be dropped for this zone.*

General Information

Contributors (also see the Comments field) **Date** 1/18/2006

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Modeler 3	Vicky Edwards	vedwards@fs.fed.us	**Reviewer**	Tim Belton	tbelton@fs.fed.us

Vegetation Type

Forest and Woodland

Map Zone

21

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 ARCO9
VASC MARE11
ABLA CAGE2
PIEN

General Model Sources

☐ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

The Rocky Mountain Lodgepole Pine Forest BpS (1050) and 1055 occurs throughout MZ21, including west-central WY, ranging from the eastern flanks of the Wind River Range west to the Bridger-Teton National Forest, north to the Gallatin Range and west towards Island Park, ID. It encompasses mid and upper elevations of the Bridger-Teton National Forest and portions of the Caribou Targhee in this mapzone. It is also found in subsections highlands M331Dm, M331Dd, M331Aa and M331Ae.

Biophysical Site Description

Subalpine cold climate, relatively moist but usually comes in the winter months as snow, except at the eastern flanks of the Wind River Range where the majority of the precipitation occurs in the spring months. Soils are usually excessively well-drained, residual or glacial till and alluvium on valley floors, droughty moderately deep to deep soils over fractured granodiorite, quartzite, and sandstone bedrock. Coarse fraction 30-50% in soil, soils moderately deep to deep to broken rock or bedrock. Soils are acidic, and rarely formed from calcareous parent materials. Biophysical setting 1050 occurs regularly and conspiciously on the Flathead Sandstone Formation along the entire eastern Flank of the Wind River Range. Precipitation 400-900 mm/yr.

Vegetation Description

These forests are dominated by Pinus contorta with shrub, grass or barren understories. Sometimes there are intermingled mixed conifer/Populus tremuloides stands with the latter occurring with inclusions of deeper, typically fine-textured soils. The shrub stratum may be conspicuous to absent; common species include Arctostaphylos uva-ursi, Ceanothus velutinus, Mahonia repens, Spiraea betulifolia, Spiraea douglasii, Shepherdia canadensis, Vaccinium spp, Symphoricarpos oreophilus, Ribes viscosissimum, Sambucus cerulea, Pachistima myrinsites, Salix scouleriama and Prunus virginiana. Grasses include Elymus glauccus,

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Poa wheeleri, Carex rossii, Carex geyeri and Carex hoodii. Dominant forbs are Arnica cordifolia and Hieracium alboflorum.

Disturbance Description

These are subalpine forests where the dominance of Pinus contorta is related to fire history and topo-edaphic conditions. Following stand-replacing fires, Pinus contorta will rapidly colonize and develop into dense, even-aged stands depending on site characteristics and cone serotiny. In areas with low serotiny, the stands will be less dense and gradually seed in (versus immediate development of even-aged stands). The mean FRI is variable depending on elevation, precipitation and temperature (200-400yrs).

At approximately 80-100yrs of age, insect, disease and/or blow down create small openings in forest canopy maintaining class B. Under favorable (extreme, 95% percentile) weather, early successional stands will burn where live herbaceous fuel load is sufficient to carry fire. Wind/weather events were not modeled.

Fire size is largely dependent on climatic conditions. During periods when summers are rarely dry, average fire size is about 100ac but when dry summers are more common fires of 1000-100000ac are more frequent.

Fire frequency <300yrs will keep lodgepole pine on the landscape.

According to Fisher and Clayton (1983), fire return intervals at elevations greater than 7500ft average 150yrs, but range from 300-400yrs in Yellowstone. In areas at <7500ft, fire return intervals vary from 100-500yrs with some recurring cool fires that thin stands without serious damage for this type (Novak, personal correspondence).

Adjacency or Identification Concerns

1050 is not a BpS in MZ21 but is a seral component of this BpS. This type was modified from 1810500 by adding class D, the spruce/fir climax that would occur without fire.

Lodgepole pine stands in the montane and lower subalpine zones, that are on less well-drained soils, are usually seral to mixed conifer or subalpine BpS, including species such as Douglas-fir, Engelmann spruce, whitebark pine and subalpine fir. Some Pinus contorta forests will persist on sites that are too extreme (hot and dry) for other conifers to establish (BpS 1167). Persistent PICO is also found in frost pockets (reviewers, MZ21).

Departure is going to show up as probably high in this system currently - In Targhee (logged) and Yellowstone National Park (much of the area recently burned) there is probably a lot of early seral. The system is actually not departed in Yellowstone National Park, but it might show up as departed when calculating departure - because it has burned recently. In Targhee, however, it has been clear-cut, therefore it is truly departed. (should show up as herb EVT).

Native Uncharacteristic Conditions

Scale Description

The Rocky Mountain Lodgepole Pine Forest occurs in large (100-1000s of acres) tracts often times following patterns of bedrock and/or surficial geology. The scale of disturbance is generally large, ranging from 100-1000s of acres. Microclimate may have significant influence on the patch size and mosaic of the disturbance.

Issues/Problems

BpS 1050 Rocky Mountain Lodgepole Pine Forest is a successional stage of BpS 1055 Rocky Mountain

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Dry Mesic Dry-Spruce-Fir Forest and Woodland. Fire frequency at <300yrs will keep lodgepole pine on the landscape.

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

Comments

This model for MZ21 is based on the LANDFIRE model for BpS 1050 from MZ18 created by Sarah Heide (sarah_heide@blm.gov) and reviewed by Louis Provencher (lprovencher@tnc.org). This type for MZ21 was modified from 1810500 by adding class D, the spruce/fir climax that would occur without fire. Model for MZ21 was further reviewed by an anonymous reviewer in February and Heidi Whitlatch (hwhitlatch@fs.fed.us), David Barron (dbarron@fs.fed.us), Spencer Johnston (sjohnston@fs.fed.us), Candi Eighme (ceighme@fs.fed.us) Lisa Heiser (lheiser@fs.fed.us).

Vegetation Classes

Class A 5%

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 5

Indicator Species* and Canopy Position

VASC	Lower
RIVI	Lower
CAGE2	Lower
PICO	Upper

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

Grasses, forbs, low shrubs and lodgepole seedlings-saplings. Succeeds to B after 20yrs because young lodgepole grows fast. If aspen is present, it grows faster and dominates lodgepole during this stage only. Cover of trees (seedlings-saplings) varies widely. This could be considered a grass stage unless there is a lodgepole seed source nearby (MZ21 reviewers).

Replacement fire occurs every 300yrs on average, setting back succession to age zero.

Class B 30%

Mid Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PICO	Upper
VASC	Lower
CAGE2	Lower
ABLA	Middle

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.

Description

Moderate to dense pole-sized trees, sometimes very dense (dog-hair). Aspen usually not present. Closed canopy is 51-100%. Mid-open stands are at 21-50% canopy cover and would have mature and immature aspen present. Mid-open stands would have subalpine fir in the understory. Therefore, this class is considered a mid-development, all-structures class.

Class will last until 80yrs and then succeed to C. Insects and disease (mean return interval of 75yrs) maintain class B. Replacement fire (mean FRI of 300yrs) returns vegetation to class A. Competition may maintain the dog-hair condition (prob/yr = 1/500).

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Class C **50 %**

Late Development 1 Closed

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

PICO	Upper
ABLA	Mid-Upper
VASC	Lower
CAGE2	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Description

Many mature lodgepole pine, somewhat patchy, a variety of lodgepole size classes and open canopies overall but patches of denser trees. This class lasts until 350yrs, then succeeds to the spruce fir class (class D).

Insects and disease can cause a transition to class A, but very rarely (0.001 probability). Insects rarely kill all, and they would rather cause a transition to class B (0.006 probability) or maintain it in C (0.006 probability).

A second set of reviewers suggested that insect/disease would cause a transition to A with a probability of 0.006 and a transition to B at a probability of 0.013, since if all trees were not killed by insects, the class would transition to B with insect outbreak. However, this scenario was not included in the model, as it would have caused less than five percent to go to class D, since the insect oubreak out of class C was too high.

Replacement fire occurs every 300yrs on average.

Class D **15 %**

Late Development 2 Closed

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

ABLA	Upper
PIEN	Upper
VAME	Lower
VASC	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	100 %
Height	Tree 5.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Mature spruce/fir forest with a variety of size classes from seedling to mature. Insect and disease usually affects only one species so survivors trees of other species remain in the stand.

This class is distinguished from C by species, not canopy closure or tree height.

Reviewers state that sprucee beetle could kill most of the spruce and transition this class back to class A. However, this scenario was not modeled.

Stand replacing fires occur about every 300yrs. Low severity fires are extremely rare.

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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 severity.

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

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 1000
Min 10
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	300	90	350	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 severity.

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110510 Southern Rocky Mountain Dry-Mesic Montane 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** 3/15/2005

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Modeler 3			**Reviewer**	Krista Wade	Krista_Wade@blm.gov

Vegetation Type
Forest and Woodland

Map Zone
21

Model Zone

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

Dominant Species*

ABCO	PSEUD7
PIFL2	PICO
CAGA3	PIPO
CARU	

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range
Occurs throughout the southern Rockies, north and west into UT, western WY and ID. Restricted to northern locations in MZ17.
This BpS is restricted to dry, lower elevation sites, in the northwest portion of MZ18.

Biophysical Site Description
This type is generally located just above sagebrush ecosystems. These are mixed-conifer forests occurring on all aspects at elevations ranging from 1200-3300m (4000-11000ft). Rainfall averages <75cm (29in) per year (40-60cm; 16-24in) with summer "monsoons" during the growing season contributing substantial moisture in the eastern Great Basin. The composition and structure of the overstory is dependent upon the temperature and moisture relationships of the site, and the successional status of the occurrence. At lower elevations this system occurs on north and east aspects. At higher elevations all aspects may be represented.

Vegetation Description
Abies concolor with Pseudotsuga menziesii are most frequent, Pinus ponderosa is incidental but present more frequently in MZ18 (northwest area). Pinus flexilis is common in NV. Pseudotsuga menziesii forests occupy drier sites, mostly in the northeast corner of MZ17. 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.
In MZ18, most occurrences of this system are dominated by a mix of Pseudotsuga mensiesii and Pinus ponderosa with lesser amounts of Abies grandis. Other typically seral species include Pinus contorta, Pinus monticola and Larix occidentalis. Picea engelmanii and Taxus brevifolia become increasingly common towards the eastern edge of the range: Tsuga heterophylla and Thuja plicata may be associated on more

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mesic sites. Abies grandis (a fire sensitive, shade tolerant species) on sites once dominated by Pseudotsuga mensiesii and Pinus ponderosa, which were formerly maintained by wildland fire. 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. Snowberry and Ceanothus as well

Disturbance Description

Disturbance regime described here is for Douglas-fir. 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 were 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 a generally continuous fine fuel layer. This fine fuel facilitated fire spread and thinning of the conifer or aspen seedlings (thus promoting aspen suckering).

Other disturbances included insect outbreaks (return interval of 100yrs), disease, drought, and wind and ice damage (every 1000yrs in closed stands; every 250yrs in open stands). Competition among trees was also a factor that increasingly slowed successional dynamics in more closed stands. Fire was by far the dominant disturbance agent.

Adjacency or Identification Concerns

The BpS may be too small to be mappable in MZ18 and should probably be included in BpS 1052 (Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland) due to the dominance of white fire and limber pine in the Great Basin.

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 (BpS 1011 Rocky Mountain Aspen Forest and Woodland or BpS 1061 Intermountain Basins Aspen-Mixed Conifer Forest and Woodland). Sites with a larger grand fir component and more mesic sites might be better classified as BpS 1052 as this system has less frequent fire due to cooler moister conditions.

BpS is often transitional between non-forested areas or between Pinus ponderosa woodlands (at lower elevations) and spruce-fir at higher elevations.

Native Uncharacteristic Conditions

Scale Description

This BpS occurs in patches ranging from 1000s-10000s of acres in many western locations, however in MZs 12 and 17, patch size may be much smaller (<100ac).

Issues/Problems

Douglas-fir is rare to absent in NV and the west desert of UT. The current model was clearly developed for dry Douglas-fir forests. It needs to be determined whether forests dominated by limber pine and white fir will exhibit the same fire regimes.

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Comments

For MZ21, this BpS was adopted as-is by MFSL from 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. Krista Wade reviewed this model on 5/20/05 and accepted previous MZ18 edits. Steve Rust reviewed this model on 5/6/05 for MZ18 and adopted with minor edits on species composition from the MZ16 version created by Loewen (mloewen@fs.fed.us), Page (doug_page@blm.gov) and Chappel (lchappell@fs.fed.us). Further review is needed to make sure this type is appropriately described for MZs 12 and 17 - especially species occurrence.

BpS 1051 for MZ16 was based on modifications to R2PSMEdy (original modeler Lynn Bennett, lmbennett@fs.fed.us, and modified by Louis Provencher) on 2/24/05 by Pohl for LANDFIRE BpS modeling. ABCO and PIPO were added as dominant species. Hugh Safford (hughsafford@fs.fed.us) and Steve Barrett (sbarrett@mtdig.net) were reviewers of R2PSMEdy.

10/18/07: As a result of final QC for LANDFIRE National by Kori Blankenship the user-defined min and max fire return intervals for replacement and mixed severity fire were deleted because they were not consistent with the modeled fire return intervals for these fire severity types.

Vegetation Classes

Class A 20%

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 5

Indicator Species* and Canopy Position

CARU	Low-Mid
CAGA3	Low-Mid
PSME	Upper
PIPO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	20%
Height	Shrub 0.6m	Shrub >3.1m
Tree Size Class	Seedling <4.5ft	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Grass/forb/shrub/tree seedlings. Replacement fire is frequent (mean FRI 25yrs) and causes an ecological setback of 35yrs. 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.

Class B 5%

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PSEUD7	Upper
ABCO	Upper
PIPO	Upper
PICO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31%	100%
Height	Tree 5.1m	Tree 25m
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% PIPO, PSME, white fir and limber pine. In the absence of fire, vegetation will succeed to E (closed, late-development) after 70yrs. Replacement fire (average FRI of 150yrs) and infrequent weather-related stress (return interval of 250yrs) returns vegetation to class A. Mixed severity fire (FRI of 45yrs) and insect/diseases

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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 **10 %**

Mid Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PIPO	Upper
PSEUD7	Upper
PIFL2	Upper
ABCO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	30 %
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 (if present in the area) 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 and insect/diseases (every 100yrs), primary succession is to D, the open late-development condition. Infrequent stand-replacing fire (FRI of 400yrs) 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 class E after 68yrs without fire.

Class D **60 %**

Late Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

PIPO	Upper
PSEUD7	Upper
PIFL2	Upper
ABCO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	30 %
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 10-35%. Open large tree/grass and scattered shrubs; Douglas-fir with occasional ponderosa pine. Surface fire (FRI of 10yrs) and mixed severity fire (FRI of 75yrs) maintain the stand in the open condition (ie, succession from D to D). This open condition, however, will close after 70yrs without fire (alternative path to E). Adult tree competition (prob/yr of 0.001) and insect/diseases (100yrs return interval) also disturb this class, but do not affect the successional 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

ABCO	Upper
PIFL2	Upper
PIPO	Upper
PSEUD7	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	100 %
Height	Tree 25.1m	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, limber pine and occasional lodgepole pine, scattered shrubs. Replacement fire (FRI of 150yrs) and infrequent weather/wind-related stress

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(return interval of 250yrs) cause a transition to class A. Mixed severity fire (FRI of 45yrs) open the structure of the stand (transition to D), whereas surface fire (FRI of 50yrs) and competition, although present, do not cause transitions to other classes. Insect/diseases occur every 40yrs on average, however different insects cause 50% of the time a transition to class C, whereas others cause a 50% transition to class D. Succession is from E to E in the closed condition.

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg 50
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	90			0.01111	12
Mixed	77			0.01299	14
Surface	14	10	50	0.07143	75
All Fires	10			0.09553	

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
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [x] 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 severity.

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110520 Southern Rocky Mountain Mesic Montane 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** 3/15/2005

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Modeler 2			**Reviewer**	Krista Wade-Gollnick	krista_wade@blm.gov
Modeler 3			**Reviewer**		

Vegetation Type
Forest and Woodland

Map Zone
21

Model Zone

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

Dominant Species*
ABCO PSME
PIFL2 AGBR
ABLA
PICO

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Rocky Mountains west into the ranges of the Great Basin. BpS may be more common in eastern portions of MZs 12, 17 and 18.

Biophysical Site Description
Elevations range from 1200-3300 m (4000-11000ft). Occurrences of this system are found on cooler and more mesic sites than Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland (1051). Such sites include lower and middle slopes of ravines, along stream terraces, moist, concave topographic positions and north and east-facing slopes which burn somewhat infrequently.

Vegetation Description
Abies concolor is the most common canopy dominant typically co-occurring with Picea engelmannii, Pinus flexilis and Pinus longeava. Pseudotsuga menziesii will be rare and restricted in northern NV and UT. A number of cold-deciduous shrub species can occur, including snowberry, sticky currant, some willow, serviceberry, ceanothus, Acer glabrum, Alnus incana, Betula occidentalis, Cornus sericea, Jamesia americana, Physocarpus malvaceus, Vaccinium membranaceum and Vaccinium myrtillus. Herbaceous species include Bromus ciliatus, Carex geyeri, Carex rossii, Carex siccata, Muhlenbergia virescens, Pseudoroegneria spicata, Erigeron eximius, Fragaria virginiana, Luzula parviflora, Osmorhiza berteroi, Packera cardamine, Thalictrum occidentale and Thalictrum fendleri.

In MZ18, sites are dominated by PSME and ABLA in drainages, or by ABGR in the northwestern portions of the mapzone.

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Disturbance Description

Naturally occurring fires are of variable return intervals, and mostly light, erratic and infrequent due to the cool, moist conditions. These ecological systems are in a Fire Regime Group III. Some portions of these sites are transition zones to Fire Regime Groups I, III and IV. This vegetation is a transition between the frequent surface and mixed severity fires and the more stand replacement regimes common in high elevation fir and spruce ecosystems.

Surface fire and mixed severity fire intervals were about 35-50yrs (Brown et al. 1994). Stand replacement fires occurred at intervals of 120-400+yrs (Crane 1986; Barrett 1988; Bradley 1992a, b; Brown et al. 1994; Morgan et al. 1996). Likelihood of stand replacement fires increased with canopy closure and fuel ladders caused by grand fire, PSME and white fir growth, however ground fires acted as replacement fires during early stand development (class A).

Other disturbances included insect, disease, drought and wind and ice damage. Fire was by far the dominant disturbance agent.

Adjacency or Identification Concerns

This ecological system is often transitional between Fire Regime Group I and Fire Regime Groups II, IV and V at higher elevations. Sites are dry/steep montane with a variety of aspects (often northerly) and soil conditions. In MZs 12 and 17, BpS 1051 is uncommon and should be included in BpS 1052.

This system includes mixed conifer/Populus tremuloides (aspen) stands. If aspen is present and soils show a clear organic layer, BpS 1061 Intermountain Basins Aspen-Mixed Conifer Forest and Woodland should be used.

Native Uncharacteristic Conditions

Scale Description

This BpS occurs in patches ranging from 100s-1000s of acres.

Issues/Problems

Comments

For MZ21, this BpS was adopted as-is by MFSL from 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. BpS 1052 (MZs 12 and 17) was adopted with minor revisions for MZ18 (K. Wade-Gollnick 5/19/05). Specifically, modifications included 1) addition of PSME ABGR as dominants and 2) addition of additional shrub species in vegetation description.

This model was adopted with minor edits on species composition from the MZ16 version created by Mark Loewen (mloewen@fs.fed.us), Doug Page (doug_page@blm.gov) and Beth Corbin (ecorbin@fs.fed.us). Further review is needed to make sure this type is appropriately described for MZs 12 and 17 - especially species occurrence.

This model was originally coded as R2PSMEnr and was changed to R2PSMEms on 12/13/2004 by Lynn Bennett (lmbennett@fs.fed.us). This model was changed into BpS 1052 by Mark Loehen, Doug Page, Beth Corbin and Linda Chappell on 3/3/05. Reviewers of R2PSMEms were: Hugh Safford (hughsafford@fs.fed.us), Steve Barrett (sbarrett@mtdig.net) and Clinton K Williams

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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 severity.

(cwiliam03/@fs.fed.us).

10/18/07: As a result of final QC for LANDFIRE National by Kori Blankenship the user-defined min and max fire return intervals for mixed and surface severity fires were deleted because they were not consistent with the modeled fire return intervals for these fire severity types.

Vegetation Classes

Class A 10%

Early Development 1 All Structures

Indicator Species* and Canopy Position

ABCO	Upper
PICO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	10%
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

Tree seedling-shrub-grass-forb. Succession to B after 30yrs unless replacement fire (mean FRI 120yrs) setbacks succession by 30yrs. Mixed severity fire (mean FRI 50yrs) occurs but does not change the successional age.

Class B 30%

Mid Development 1 Closed

Indicator Species* and Canopy Position

ABCO	Upper
PICO	Upper
PIFL2	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41%	100%
Height	Tree 5.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 10

Description

Forest canopy closure is >40%. Closed trees, sapling, large poles, grass and scattered shrub, 75-100% white fir, some lodgepole pine and spruce at higher elevations. Primary succession is to class E, the closed late development condition after 70yrs. Replacement fire mean FRI 120yrs. Mixed severity fire (FRI of 47yrs) and wind/weather/stress every 200yrs on average will open the stand, thus causing a transition to class C. Insects/disease (50yrs mean return interval) cause minor mortality to this stage.

Class C 30%

Mid Development 1 Open

Indicator Species* and Canopy Position

ABCO	Upper
PICO	Upper
ABLA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11%	40%
Height	Tree 5.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 8

Description

Forest canopy closure is 11-40%. Open pole-sapling/ grass scattered shrubs, may be 90% white fir. This state will succeed to the closed mid-development condition (B) after 35yrs in the absence of surface fire (mean FRI of 40yrs). With fire, insect outbreaks (every 100yrs) and weather-related stress (every 1000yrs), the vegetation

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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 severity.

will become open late-development after 70yrs. Stand replacement fire occurs on average every 400yrs.

Class D 20 %

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

ABCO	Upper
PIFL2	Upper
ABLA	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	40 %
Height	Tree 25.1m	Tree 50m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Forest canopy closure is 16-35%. Open large tree/grass and scattered shrubs; potentially 90% white fir. Replacement fire occurs every 400yrs on average, whereas surface fire (FRI of 40yrs) maintains the open condition of the stand. Insects/disease every 100yrs also maintain the structure of the stand open. After 35yrs without fire, existing trees will fill out the stand and cause succession to the late closed condition (E).

Class E 10 %

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

ABCO	Upper
ABLA	Upper
PIFL2	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 25.1m	Tree 50m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Forest canopy closure is >35%. Closed medium to large trees, scattered shrubs, 60-100% white fir. Replacement fire every 120yrs will remove the canopy, whereas mixed severity fire every 50yrs will return the stand to the open structure (D). Surface fire (FRI of 50yrs) will not affect the structure and age of trees. Occasional weather-related stress every 200yrs will open the structure of the stand and cause a transition to class D. Insect/diseases damage occurs every 50yrs causing 60% of times a transition to class C and 40% to class C.

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	185	120	400	0.00541	18
Mixed	90			0.01111	37
Surface	72			0.01389	46
All Fires	33			0.03041	

Fire Intervals (FI):

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

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110530 Northern Rocky Mountain Ponderosa Pine Woodland and Savanna

☐ *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 Rust	srust@idfg.idaho.gov	**Reviewer** anonymous		
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Vegetation Type
Forest and Woodland

Map Zone
21

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

Dominant Species*
PIPO
FEID
PSSP6
PUTR2

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Throughout the northern and central Rocky Mountains in MT, central ID and northeastern WA. In ID, the distribution of this BpS is limited to lower slope positions in the Boise, Payette and Salmon River drainages. In northeastern WA, it is found on sites <4500ft, particularly along the Columbia and Kettle Rivers and in the Okanogan Highlands.

This does not occur in MZ21 on the Bridger-Teton nor the Caribou-Targhee National Forests and is thought to be very rare or nonexistent in MZ21.

Biophysical Site Description
These stands typically occurred on hot, dry, south and west-facing slopes at lower elevations with well drained soils and gentle to moderately steep slopes.

Vegetation Description
Frequent fires promoted a grass-dominated understory with sparse shrubs and a ponderosa pine overstory. Douglas-fir and Rocky Mountain juniper may occur as incidental individuals, but overall Douglas-fir cover will be <10%.

Common snowberry, antelope bitterbrush and chokecherry are important shrubs, and mountain mahogany may also occur on rocky outcrops. Grasses may include Idaho and rough fescue (Fischer and Bradley 1987). More mesic shrubs may be present if it is a wetter habitat type that historically maintained an open stand via frequent fire.

Fischer and Bradley (1987), Fischer and Clayton (1983) and Kapler-Smith and Fischer (1997) would

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characterize this BpS as predominantly Fire Groups 2 and 4 for western MT and central ID, Fire Group 3 for eastern MT and WY and Fire Group 1 for northern ID. Also refer to Crane and Fischer (1986).

Disturbance Description

Frequent, non-lethal surface fires were the dominant disturbance factor, occurring every 3-30yrs (Arno and Petersen 1993, Arno 1976, Fischer and Bradley 1987). More median fire return intervals were likely about 15yrs. Three-year fire intervals are likely very localized and associated with Native American burning. However, there is some disagreement as to the extent of Native burning. Mixed-severity fires likely occurred about every 50yrs (MZs 10 and 19 modelers); again, depending on the vegetative state.

However, it has been suggeseted (anonymous reviewer, personal correspondence) that the above estimates are based on fire-history studies that do not use cross-dating, and this limitation increases the apparent number of fires in the composite. A multiplier is needed, given that the source of estimates is composite fire intervals. The all fire interval is sugggested to have been 120yrs, calculated as two times the non-crossdated estimate, which is then multiplied by four (Baker in press) to estimate fire rotation. The mixed-severity fire interval was also not modeled as described above, since the overall interval is thought to be much higher. Stand-replacement fires likely occurred in stands and small patches on the order of a few hundred acres every 300-700yrs depending on the vegetative state. Some authors from MZs 10 and 19 note that little information is available regarding the exact nature of stand replacement fire severity in this BpS.

Another reviewer for MZ21 stated that the MFI methodology used above is in question.

After an extensive model review process for MZ21, LANDFIRE leadership/guidance determined that the interpretation of the fire information available did not represent the majority expert opinion/interpretations. Therefore, model for MZs 10 and 19 was adopted for MZ21. Instead of using an overall FRI of approximately 120yrs, an FRI of 13yrs was therefore used, as in the adjacent mapzones and according to majority opinion.

Western pine beetle can attack large ponderosa pine in any canopy density.

Adjacency or Identification Concerns

Vegetation is characterized by Pfister et al. (1977) as the ponderosa pine series, by Steele et al. (1981) as the ponderosa pine series, and by Williams et al. (1995) as Douglas-fir-ponderosa pine.

These sites typically formed the lower timberline in the area and were historically found adjacent to grasslands and shrublands that dominated valley bottoms. The early seral stages often resemble adjacent shrubland or grassland BpS.

In the 21st century, after missing several fire return intervals, these stands may support an overabundance of stagnant ponderosa pine pole thickets, heavy duff and litter layers and few grasses or shrubs. As a result it may be difficult to distinguish this BpS in its mid and late seral stages from BpS 1045.

Dense pockets of Douglas-fir may also occur. This BpS may be found on several different habitat types depending on the local fire regime; FRG I maintained these stands as ponderosa pine, but today they may be supporting Douglas-fir in some areas.

This vegetation type continues to be commercially logged. Site modifications include plantations and terraces.

Native Uncharacteristic Conditions

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Cover >60% can be considered uncharacteristic in this woodland community.

Scale Description

Stands dominated by ponderosa pine with frequent fire return intervals commonly exhibit very small patch sizes even though fire events occurred over hundreds or thousands of acres (Agee 1998). Open, late-seral stands typically dominated the landscape with frequent fire, though even-aged stands were uncommon. In ID, this type was often found as a narrow band between grassland/shrublands at lower elevations and Douglas-fir types at higher elevations.

Issues/Problems

For MZs 10 and 19: 1) Fischer and Bradley (1987) show only a single pathway from the dense pole stage characterized by succession without a fire disturbance (class A to class B). However, it seems that under a frequent fire regime, these stands would typically bypass class B and move directly to class C--unless there is not enough fuel to carry fire at this stage; insufficient stand density and leaf litter. 2) Mixed-severity and stand-replacement fire return intervals are not well documented in the literature for this BpS. Some evidence suggests these fires indeed occurred, but there may be room to improve the assumptions used in this modeling effort. 3) There was some debate in the in-workshop peer review over the probability of mixed fire. Currently the model shows a fire interval of about 70yrs for mixed severity fire; some thought it should be more like 50yrs.

The southern portion of MZ10 may have supported a more frequent fire regime and thus more of class D. The BpS was not split for MZ10.

Comments

For MZ21, this model was originally adapted from the same BpS in MZ19 created by Steve Rust (srust@idfg.idaho.gov), Larry Kaiser (larry_kaiser@blm.gov), Kathy Geier-Hayes (kgeierhayes@fs.fed.us) and reviewed by Carly Gibson, John DiBari and Dana Perkins. Quantitative changes to the model were made in fire return intervals. After an extensive model review process, LF leadership/guidance determined that the interpretation of the fire information available did not represent the majority expert opinion/interpretation of the fire literature. The MZ21 model was therefore altered to reflect majority opinion/interpretation of literature regarding the fire regime of this system. Model for MZs 10 and 19 was therefore re-adopted. This BpS is also very infrequent in MZ21. Minor changes in succession class structural information were made based on review by Jeff Jones, Doug Havlina and Steve Barrett on 7/06.

For MZ19, additional reviewers were Steve Barrett (sbarrett@mtdig.net), Susan Miller (smiller03@fs.fed.us), Lyn Morelan (lmorelan@fs.fed.us), Catherine Phillips (cgphillips@fs.fed.us) and Cathy Stewart (cstewart@fs.fed.us). Peer review resulted in additions to the description.

The original model was adapted from the Rapid Assessment model R0PIPOnr by Tonja Opperman and Lynnette Morelean and reviewed by Steve Barrett, Cathy Stewart and Jane Kapler-Smith.

Vegetation Classes

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Class A 5%

Early Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Description

Indicator Species* and Canopy Position

FEID	Lower
PSSP6	Lower
PIPO	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.

Grass species are the dominant lifeform in this class attaining maximum heights of three feet and being patchy in distribution (25-75% cover).

Fire-maintained grass/forb and/or seedlings and saplings. Seedling/sapling size class would be less than five inches in diameter; no very large or old-growth trees would be present in patches of 10s to 100s of acres to be counted in this class. This is due to poor site conditions and abundance of rock outcroppings.

Dispersed large diameter fire remnant ponderosa pines with snag trees also present. These large diameter trees would have a density of less than one tree/acre.

Replacement fires occur every 50yrs, and mixed fire every 60yrs.

This class can succeed to a mid-closed state in the absence of fire for 25yrs.

This class will move to a mid-open state after approximately 30yrs.

Class B 10%

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Description

Indicator Species* and Canopy Position

PIPO	Upper
FEID	Lower
PSSP6	Lower
PSME	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31%	60%
Height	Tree 5.1m	Tree 10m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Closed PIPO pole and medium stand; may have Douglas-fir as incidentals. Larger, old-growth trees may be present in this class, the pole and medium diameter class (5-21in) occurring between these large trees is most abundant and characteristic of this class. May see large diameter snags, dead and down trees present. High density stunted pole stands are counted here; may see insect/disease here.

Replacement fire occurs every 300yrs, and mixed fire every 15yrs, taking it to an open state.

Insect/disease also can occur with a probability of .01, bringing the class to a more open state.

This class succeeds to a late closed state after 130yrs.

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Class C 20 %

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
FEID	Lower
PSSP6	Lower
PSME	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	30 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Open PIPO pole and medium stand that may have Douglas-fir as incidentals. Larger, old-growth trees may be present in this class, the pole and medium (5-21in) diameter trees are what should be counted for this class. These patches have probably had recent fire or are drier therefore retaining a more open condition.

Replacement fire occurs every 500yrs, surface fire every 20yrs and mixed fire every 60yrs. In the absence of fire for 25yrs, this class can move to a mid-closed state.

This class succeeds to a late open state in approximately 75yrs.

Class D 55 %

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
FEID	Lower
PSSP6	Lower
PSME	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	30 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Very Large >33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Fire-maintained open, park-like PIPO; nearly any fire maintains; Douglas-fir may be seen as incidentals or in patches, but not a major component of the overstory. The overstory is characterized by large and very large ponderosa pine and isolated Douglas-fir. Understory is dominated by grasses and is relatively open. Seedlings are very infrequent, with <10% cover usually occurring in patches.

Insect/disease outbreaks might occur, with a probability of 0.01, but this stage is maintained.

Replacement fire occurs every 1000yrs, while surface fire occurs every 10yrs and mixed every 100yrs. In the absence of fire for 25yrs, this class may succeed to a late closed state. Otherwise, this class will persist.

Class E 10 %

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

PIPO	All
PSME	All

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	60 %
Height	Tree 10.1m	Tree 50m
Tree Size Class	Very Large >33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

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High density, multi-storied PIPO stand; Douglas-fir regeneration on some sites. Thickets of various size classes distributed within the class and may be interspersed with large snags. This class was originally classified as trees from 10-50m; however, due to overlap with class C, this class was changed to 25-50m trees.

Replacement fire occurs every 200yrs, while mixed occurs every 25yrs, bringing the class to a more open state.

Insect/disease (probability of 0.04) and Wind/weather (probability of 0.02) also can bring the class to an open late state.

Disturbances

Fire Regime Group:** I

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	360	50	1000	0.00278	4
Mixed	55	15	100	0.01818	26
Surface	20	10	200	0.05	70
All Fires	14			0.07096	

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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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110550 Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

☑ *This BPS is lumped with: 1050*

☐ *This BPS is split into multiple models: 1050 and 1055 are lumped/identical. 1050 is seral to 1055 and should probably be dropped for this zone.*

General Information

Contributors (also see the Comments field) **Date** 1/18/2006

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Vegetation Type

Forest and Woodland

Map Zone

21

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 ARCO9
VASC MARE11
ABLA CAGE2
PIEN

General Model Sources

☐ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

The Rocky Mountain Lodgepole Pine Forest BpS (1050) and 1055 occurs throughout MZ21, including west-central WY, ranging from the eastern flanks of the Wind River Range west to the Bridger-Teton National Forest, north to the Gallatin Range and west towards Island Park, ID. It encompasses mid and upper elevations of the Bridger-Teton National Forest and portions of the Caribou Targhee in this mapzone. It is also found in subsections highlands M331Dm, M331Dd, M331Aa and M331Ae.

Biophysical Site Description

Subalpine cold climate, relatively moist but usually comes in the winter months as snow, except at the eastern flanks of the Wind River Range where the majority of the precipitation occurs in the spring months. Soils are usually excessively well-drained, residual or glacial till and alluvium on valley floors, droughty moderately deep to deep soils over fractured granodiorite, quartzite, and sandstone bedrock. Coarse fraction 30-50% in soil, soils moderately deep to deep to broken rock or bedrock. Soils are acidic, and rarely formed from calcareous parent materials. Biophysical Setting 1050 occurs regularly and conspiciously on the Flathead Sandstone Formation along the entire eastern Flank of the Wind River Range. Precipitation 400-900 mm/yr.

Vegetation Description

These forests are dominated by Pinus contorta with shrub, grass or barren understories. Sometimes there are intermingled mixed conifer/Populus tremuloides stands with the latter occurring with inclusions of deeper, typically fine-textured soils. The shrub stratum may be conspicuous to absent; common species include Arctostaphylos uva-ursi, Ceanothus velutinus, Mahonia repens, Spiraea betulifolia, Spiraea douglasii,

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Shepherdia canadensis, Vaccinium spp, Symphoricarpos oreophilus, Ribes viscossissimum, Sambucus cerulea, Pachistima myrinsites, Salix scouleriama and Prunus virginiana. Grasses include Elymus glauccus, Poa wheeleri, Carex rossii, Carex geyeri and Carex hoodii. Dominant forbs are Arnica cordifolia and Hieracium alboflorum.

Disturbance Description

These are subalpine forests where the dominance of Pinus contorta is related to fire history and topo-edaphic conditions. Following stand-replacing fires, Pinus contorta will rapidly colonize and develop into dense, even-aged stands depending on site characteristics and cone serotiny. In areas with low serotiny, the stands will be less dense and gradually seed in versus develop even-aged stands immediately. The mean FRI is variable depending on elevation, precipitation and temperature (200-400yrs).

At approximately 80-100yrs of age, insect, disease and/or blow down create small openings in forest canopy maintaining class B. Under favorable (extreme, 95% percentile) weather, early successional stands will burn where live herbaceous fuel load is sufficient to carry fire. Wind/weather events were not modeled.

Fire size is largely dependent on climatic conditions. During periods when summers are rarely dry, average fire size is about 100ac but when dry summers are more common fires of 1000-100000ac are more frequent.

Fire frequency <300yrs will keep lodgepole pine on the landscape.

According to Fisher and Clayton (1983), fire return intervals at elevations greater than 7500ft average 150yrs, but range from 300-400yrs in Yellowstone. In areas at <7500ft, fire return intervals vary from 100-500yrs with some recurring cool fires that thin stands without serious damage for this type (Novak, personal correspondence).

Adjacency or Identification Concerns

1050 is not a BpS in MZ21 but is a seral component of this BpS. This type was modified from 1810500 by adding class D, the spruce/fir climax that would occur without fire.

Lodgepole pine stands in the montane and lower subalpine zones, that are on less well-drained soils, are usually seral to mixed conifer or subalpine BpS, including species such as Douglas-fir, Engelmann spruce, whitebark pine and subalpine fir. Some Pinus contorta forests will persist on sites that are too extreme (hot and dry) for other conifers to establish (BpS 1167). Persistent PICO is also found in frost pockets (reviewers, MZ21).

Departure is going to show up as probably high in this system currently - In Targhee (logged) and Yellowstone National Park (much of the area recently burned) there is probably a lot of early seral. The system is actually not departed in Yellowstone National Park, but it might show up as departed when calculating departure - because it has burned recently. In Targhee, however, it has been clear-cut, therefore it is truly departed. (should show up as herb EVT).

Native Uncharacteristic Conditions

Scale Description

The Rocky Mountain Lodgepole Pine Forest occurs in large (100-1000s of acres) tracts often times following patterns of bedrock and/or surficial geology. The scale of disturbance is generally large, ranging from 100-1000s of acres. Microclimate may have significant influence on the patch size and mosaic of the disturbance.

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Issues/Problems

BpS 1050 Rocky Mountain Lodgepole Pine Forest is a successional stage of BpS 1055 Rocky Mountain Dry Mesic Dry-Spruce-Fir Forest and Woodland. Fire frequency at <300yrs will keep lodgepole pine on the landscape.

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

Comments

This model for MZ21 is based on the LANDFIRE model for BpS 1050 from MZ18 created by Sarah Heide (sarah_heide@blm.gov) and reviewed by Louis Provencher (lprovencher@tnc.org). This type for MZ21 was modified from 1810500 by adding class D, the spruce/fir climax that would occur without fire. Model for MZ21 was further reviewed by an anonymous reviewer in February and Heidi Whitlatch (hwhitlatch@fs.fed.us), David Barron (dbarron@fs.fed.us), Spencer Johnston (sjohnston@fs.fed.us), Candi Eighme (ceighme@fs.fed.us) and Lisa Heiser (lheiser@fs.fed.us).

Vegetation Classes

Class A 5%

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 5

Indicator Species* and Canopy Position

VASC	Lower
RIVI	Lower
CAGE2	Lower
PICO	Upper

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

Grasses, forbs, low shrubs and lodgepole seedlings-saplings. Succeeds to B after 20yrs because young lodgepole grows fast. If aspen is present, it grows faster and dominates lodgepole during this stage only. Cover of trees (seedlings-saplings) varies widely. This could be considered a grass stage unless there is a lodgepole seed source nearby (MZ21 reviewers).

Replacement fire occurs every 300yrs on average, setting back succession to age zero.

Class B 30%

Mid Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PICO	Upper
VASC	Lower
CAGE2	Lower
ABLA	Middle

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.

Description

Moderate to dense pole-sized trees, sometimes very dense (dog-hair). Aspen usually not present. Closed canopy is 51-100%. Mid-open stands are at 21-50% canopy cover and would have mature and immature aspen present. Mid-open stands would have subalpine fir in the understory. Therefore, this class is considered a mid-development all-structures class.

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Class will last until 80yrs and then succeed to C. Insects and disease (mean return interval of 75yrs) maintain class B. Replacement fire (mean FRI of 300yrs) returns vegetation to class A. Competition may maintain the dog-hair condition (prob/yr = 1/500).

Class C **50 %**

Late Development 1 Closed

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

PICO	Upper
ABLA	Mid-Upper
VASC	Lower
CAGE2	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Description

Many mature lodgepole pine, somewhat patchy, a variety of lodgepole size classes and open canopies overall but patches of denser trees. This class lasts until 350yrs, then succeeds to the spruce fir class (class D).

Insects and disease can cause a transition to class A, but very rarely (0.001 probability) kill everything. They would rather cause a transition to class B (0.006 probability) or maintain it in C (0.006 probability).

A second set of reviewers suggested that insect/disease would cause a transition to A with a probability of 0.006 and a transition to B at a probability of 0.013, since if all trees were not killed by insects, the class would transition to B with insect outbreak. However, this scenario was not included in the model, as it would have caused less than five percent to go to class D, since the insect oubreak out of class C was too high.

Replacement fire occurs every 300yrs on average.

Class D **15 %**

Late Development 2 Closed

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

ABLA	Upper
PIEN	Upper
VAME	Lower
VASC	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	100 %
Height	Tree 5.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Mature spruce/fir forest with a variety of size classes from seedling to mature. Insect and disease usually affects only one species so survivors trees of other species remain in the stand.

This class is distinguished from C by species, not canopy closure or tree height.

Reviewers state that spruce beetle could kill most of the spruce and transition this class back to class A. However, this scenario was not modeled.

Stand replacing fires occur about every 300yrs. Low severity fires are extremely rare.

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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

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 1000
Min 10
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	300	90	350	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 severity.

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: **2110560** **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** 1/27/2006

Modeler 1	Vicky Edwards	vedwards@fs.fed.us	**Reviewer**	Bill Romme	romme@warner.cnr.colostate.edu
Modeler 2	Tim Brickell	tbrickell@fs.fed.us	**Reviewer**	Liz Davy	edavy@fs.fed.us
Modeler 3	Don Despain	don_despain@usgs.gov	**Reviewer**	Tim Belton	tbelton@fs.fed.us

Vegetation Type
Forest and Woodland

Map Zone
21

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

Dominant Species*
PIEN
ABLA
PICO

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Northern Rockies, including MT, ID and WY.

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.

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 successional 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 and Ledum glandulosum. Herbaceous species include Actaea rubra, Maianthemum stellatum, Cornus canadensis, Erigeron engelmannii, Saxifraga bronchialis, Lupinus argenteus ssp. subalpinus, 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

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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.

Based on input for MZs 10 and 19, a reduction in the overall mean fire return interval (from 300yrs to 175yrs) was made. For MZ21, however, 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.

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 iin each class.

Currently, there is probably not much A on the landscape. Overall, this system probably isn't departed. It might lack some open stands, but overall it's probably in good shape.

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.

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

Comments

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

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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.

Vegetation Classes

Class A 10 %

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 5

Indicator Species* and Canopy Position

PIEN	Upper
PICO	Upper
ABLA	Mid-Upper

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 40yrs. This class might also succeed to class C, a mid-development open state with a probability of 0.001.

Replacement fire occurs every 500yrs.

Class B 20 %

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ 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 110yrs.

Replacement fire occurs every 500yrs.

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

Class C **10 %**

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ 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 110yrs.

Replacement fire occurs every 500yrs.

Class D **40 %**

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ 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 25m
Tree Size Class	Medium 9-21"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.

This stage occupies 15-50% of the landscape.

Replacement fire occurs between 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 0.001. Otherwise, this class will persist.

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Class E 20 %

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ 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 25m
Tree Size Class	Medium 9-21"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 100-200yrs.

Endemic spruce beetle occurs at 200-300 year 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.

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	455	100	600	0.0022	66
Mixed	900			0.00111	33
Surface					
All Fires	302			0.00332	

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110620 Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland

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

General Information

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

Modeler 1	Sarah Heide	sarah_heide@blm.gov	**Reviewer**	Jon Bates	jon.bates@oregonstate.edu
Modeler 2			**Reviewer**	Klara Varga	klara@ida.net
Modeler 3			**Reviewer**	Tristan Fluharty	tfluharty@fs.fed.us

Vegetation Type
Upland Shrubland

Map Zone
21

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

Dominant Species*
CELE3
ARTRV
PUTR2
SYMPH

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

In MZ21, this BpS is a very minor component, primarily in the northwestern corner of the zone. This BpS occurs throughout the western portion of MZ21 as well.

The curlleaf mountain mahogany (Cercocarpus ledifolius var. intermontanus) 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).

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.

This type almost always occurs on south facing slopes in MZ21.

Vegetation Description

Mountain big sagebrush is one of the most common codominants 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

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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. Mountain big sagebrush, black sagebrush and antelope bitterbrush are often associated. Snowberry, Utah serviceberry and currant are present on cooler, moister sites. Utah juniper, western juniper, Douglas-fir, red fir, white fir, Rocky Mountain juniper, Jeffrey pine, 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).

Reviewers for MZ21 state that Utah juniper, Western juniper, red fir, white fir, jeffrey pine, singleleaf pinyon and prickly phlox are not present in MZ21.

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, and ground cover. 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 infrequent (FRI of 500yrs). In such cases, thick duff and extreme winds and drought 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-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. 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 and 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.

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. Extreme winds, drought, windthrow and snow creep are not modeled.

Adjacency or Identification Concerns

Some existing curlleaf mountain mahogany stands may be in the big sagebrush (BpS 1125, Inter-Mountain

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Basins Big sagebrush Steppe and BpS 1126, Inter-Mountain Basins Montane Sagebrush Steppe), now uncharacteristic because of fire exclusion.

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 model is identical to the LANDFIRE model for the same BpS from MZ19. Only minor edits to the description were made, and a switch in indicator species within some of the successional classes. It was adopted as is by an anonymous reviewer. Reviewer for MZ19 was Jon Bates. Reviewers for MZ21 were Klara Varga (klara@ida.net) and Tristan Fluharty (tfluharty@fs.fed.us).

MZ19 model is identical to the model from 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 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 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 Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ 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%	30%
Height	Tree 0m	Tree 5m
Tree Size Class	Seedling <4.5ft	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Curlleaf mountain mahogany rapidly invades bare mineral soils after fire. Litter and shading by woody plants inhibits establishment. 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 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 15%

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 9

Indicator Species* and Canopy Position

CELE3	Upper
ARTR2	Mid-Upper
PUTR2	Mid-Upper
PSSP6	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31%	60%
Height	Tree 0m	Tree 10m
Tree Size Class	Sapling >4.5ft; <5"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

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. Reviewers for MZ21 state that this occurs much more frequently in MZ21; however, this suggestion was not incorporated into the model.

Reviewers for MZ21 recommended replacing SYMPH as an indicator species with PSSP6.

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 10 %

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
PSSP6	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	30 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Sapling >4.5ft; <5"DBH	

☐ 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.

Reviewers for MZ21 recommended replacing SYMPH as an indicator species with PSSP6.

Class D 20 %

Mid Development 2 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 9

Description

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.

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 old age.

Class E 45 %

Late Development 1 Closed

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 6

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.

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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+.

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	25
Mixed	150	50	150	0.00667	47
Surface	250	50	250	0.004	28
All Fires	71			0.01418	

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

References

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

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110700 Rocky Mountain Alpine Dwarf-Shrubland

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

General Information

Contributors (also see the Comments field) **Date** 3/8/2006

Modeler 1	Jim Ozenberger	jozenberger@fs.fed.us	**Reviewer**	same as modelers above
Modeler 2	Andy Norman	anorman@fs.fed.us	**Reviewer**	Anonymous
Modeler 3	Sarah Canham	scanham@fs.fed.us	**Reviewer**	

Vegetation Type
Upland Shrubland

Map Zone
21

Model Zone

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

Dominant Species*

CAME7	SARE2
DRIN4	PHEM
DROC	VACCI
SAAR27	ERIGE2

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 CO, NM, AZ, UT, NV, ID, MT, WY and north into Canada.

This BpS in common in MZ21 in subsections 342Dd, M331Ja, M331Df and M331Da (Wind River Range, Gros Ventre Range, Salt River Range, ranges in WY where elevations are over 10000ft).

Biophysical Site Description

Elevations are above 3360m in the CO Rockies, but drop to less than 2250m in southeastern British Columbia. This system occurs in areas of level or concave glacial topography, with late-lying snow, and sub-irrigation from surrounding slopes. Soils have become relatively stabilized in these sites, are moist, but well drained, strongly acid, and often with substantial peat layers.

At 46 degrees latitude, these conditions would occur at 10000ft (3000m). It is questionable as to how often peat layers are found at these elevations in MZ21.

Vegetation Description

This ecological system is characterized by a semi-continuous layer of ericaceous dwarf-shrubs, or dwarf willows which form a heath type ground cover less than 0.5m in height. Dense tuffs of graminoids and scattered forbs occur. Dryas octopetala or Dryas integrifolia communities are included here, although they occur on more wind-swept and drier sites than the heath communities. Within these communities, Cassiope mertensiana, Dryas integrifolia, Dryas octopetala, Salix arctica, Salix reticulata or Phyllodoce empetriformis can be dominant shrubs. Vaccinium spp, Ledum glandulosum, Phyllodoce glanduliflora and Kalmia microphylla may also be shrub associates. The herbaceous layer is a mixture of forbs and graminoids, especially sedges, including, Erigeron spp, Luetkea pectinata, Antennaria lanata, Oreostemma

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alpigenum (=Aster alpigenus), Pedicularis spp, Castilleja spp, Deschampsia caespitosa, Caltha leptosepala, Erythronium spp, Juncus parryi, Luzula piperi, Carex spectabilis, Carex nigricans and Polygonum bistortoides. Fell-fields often intermingle with the alpine dwarf-shrubland. For MZ21, Haplopappus suffruticosus is also present.

Reviewers/modelers for MZ21 decided to add krummholz descriptive information here, as a krummholz BpS is absent from the BpS list, except for perhaps 1046, and krummholz would fit in closely with this BpS. For krummholz, species such as Abies lasiocarpa, Picea engelmannii, Pinus ablicaulis, Ribes montigenus and Carex are present.

Disturbance Description

Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost and a short 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.

Fire return interval is approximately 500yrs+. It has been suggested that it might be 2000yrs as there is little evidence of spreading fire in this type.

Avalanches on stepper slopes where soil accumulated can cause infrequent soil-slips, which exposed bare ground.

Very small burns of a few square meters (replacement fire) 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.

Native herbivores (Rocky Mountain bighorn sheep, mule deer, elk and pica) were common in the alpine but probably did not greatly affect vegetation cover because animals move frequently as they reduce vegetation cover.

Adjacency or Identification Concerns

Adjacent to and inter-mixed with Rocky Mountain Dry Tundra.

Reviewers/modelers for MZ21 decided to add krummholz descriptive information here, as a krummholz BpS is absent from the BpS list, except for perhaps 1046, and krummholz would fit in closely with this BpS.

Native Uncharacteristic Conditions

Scale Description

This ecological system can occupy large areas of the alpine. Patch size varies from a few acres to 100ac in mountain basins. 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

Scarce information on this system.

Increased recreation use in the alpine zone (summer and winter) may have an effect on this BpS currently.

Comments

For MZ21, this model was adopted from the model from the same BpS for MZ19 originally created by

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Louis Provencher (lprovencher@tnc.org) and reviewed by Vic Ecklund and Chuck Kostecka. Slight modifications to the description were made. However, the reviewers for MZ21 found an error in the VDDT model to where it did not match the disturbance descriptions in general or in the class descriptions (500yrs vs 200yrs FRI). Therefore, when they fixed the probabilities to concur with the descriptions throughout MTDB, the class percentages and return intervals changed. The model for MZ21 therefore differs from the models for this BpS from other mapzones (19, 10, 23,etc). Reviewers and therefore modelers for MZ21 included Jim Ozenberger, Andy Norman, Sarah Canham and Brenda Fiddick (bfiddick@fs.fed.us).

For MZ19, this is identical to the model for the same BpS in MZs 16, 23, 24 and 28. Input to the model was based on discussion with Kimball Harper (retired USFS scientist; UT), an alpine specialist of the Utah High Plateau. Due to the simplicity of this system, we used the same model as 1144 (Rocky Mountain Dry Tundra), but increased the duration of early development recovery of shrubs from three years to 10yrs.

Vegetation Classes

Class A 10%

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

CAREX	Upper
ERIGE2	Upper
DECA18	Upper
LUPE	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. Exposed soil could also be due to other conditions such as wind and drought. Soil (not rock) may dominate the area. Grasses are more common than forbs or shrubs. Succession to class B after 10yrs.

This model originally had canopy closure of 0-10% herbaceous; however, because that is unmappable, the canopy closure was changed to 20%.

Outside reviewer commented that class should have higher than 20% cover. This is probably a discrepancy between modeler and mapping perspective (scale). On the landscape, might be 0-20% cover, but of the pixel covered by grass, would be higher cover. It is suggested that this BpS even be modeled as a one-box model.

Class B 90%

Late Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 6

Indicator Species* and Canopy Position

CAME7	Upper
DRIN4	Upper
DROC	Upper
SAAR27	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	50 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Alpine community is dominated by semi-continuous layer of ericaceous shrubs. Plant cover may vary from 10% on exposed sites to as much as 50% on mesic and more protected sites. Infrequent replacement fire in the form of lightning strikes (mean FRI of 500yrs), severe summer droughts (mean return interval of 100yrs) and rare avalanches on steeper slopes with soil (1/1000) cause a transition to class A.

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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

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	555			0.00180	99
Mixed					
Surface					
All Fires	554			0.00182	

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) avalanches
☐ 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 severity.

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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110790 Great Basin Xeric Mixed Sagebrush Shrubland

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

General Information

Contributors (also see the Comments field) **Date** 5/31/2005

Modeler 1	Crystal Kolden	ckolden@gmail.com	**Reviewer**	Jon Bates	jon.bates@oregonstate.edu
Modeler 2	Gary Medlyn	gmedlyn@nv.blm.gov	**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type
Upland Shrubland

Map Zone
21

Model Zone

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

Dominant Species*
ARNO4
ACHY
ACTH7
PSSP6

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Western UT, eastern/central/northern NV and southern ID.

Biophysical Site Description
This type describes black sage and low sagebrush, mostly on convex slopes with Wyoming sagebrush and basin big sagebrush occurring in concave slopes and inset alluvial fans. Great Basin alluvial fans, piedmont, bajadas, rolling hills and mountain slopes. Can also be found on flats and plains. Other species include horsebrush, spiny hopsage and rubber rabbitbrush, although these are mostly associated with Wyoming and basin big sagebrush areas. Low/green rabbitbrush is associated with black sagebrush, as well as shadscale. Elevations range from 1500-2600m. Low sagebrush tends to grow where claypan layers exist in the soil profile and soils are often saturated during a portion of the year. Black sagebrush tends to grow where there is a root-limiting layer in the soil profile. Wyoming big sagebrush and basin big sagebrush generally occur on moderately deep to deep soils that are well-drained.

Vegetation Description
This type includes communities dominated by black sagebrush (Artemisia nova), low sagebrush (Artemisia arbuscula) and Wyoming big sagebrush (Artemisia tridentata spp wyomingensis) where there is a potential for pinyon (Pinus monophylla) and/or juniper (Juniperus osteosperma) establishment. Black sagebrush is the dominant shrub in this system with Wyoming big sagebrush and basin big sagebrush occurring in minor compositions, sometimes scattered but mostly continuous. Black sagebrush generally has relatively low fuel loads with low growing and cushion forbs and scattered bunch grasses such as bluebunch wheatgrass (Pseudoroegneria spicata), needlegrasses (Achnatherum spp), Sandberg bluegrass (Poa secunda) and Indian ricegrass (Achnatherum hymenoides). Forbs often include buckwheats (Eriogonum spp), fleabanes (Erigeron spp), phloxs (Phlox spp), paintbrushes (Castilleja spp), globemallows (Sphaeralcea spp) and

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lupines (Lupinus spp).

Disturbance Description

Black sagebrush generally supports more fire than other dwarf sagebrushes. This type generally burns with mixed severity (average FRI of 100-140yrs) due to relatively low fuel loads and herbaceous cover. Bare ground acts as a micro-barrier to fire between low stature shrubs. Stand-replacing fires (average FRI of 200-240yrs) can occur in this type when successive years of above average precipitation are followed by an average or dry year. Stand replacement fires dominate in the late successional class where the herbaceous component has diminished or where trees dominate. This type fits best into Fire Group IV.

Grazing by wild ungulates occurs in this type due to its high palatability (mostly for A. nova and A. arbuscula) compared to other browse. Native browsing tends to open up the canopy cover of shrubs but does not often change the successional stage. Native grazing was not included in the model.

Severe drought is a stress factor (average return interval of 200yrs) that causes two transitions: 50% of times drought thins the stand (same class transition), whereas 50% of other times severe thinning by drought causes a transition to the previous development class.

Burrowing animals and ants breaking through the root restrictive zone of low and black sagebrush types create mounds of mineral soil (seedbed) that is readily colonized by big sagebrush. Burrowing creates small patches (ie, generally less than 200 sq. ft) of big sagebrush in the low sagebrush types, which could affect fuel loads. This was not considered in the model.

Adjacency or Identification Concerns

In the transition area between the Great Basin and Columbia Plateau, BpS 1079 can be confused with Columbia Plateau Low Sagebrush Steppe (1124), which has a higher herbaceous cover.

The black and low sagebrush type tends to occur adjacent to either Wyoming big sagebrush or basin big sagebrush types. The Wyoming big sagebrush and basin big sagebrush types create a mosaic within the black and low sagebrush types. These big sagebrush types have a different fire regime that acts to carry the fire, with black and low sagebrush serving as fire breaks most of the time.

After mixed or low-severity fires, composition is primarily islands of black sagebrush with interspaces dominated by low rabbitbrush that resprouts, and with time, increases of shadscale and herbaceous species.

Native Uncharacteristic Conditions

Scale Description

Black sagebrush can occupy extremely large areas (>100000ac) in eastern NV and western UT. Occurrences are typically smaller towards western and northern NV and southern ID. Disturbance patch size for this type is not well known but is estimated to be 10s to 100s of acres due to the relatively small proportion of the sagebrush matrix it occupies and the limited potential for fire spread. Where these sites exist in a more herbaceous state, fire expands readily where there is continuity of fine fuel and sufficient wind. It is usually a low intensity burn. Fire sizes up to 800ac possible in these situations.

Issues/Problems

The effect of insect outbreaks (independent of drought) on mature pinyon and juniper in class D can cause a 50% reduction in class D (from 10% to 5%) if part or all of the outbreak sufficiently thins older trees (transition to class C). We assumed that 25% of outbreaks results in a transition to class C from D.

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Comments

For MZ21, this BpS was adopted as-is by MFSL from 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. Jon Bates revised BpS 1079 for MZ 18 with no changes. Reviewer does not consider himself an expert of this system and, therefore, was not retained as a modeler.

Mike Zielenski (mike_zielenski@nv.blm.gov) reviewed BpS 1079 for MZs 12 and 17, which resulted in significant changes to the description. BpS 1079 was originally based on the Rapid Assessment model R2SBDW (dwarf sagebrush) developed by Gary Medlyn (gmedlyn@nv.blm.gov) and Sarah Heidi (sarah_heidi@blm.gov). Following expert review, choice of model was switched to R2SBDWwt (dwarf sagebrush with trees) developed by Gary Medlyn and Sarah Heidi because the NatureServe description includes pinyon and juniper encroachment and the appropriate elevation. Also, the reviewer indicated that black sagebrush is usually associated with juniper or pinyon in northcentral NV and recommended the version of the model with tree encroachment. Modifications were made to weather stress pathways and probabilities for R2SBDWwt. R2SBDW was reviewed by Paul Blackburn (paul.blackburn@usda.gov), Gary Back (gback@srk.com) and Paul Tueller (ptt@intercomm.com), whereas R2SBDWwt was reviewed by Paul Tueller.

Vegetation Classes

Class A 15%

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 1

Description

Indicator Species* and Canopy Position

PSSP6	Middle
POSE	Low-Mid
ACHY	Middle
ACTH7	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	10%
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

☑ Upper layer lifeform differs from dominant lifeform.

Dominant life form is primarily herbaceous with some resprouting rabbitbrush. Canopy cover 4-10%, height 18-36cm (0.2-0.4m).

Early seral community dominated by herbaceous vegetation; less than six percent sagebrush canopy cover; up to 24yrs post-disturbance. Fire-tolerant shrubs (green/low rabbitbrush) are first sprouters after stand-replacing, high-severity fire. Replacement fire (mean FRI of 250yrs) maintains vegetation in state A. Prolongued drought every 500yrs on average maintains vegetation in class A. Succession to B after 25yrs.

Class B 60%

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 1

Description

Indicator Species* and Canopy Position

ARNO4	Upper
POSE	Lower
ACHY	Mid-Upper
PSSP6	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11%	20%
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

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Mid-seral community with a mixture of herbaceous and shrub vegetation; 6-10% sagebrush (sagebrush/brush) canopy cover present; between 20-59yrs post-disturbance. Drought every 200yrs causes two transitions: 50% of times drought thins shrubs while maintaining vegetation in class B, whereas 50% of times drought causes a stand replacing event. Replacement fire (FRI of 250yrs) causes a transition to A, whereas mixed severity fire (FRI of 100yrs) maintains the site in its present condition. In the absence of fire for at least 120yrs, the site will follow an alternative successional path to C. Otherwise, succession and mixed severity fire keeps site in class B.

Class C 15%

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 2

Indicator Species* and Canopy Position

ARNO4	Upper
JUOS	Upper
PSSP6	Mid-Upper
ACHY	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	10%
Height	Tree 0m	Tree 5m
Tree Size Class	Seedling <4.5ft	

☑ Upper layer lifeform differs from dominant lifeform.

Juniper, and maybe pinyon, overtopping shrubs. Tree cover less than six percent.

Description

Late seral community with a mixture of herbaceous and shrub vegetation; 10-25% sagebrush canopy cover present; and dispersed conifer seedlings and saplings established at less than six percent cover. Insects attack the vegetation in this state every 60yrs on average, but that does not cause a transition to another state. Severe droughts (return interval of 200yrs) causes two thinning disturbances: to class B (50% of times) and within class C. Replacement fire is every 200yrs on average, whereas mixed severity fire is less frequent than in class B (FRI of 130yrs). Succession is to class D after 75yrs.

Class D 10%

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 2

Indicator Species* and Canopy Position

JUOS	Upper
PIMO	Upper
ARNO4	Middle
ACHY	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11%	40%
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Late seral community with a closed canopy of conifer trees (6-40% cover). The degree of tree canopy closure differs depending on whether it is a low sagebrush (max 15%) or black sagebrush (max 40%) community. In low sagebrush communities a mixture of herbaceous and shrub vegetation with >10% sagebrush canopy cover would still be present. In black sagebrush communities the herbaceous and shrub component would be greatly reduced (less than one percent). When Ips beetle outbreaks occur the pinyon component is reduced (return interval of 60yrs): 75% of times thinning is not intense enough to cause a transition whereas in 25% of cases a transition to class C will occur. The only fire is replacement (FRI of 150yrs) and driven by a greater amount of woody fuel than in previous states. Prolongued droughts have the same effect as before. Succession from class D to D without fire.

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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

Fire Regime Group:** **III**

Historical Fire Size (acres)

Avg 50
Min 1
Max 2000

Sources of Fire Regime Data

☑ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals	*Avg FI*	*Min FI*	*Max FI*	*Probability*	*Percent of All Fires*
Replacement	227	100	250	0.00441	37
Mixed	133	75	140	0.00752	63
Surface					
All Fires	84			0.01193	

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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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110801 Inter-Mountain Basins Big Sagebrush Shrubland - Basin Big Sagebrush

☐ *This BPS is lumped with:*

☑ *This BPS is split into multiple models:* *Differences in fire regime, floral component and habitat. Soils are deeper, vegetative structure is taller/larger than Wyoming big sagebrush. Split so that Wyoming big sagebrush could be modeled separately. Basin big sagebrush is found at lower elevations and is usually restricted to comparatively moist ravines or valleys (Barker and McKell 1986 in Knight 1994). It also grows taller than any other species of Artemisia (up to two meters or more.). Wyoming big sagebrush is the most common shrub of the intermountain basins. It is normally less than 0.5 m tall and occupies the drier uplands, with the taller basin big sagebrush occurring in adjacent ravines (Knight 1994). Basin big sagebrush is more common on sandy soils, and Wyoming big sagebrush is more common on fine-textured soils (Knight 1994). There is more available moisture in basin big sagebrush sites than Wyoming big sagebrush sites. Basin big sagebrush - drainages, greater soil depth (moderately deep to deep soils). Shallower on Wyoming big sagebrush sites. Basin big sagebrush tends to grow in deep, fertile soils and is an indicator of productive sites.*

General Information

Contributors (also see the Comments field) **Date** 7/12/2006

Modeler 1	Steve Kilpatrick	Steve.Kilpatrick@wgf.state.wy.us	**Reviewer**	Dave Tart	dtart@fs.fed.us
Modeler 2	Klara Varga	klara@ida.net	**Reviewer**	Stan Kitchen	skitchen@fs.fed.us
Modeler 3			**Reviewer**	Mack McFarland	mack_mcfarland@nps.gov

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

21

Model Zone

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

Dominant Species*

ARTRT FEID
PSSP6
ELTR7
CHRYS9

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Basin big sagebrush is found throughout WY. It does not occur in Grand Teton and Yellowstone National Parks.

Biophysical Site Description

This type is found between 3000-7000ft elevation on deep, well drained, alluvial soils and have been observed on sandy sites where soil moisture prevails until August.

This type can be a few meters wide on ephemeral streams. This could be 100m wide on larger streams. It

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tends to follow the stream. This system is in a riparian setting, but not wet enough to support willows, cottonwoods and other riparian vegetation.

Vegetation Description

A dense canopy of basin big sagebrush (Artemisia tridentata ssp. tridentata) dominates the shrub layer, except on alkaline soils, where greasewood (Sarcobatus vermiculatus) makes up as much as 25%. Greasewood, however, is not a significant component of the basin big sagebrush community in MZ21. Some greaewood may occur in the southern portion but not in significant quantities. Rabbitbrush (Chrysothamnus spp) and Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis) may also be present. This type may intergrade with the Wyoming big sagebrush. Some stands have silver sagebrush (Artemisia cana ssp. cana) intermixed (Williams, pers. comm.) and in early seral states Artemesia dracunculus may occur in the understory.

Understory grasses include, needle and thread (Hesperostipa comata), basin wildrye (Leymus cinerius), squirreltail (Elymus elymoides), slender wheatgrass (Elymus trachycaulus), bluebunch wheatgrass (Pseudoroegneria spicata) and Idaho fescue (Festuca idahoensis).

Forbs were sparse, and included hawksbeard (Crepis acuminata), bird's beak (Cordylanthus spp) , blue bell (Mertensia spp), lupine (Lupinus spp), buckwheat (Eriogonum spp), Rocky Mountain aster (Aster spp), Daisier (Erigeron spp) and Phlox species.

Disturbance Description

Fire regime group IV. Fire return intervals are estimated to average approximately 100yrs, and range from 50-150yrs. Fires were mostly replacement severity (Tirmenstein 1999, Sapsis and Kauffman 1991).

Reviewers for MZ21 recommended a FRI of 50yrs, or between 15-70yrs as per Sapsis (1990). However, it was noted by another reviewer that Sapsis (1990) is not a study of fire frequency and has no primary data about that. The two primary sources of information about fire frequency are fire scars on trees nearby and the recovery rate of sagebrush after fire. Neither has been measured adequately for basin big sagebrush. All we have to go on to estimate FRI in basin big sagebrush is that it seems to recover more quickly than does Wyoming big sagebrush, so maybe that implies that it might burn somewhat more often, but probably not much. The occurrence of basin big sagebrush in small patch sizes next to mountain big sagebrush stands in this mapzone may result in a shorter return interval than basin big sagebrush next to Wyoming big sagebrush in other mapzones. However, more research is needed.

Drought may have caused replacement disturbances rarely. Mortality by drought is more common in Wyoming big sagebrush than basin big sagebrush, due to better soils, better water availability and a possibly deeper rooting habit. Death by drought in basin big sagebrush is more isolated than in Wyoming big sagebrush. The frequency of a drought that would be severe enough to broadly affect basin big sagebrush probably occurs once every 100-200yrs, not considering global warming. (Williams, personal correspondence).

Insects and disease would have been replacement and mixed-severity disturbances in this type, but little information exists on the frequency of these disturbances under reference conditions. They are not modeled here.

Normal, relatively less severe native grazing by large ungulates, including bison, elk, mule deer and pronghorn might have maintained more of an open condition and caused rare, small degraded sites (ie, wallows) that may have occupied less than five percent of the landscape. This disturbance is not modeled here.

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Some believe that sagebrush is fire-adapted (Harrell, personal correspondence), although others believe it does not show classic types of fire adaptation. Fine fuel in the shrub canopy and on the ground along with grasses and forbs will help carry the fire; in sagebrush it is considered a canopy fire (Harrell, personal correspondence). The later the successional stage, the more likely it will be stressed by competition and drought. This may decrease live fuel moisture and cause drought mortality or dry fuel conditions, which could increase the flammability of the fuel and, after a fire, send the BpS to an earlier seral stage or state. The fire frequency may be shorter for later seral conditions and longer for earlier seral stages (Harrell, personal correspondence).

Some state that the fire return intervals are over 100yrs on average. Some stands will burn more frequently; especially those at higher elevations that are surrounded by mountain big sagebrush - it is generally accepted that the surrounding vegetation will have a large effect on fire regimes. For additional evidence, Williams presents a graph on recovery rates in basin big sagebrush communities following prescribed fires - some of the burns are almost 20yrs old now. The mean data points have a linear pattern. Extrapolating, the data suggest that it will take at least 50yrs on average for these communities to reach 40% cover. This is the threshold we have defined as required to enter the late seral closed class. This community was "aged" an additional 20-30yrs and following the advice of Baker (in press), an estimate of 140-160yrs FRI was reached. Since this data was collected from southern WY, which is probably on the high end within MZ22 with respect to recovery, we averaged the FRI to 110yrs. This number may be higher than the folks in the northern part of the MZ22 may want to use – in the south we are looking at mainly a 6-12in precipitation zone for basin big sagebrush and it is generally confined to riparian areas. This methodology has been debated by some researchers.

Basin big sagebrush rarely burned due to lack of fuel. It is possible that prior to grazing, there was more frequent burning, but due to poor clay and low precipitation, the basin big fire interval was probably well over 100yrs (Romme, personal correspondence).

Tart (personal correspondence) states that Johnson (2000) reports an FRI of 12-43yrs based on the thesis of Sapsis (1990). Where basin big sagebrush occupies small draws and swales, as in MZ21, its return interval would be controlled by the adjacent vegetation.

Fire scars provide little information on low elevation sage where there are no forests nearby; fire scar estimates are therefore low estimates of fire rotation as they come from locations that would have had more fire than is typical of sagebrush (Baker, 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 MFI for these systems. Based on what has been shown through different approaches and field experience of those who know the system, the estimate of total MFI for Basin big sagebrush shrubland is between 75-150yrs (Kitchen, personal correspondence). We really don't know how fire might have behaved across the fuel threshold at the forest/shrubland ecotone. Therefore, we don't know how accurately proxy fire chronologies derived from fire-scarred trees predict fire regimes in nearby shrublands (Kitchen, personal correspondence).

For MZ22, basin big sagebrush is influenced by the surrounding vegetation, including riparian areas. The FRI could be longer than in other areas, as basin big sagebrush extends from Cody through Rawlins. The Cody area probably burns more often than Rawlins; however, the 120yr interval for MZ22 was retained, as it is thought that overall the FRI might be higher in this area of WY, versus, for instance, Yellowstone or other areas (Williams, pers comm). Some reviewers for MZ22, however, felt that 120yr interval was too long for

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basin big sagebrush (Warren, pers comm); however, the interval was retained since the majority of review did not request a change of the interval - since it varied so much in this area. In MZ21 in the Yellowstone area, recovery is much faster than in this part of WY (Williams, pers comm).

For the Rapid Assessment (RA), there was disagreement about the frequency of fire in this system. Estimates ranged from 40yrs to 150yrs. For the RA, FRI was modeled at 60yrs.

After an extensive model review process, LF leadership/guidance determined that the MZ22 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 used for MZ21. The original MZ21 model was therefore altered to reflect majority opinion/interpretation of literature regarding the fire regime of this sagebrush system. For MZ21, an interval of 70yrs was chosen. This interval is still considered on the longer side of the range by some (A Winward, pers comm). This interval was similar to that used in MZs 18, 23,10 and 19 and R0SBBB (if mixed fire removed). This is also in line with Kitchen's estimate of 75-150 year interval for basin big sagebrush. This interval, although on the high end of what the reviewers of MZ21 recommended (15-70yrs), represents a compromise between the differing views and reflects majority opinion. Also, because this interval must be longer than that for mountain big sage (50yrs), 70yrs seemed an appropriate value.

Adjacency or Identification Concerns

Basin big sagebrush grows along streams, sometimes with greasewood or silver sagebrush intermixed or adjacent, often with Wyoming big sagebrush and mountain big sagebrush on adjoining drier slopes. Distribution is a result of local soil characteristics on a fine scale (1-500ac). This type occurs on deeper soils than Wyoming or mountain big sagebrush types.

In MZ21, there is very little, if any PJ or greasewood.

Much of this type has been lost due to land clearing for agriculture. Some stands have been converted to cheatgrass (Bromus tectorum), others have substantial cheatgrass component. Occasionally, in some areas, stands may have been replaced by greasewood after burning (Williams, Pers. Comm.).

Sometimes, incised channels may decrease the contact with the watertable and the resulting terrace may provide conditions for basin big sagebrush. This type may occur in small patches and may best be mapped by soil characteristics.

Native Uncharacteristic Conditions

Scale Description

Fuel may be continuous resulting in spread throughout patches. Disturbance size therefore probably resembles the patch size of the vegetation. Smaller patches throughout the map zone compared to the other sagebrush subspecies.

This type may occur in small patches and may best be mapped by soil characteristics.

Issues/Problems

It is difficult to map and identify the subspecies of big sagebrushes (Artemesia tridentata) without the aid of field assessments.

Comments

This model for MZ21 was adapted from the draft model from MZ22 for BpS 10801, created by Mark

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Williams, Vicki Herren, Destin Harrell, Tim Kramer and an anonymous contributor. Quantitative revisions and changes in cover and structure were made to the model by reviewers for MZ21 who were Steve Kilpatrick (steve.kilpatrick@wgf.state.wy.us), Mack McFarland (mack_mcfarland@nps.gov), Klara Varga (klara@ida.net), Don Delong and Tristan Fluharty. These reviewers therefore became the modelers for MZ21. After an extensive model review process, LF leadership/guidance determined that the modelers for MZ22 used an interpretation of the fire information available on sagebrush systems that did not represent the majority expert opinion/interpretation of the fire literature for MZ21. The original MZ21 model was therefore altered to reflect majority opinion/interpretation of literature regarding the fire regime of this sagebrush system. RL implemented model changes based on guidance.

The model for MZ22 was adapted and changed quantitatively from Rapid Assessment (RA) model R0SBBB created by Diane Abendroth. Other modelers for MZ22 included Dave Roberts: dave_a_roberts@blm.gov, Destin Harrell (Destin_harrell@blm.gov), Tim Kramer (tim_kramer@blm.gov) and Eve Warren (eve_warren@blm.gov).

Workshop code for RA model was BSAG.

Additional reviewers during RA included: Karen Clause (karen.clause@wy.usda.gov), Dennis Knight (dhknight@uwyo.edu); Thor Stephenson (thor_stephenson@blm.gov), Curt Yanish (curt_yanish@blm.gov), Gavin Lovell (gavin_lovell@blm.gov) and Eve Warren (eve_warren@blm.gov).

Peer review for RA was incorporated 4/26/2005. There was considerable disagreement among reviewers about how to model this type. All comments were incorporated into the description. The following changes were made to the quantitative model based on peer review for RA model. See that model for details.

Vegetation Classes

Class A 20%

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PSSP6	Upper
ELTR7	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	30%
Height	Herb 0m	Herb 0.5m
Tree Size Class	no data	

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

The upper layer lifeform are shrubs with cover of approximately 10-15%. Grasses are dominant.

Description

Grass-dominated community. Shrub cover is approximately 0-10% or 15%.

If soils are alkaline, resprouting greasewood may also be present. This class lasts up to approximately 15yrs (10yrs was suggested based on recovery rates in Big Horn Basin) post disturbance and succeeds to mid-development open (class B) unless drought (not modeled) or replacement fire (every 70yrs) cause stand-replacing disturbance.

The upper layer lifeform is shrubs. However, per new direction from MFSL the dominant lifeform is indicated in the structural data boxes.

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Class B **35%**

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

ARTRT	Upper
PSSP6	Lower
ELTR7	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	20 %
Height	Shrub 0.6m	Shrub 3.0m
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush dominated open shrub community with abundant grasses. This class lasts approximately 20-50yrs post disturbance and succeeds to late-development closed (class C) unless replacement fire causes a transition to class A, approximately every 70yrs.

Maximum height in this class is more like 1.5 m.

Class C **45%**

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

ARTRT	Upper
PSSP6	Lower
ELTR7	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Shrub 0.6m	Shrub 3.0m
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Mature and overmature sagebrush with suppressed understory. This class begins at approximately age 50yrs and can perpetuate until disturbance causes a transition to another class. Replacement fire may cause a transition to class A, approximately every 75yrs.

Wind/weather/stress/drought can also cause a transition back to A at 0.005 probability.

Greasewood is not necessarily an indicator of all classes.

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

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

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	72	30	150	0.01389	100
Mixed					
Surface					
All Fires	72			0.01391	

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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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110802 Inter-Mountain Basins Big Sagebrush Shrubland - Wyoming Big Sagebrush

☐ *This BPS is lumped with:*

☑ *This BPS is split into multiple models:* *Different from basin big sagebrush in fire regimes, floral composition and occurrence in drier uplands. See 10801 for split reasons also.*

Basin big sagebrush is found at lower elevations and is usually restricted to comparatively moist ravines or valleys (Barker and mcKell 1986 in Knight 1994). It also grows taller than any other species of Artemisia (up to two meters or more.). Wyoming big sagebrush is the most common shrub of the intermountain basins. It is normally less than 0.5 m tall and occupies the drier uplands, with the taller basin big sagebrush occurring in adjacent ravines (Knight 1994). Basin big sagebrush more common on sandy soils, and Wyoming big sagebrush more common on fine-textured soils (Knight 1994).

Wyoming big sagebrush tends to grow on shallower, well-drained, and xeric soils when compared to mountain and basin big sagebrush (Barker and McKell 1983). When Wyoming big sagebrush occurs with black, longleaf (A. longiloba) and threetip sagebrush communities, it often occupies the relatively deeper soils (Tweit and Houston 1980).

Where Wyoming, basin and mountain big sagebrush ranges overlap, Wyoming big sagebrush tends to grow on shallowest, most well-drained, and hottest soils relative to the other two subspecies. Basin big sagebrush tends to occupy the deepest, most fertile soils (FEIS).

General Information

Contributors (also see the Comments field) **Date** 7/12/2006

Modeler 1	Steve Kilpatrick (model input)	Steve.Kilpatrick@wgf.state.wy.us	**Reviewer**	Dave Tart	dtart@fs.fed.us
Modeler 2			**Reviewer**	Stan Kitchen	skitchen@fs.fed.us
Modeler 3			**Reviewer**		

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

21

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 STAC
PSSP6 PHHO
POSE FEID
CHRYS9

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Wide-ranging, common to Basin and Range province, extending into the Columbia Plateau and east into the northern and central Rockies and the western edge of the short grass prairie. Common throughout MZ22.

*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 severity.

Biophysical Site Description

Wyoming big sagebrush occupies foothills, terraces, slopes, plateaus and basin edges. Soils are shallow to moderately deep and well drained. Wyoming Big sagebrush generally occurs in the 5-14in precipitation zones. Soil depth and accumulation of snow enhances these communities in lower precipitation zones (Knight 1994).

Wyoming big sagebrush tends to grow on shallower, well-drained, and xeric soils when compared to mountain and basin big sagebrush (Barker and McKell 1983). In WY, a considerable amount of Wyoming big sagebrush occurs in the 5-9in and the 10-14in precipitation zones.

When Wyoming big sagebrush occurs with black, longleaf (A. longiloba) and threetip sagebrush communities, it often occupies the relatively deeper soils (Tweit and Houston 1980).

WY: 5000-7000ft (1500-2100m)

Vegetation Description

Wyoming big sagebrush is the dominant mid to late-seral species within this plant assemblage. Cool season grasses such as Indian ricegrass, bluebunch wheatgrass, needle-and-thread, blue grama, Sandberg bluegrass, squirreltail and infrequently Thurber's needlegrass are common. Rhizomatous wheatgrasses, such as western wheatgrass, are common species within this map zone. Common forbs are species of Astragalus, Crepis, Delphinium and Phlox and Castilleja, while associated shrubs and shrub-like species can be small green rabbitbrush, black sagebrush, spiny hopsage, winterfat and broome snakeweed. 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. Cryptobiotic organisms (VAM) are important.

Wyoming big sagebrush sites have fewer understory species relative to other big sagebrush subspecies, though at higher elevations or moister areas of this vegetation community there is a higher potential for herbaceous species. On the southeastern side of the MZ22, in subsections 342 Fj, 342Fl, 342Fi, 342Ff and 331Gb, herbaceous cover increases transitioning into the short-grass prairie.

In MZ21, in western MT, Artemisia tridentata is in the habitat types of ARTR/AGSP, ARTR/FESC and ARTR/FEID.

In MT, Ericameria nauseosa (=Chrysothamnus nauseosus) and Artemisia frigida are consistently present in amounts less than five percent, unless the community has experienced abusive grazing. Elymus lanceolatus is conventionally the dominant and diagnostic graminoid, though in exceptionally mesic representations it may have less cover than Nassella viridula or Poa pratensis. Other important associated graminoids include Koeleria macrantha, Hesperostipa comata (=Stipa comata), Bouteloua gracilis and Carex filifolia. Total forb cover is low while the more constant species are Sphaeralcea coccinea, Vicia americana, Achillea millifolium and Opuntia polyacantha.
(http://www.mtnhp.org/Community/guide_report.asp?elcode=CEGL001044)

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 more significant disturbance than native grazing or insects, so was included at 500yr

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intervals.

Native grazing by large ungulates (eg, bison), and insects were included, but at 1000yr intervals.

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 bank, 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 could have ranged from 100-240yrs or more (Baker in press), and some feel that they appear to have ranged from 10-110yrs or more, and recovery to 20% canopy cover from a burn may take more than 40yrs (Young and Evans 1981, Winward 1991). Bunting et al. (1987) found that the average recovery time following fire in Wyoming big sagebrush communities was 30yrs. Others have cited intervals of Wyoming big sagebrush at between 50-100yrs (Miller and Eddleman 2004; Miller et al. 1994; Wright and Biley 1982; Whisenant 1990; Miller and Tausch 2001) and up to 110yrs (West 1999; Whisenant 1990). It is unclear as to whether or not these studies considered recovery rate or the limitations of fire history studies.

Reviewers for MZ22 felt that 130-year interval was justified, as Wyoming big sagebrush does not re-establish for multiple decades, and fire was therefore likely infrequent (Warren, pers comm).

Reviewers for Rapid Assessment disagreed about the frequency of fire and severity of fire, suggesting MFIs of 90-140yrs and no mixed severity fire to 50% mixed severity fire. The majority of reviewers agreed with the original model, however, so the quantitative model was unchanged. Descriptive information was added to capture the disparate opinions of reviewers.

Fire scars provide little information on low elevation sage when there are no forests nearby; fire scar estimates are therefore low estimates of fire rotation as they come from locations that would have had more fire than is typical of sagebrush (anonymous contributor, 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 MFI for these systems. Based on what has been shown through different approaches and field experience of those who know the system, the estimate of total MFI for Wyoming big sagebrush steppe (productive) is between 60-120yrs and 75-200yrs for Wyoming big sagebrush shrubland (Kitchen, personal correspondence). We really don't know how fire might have behaved across the fuel threshold at the forest/shrubland ecotone. Therefore, we don't know how accurately proxy fire chronologies derived from fire-scarred trees predict fire regimes in nearby shrublands (Kitchen, personal correspondence).

As per FEIS (Howard 1999) - Wyoming big sagebrush steppe communities historically had low fuel loadings and were characterized by 10-70yr interval, patchy fires that produced a mosaic of burned and unburned lands. Fire scars on western juniper in a Wyoming big sagebrush/bluebunch wheatgrass community in Lassen County, CA, showed fire return intervals ranging from 10-40yrs. Vincent suggests that in northern NM, infrequent fire probably maintained Wyoming big sagebrush communities as open, seral stands of Wyoming big sagebrush with productive herbaceous understories. Historic mean fire return

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interval in northern NM of Wyoming big sagebrush communities is estimated at 40-50yrs

After an extensive model review process, LANDFIRE leadership/guidance determined that the original modelers for MZ22 used an interpretation of the fire information available on sagebrush systems that did not represent the majority expert opinion/interpretation of the fire literature to be used for MZ21. The MZ21 model was therefore altered to reflect majority opinion/interpretation of literature regarding the fire regime of this sagebrush system. For MZ21, an interval of 100yrs was chosen. This interval is still considered on the longer side of the range by some (A Winward, pers comm). This interval was similar to that used in MZs 18, 23, 10, 19 (if mixed fire removed) and 20 and R0SBWYwy. This is also in line with Kitchen's estimate of 60-120yrs in Wyoming big sagebrush productive steppe and 75-200yrs in Wyoming big sagebrush shrub. It is somewhat higher (less frequent fire) than FEIS's estimate. Also, because this interval must be longer than that for mountain big sage (50yrs) and basin big sagebrush(70yrs), 100yrs seemed to be an appropriate value.

Adjacency or Identification Concerns

This type merges into various other types and Wyoming big sagebrush may hybridize with mountain sagebrush and basin big sagebrush. Local data show that hybridized taxa may have more resiliency to prescribed fire than non-hybridized Wyoming big sagebrush (Eve Warren, Wyoming BLM).

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, limber pine-juniper, ponderosa pine, mountain sagebrush, salt desert shrub and grassland vegetation types across its range.

Cheatgrass now dominates the herbaceous layers of many Wyoming big sagebrush communities, creating more frequent fire regimes. Broom snakeweed and Halogeton may dominate sites disturbed by overgrazing, oil and gas development or other disturbances.

Juniper invasion into Wyoming big sagebrush systems could possibly be occurring in some locations today, but this does not appear to be a common occurrence in this map zone. In some cases apparent invasions are simply recovery from past fires or temporary fluctuations along ecotones (Pers. Comm., Mark Williams, anonymous contributor).

Native Uncharacteristic Conditions

Greater than 60% canopy cover of Wyoming big sagebrush. In drier sites, canopy cover may not exceed >50%.

Scale Description

Occurrences may cover thousands of hectares.

Issues/Problems

Difficult to identify where hybrids occur with other big sagebrush taxa.

Comments

This model for MZ21 was adopted from the draft model from MZ22 BpS 10802 created by Mark Williams (mark_a_williams@blm.gov), Vicki Herren (vicki_herren@blm.gov) and an anonymous contributor and reviewed by Tim Kramer (tim_kramer@blm.gov), Destin Harrell (destin_harrell@blm.gov) and Eve Warren (eve_warren@blm.gov). Some modifications in descriptions were made. After an extensive model review process, LANDFIRE leadership/guidance determined that the original modelers for MZ22 used an interpretation of the fire information available on sagebrush systems that did not represent the majority expert opinion/interpretation of the fire literature to be used for MZ21. The MZ21 model was therefore altered to reflect majority opinion/interpretation of literature regarding the fire regime of this sagebrush

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system.

This model for MZ22 was adapted from Rapid Assessment (RA) model R0SBWYwy created by Tim Kramer (tim_kramer@blm.gov) and reviewed by Bill Baker, Don Bedunah and Dennis Knight.

Workshop code for Rapid Assessment (RA) was WYSB. This model was combined with another RA 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.

Model is based on the original FRCC PNVG (WYSB1) with modifications from Wyoming Interagency Vegetation Committee (2002) and expert estimates.

Peer review 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). Reviewers disagreed about the frequency of fire and severity of fire. Descriptive information was added to capture the disparate opinions of reviewers.

Vegetation Classes

Class A 25%

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

PSSP6	Upper
ACHY	Upper
PASM	Upper
HECO26	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	60%
Height	Herb 0m	Herb 0.5m
Tree Size Class		

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

Description

Herbs dominate this class, but shrubs are growing up and do not yet dominate the class. Shrub cover less than five percent belongs in this class.

Herbaceous dominated. Primarily grasses with forbs. Exact species will vary depending on location. Western wheatgrass, Sandberg bluegrass, Indian ricegrass, needle and thread, bluebunch wheatgrass, squirreltail 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.

This class succeeds to mid-development open stage after 30yrs.

Insect/disease and grazing occur with a probability of 0.001. Wind/weather stress occurs every 100yrs.

Replacement fire occurs every 90yrs.

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Class B 20 %

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8	Upper
ACHY	Middle
PASM	Middle
HECO26	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	30 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is greater than five percent but <25%. Understory is well represented by herbaceous species as described for class A. Bottlebrush squirrel tail may also be an indicator.

This class succeeds to an open stage with taller shrubs in 40yrs, although it can succeed to a closed stage with taller shrubs with a probability of 0.01.

Insect/disease and grazing occur with a probability of 0.001 and wind/weather stress occurs every 500yrs, but do not cause a transition.

Replacement fire occurs every 100yrs.

Class C 25 %

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW	Upper
ACHY	Middle
PASM	Middle
HECO26	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	30 %
Height	Shrub 0.6m	Shrub 1.0m
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is greater than five percent but <25%, occasionally reaching 30%. Understory is well represented by herbaceous species as described for class A. This class is more common on drier sites. Bottlebrush squirrel tail may also be an indicator.

This class persists, although it could succeed to a closed stage with a 0.01 probability. Note: ages for this class in the model start at age 30, just so that the disturbance/alternate succession doesn't necessarily advance age. However, this class truly starts at age 70 and persists. This does not make a difference in the model output but rather just conforms to modeling rules.

Insect/disease and grazing occur with a probability of 0.001 and wind/weather stress occurs every 500yrs, but do not cause a transition.

Replacement fire occurs every 100yrs.

Outside reviewer for MZ21 commented, after models delivered, that classes B and C might be better represented if combined together into one class.

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Class D 30 %

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8	Upper
ACHY	Middle
PASM	Middle
PSSP6	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	60 %
Height	Shrub 0.6m	Shrub 1.0m
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is >25%. All primary components of the herbaceous community are present with significant component of other shrubs. This class is more common on moister sites. Squirreltail could also be an indicator.

This class will persist. Note: ages for this class in the model start at age 30, just so that the disturbance/alternate succession doesn't necessarily advance age. However, this class truly starts at age 70 and persists. This does not make a difference in the model output but rather just conforms to modeling rules.

Insect/disease and grazing occur with a probability of 0.001, but do not cause a transition. Wind/weather stress occurs every 200yrs and causes a transition to an open stage.

Replacement fire occurs every 100yrs.

Outside reviewer for MZ21 commented after model already delivered, that over 30% cover is a lot of cover for this type in this mapzone, and that 60% cover would be unheard of. And if this class D is 30-60% cover, there should be less than 10% of class D in reference conditions and not 30%.

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:** IV

Historical Fire Size (acres)

Avg
Min
Max

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	100	30	240	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 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
- [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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110810 Inter-Mountain Basins Mixed Salt Desert Scrub

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

General Information

Contributors (also see the Comments field) **Date** 1/18/2006

Modeler 1 Gary Medlyn	gary_medlyn@nv.blm.gov	**Reviewer** anonymous		
Modeler 2 Crystal Kolden	ckolden@gmail.com	**Reviewer** John Simons	john_Simons@blm.gov	
Modeler 3 Don Major	dmajor@tnc.org	**Reviewer** Reggie Clark	rmclark@fs.fed.us	

Vegetation Type
Upland Shrubland

Map Zone
21

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

Dominant Species*
ATCO
PIDE4
KRLA2
ELEL5

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This BpS is not common, if at all present, in MZ21. It may be found on the east and southeast edge of the mapzone.

Great Basin; OR, ID, UT, NV, CA and Colorado Plateau. This ecological system occupies sites west of the Wasatch Mountains, east of the Sierras, south of the Idaho batholith and north of the Mojave Desert.

Biophysical Site Description

This type occurs from lower slopes to valley bottoms ranging in elevation from 3800-6500ft. Soils are often alkaline or calcareous. Soil permeability ranges from high to low, with more impermeable soils occurring in valley bottoms. Water ponds on alkaline bottoms. Texture is variable becoming finer toward valley bottoms. Many soils are derived from alluvium. Average annual precipitation ranges from 3-10in, however, this system is in 5-8in of effective moisture within this broader range. Thus, other sites characteristics (eg, aspect, drainage and soil type) should be considered in identifying this ecotype. At the precipitation extremes, this system generally occurs as small patches and stringers. Summers are hot and dry with many days reaching 100F. 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 from November through April.

This group generally lies above playas, lakes and greasewood communities. Both to the north and up slope it is bordered by low elevation big sagebrush groups, commonly ARTRWY, ARAR8 and ARNO4 communities. To the south this group is bordered by Mojave Desert transition communities.

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Vegetation Description

In MZ21, the species present in the undertory are Indian ricegrass, needle-and-thread and bottlebrush squirreltail, globemallows. Shrubs present are shadscale saltbush, fourwing saltbush, snakeweed and winterfat.

This ecological system includes low (less than three feet) and medium-sized shrubs found widely scattered (often 20-30ft apart) to high density (3-5 plants per sq. m) shrubs interspersed with low to mid-height bunch grasses. Common shrubs are shadscale, winterfat, budsage, Nevada ephedra, horsebrush, low rabbitbrush, broom snakeweed and spiny hopsage. Shrub dominance is highly dependant on the site. Some of these shrubs will be present. Common bunch grass species are Indian ricegrass, needle-and-thread, purple three-awn and bottlebrush squirreltail, and where monsoonal influences are present you will find common rhizomatous/sod forming grasses such as galleta grass, sand dropseed and blue grama. Globe mallows are the most common and widespread forbs. The understory grasses and forbs are salt-tolerant, not particularly drought tolerant and are variably abundant. The relative abundance of species may vary in a patchwork pattern across the landscape in relation to subtle differences in soils (eg, sand sheets or other surface textural differences, biological crust coverage, etc.) and reflect variation in disturbance history. Total cover rarely exceeds 25% and annual precipitation 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 coupled with insect infestations, the system will tend more toward class A.

Disturbance Description

Disturbance was unpredictable. But flooding, drought and insects may all occur in these systems. Fire may have been rare. For the model, extended wet periods occurred every 55yrs (30-80yrs), and drought periods occurred every 55yrs (30-80yrs).

Documented Mormon cricket/grasshopper outbreaks since settlement have corresponded with drought; outbreaks cause shifts in composition amongst dominant species, but do not typically cause shifts to different seral stages. During outbreaks Mormon crickets prefer open, low plant communities. Herbaceous communities and the herbaceous component of mixed communities were more susceptible to cricket grazing. Scale insects can have significant effects on shrub component (especially in combination with drought periods) thereby resulting in possible shifts in seral states (Sharp et al. 1990).

Fire was rare and limited to more mesic sites (and moist periods) with high grass productivity. Mixed severity fire with mean FRI of 1000yrs (for the model).

Extended wet periods tended to favor perennial grass development, while extended drought tended to favor shrub development. Shrubs, however, were always dominant.

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.

Adjacency or Identification Concerns

This ecological system contains the typical Great Basin salt desert shrub communities. Salt desert shrub communities are varied and the current model and description capture the most typical. Salt desert shrub is also common in the Wyoming big sagebrush community and there is some species overlap.

A wide range of salt desert shrubs can occur in this group. Two important types that were not included in the list of BpSs are winterfat (KRLA2) and Atriplex gardneri (Gardner's or sickle saltbush) (ATGA). Winterfat

*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 severity.

forms vast, homogeneous, and low-stature communities on silty soils resembling gray golf courses. Winterfat is critical to wildlife and livestock because it is more palatable than alfalfa and typically the only forage available during the winter. Gardner's saltbush resembles shadscale (thus BpS 1081) but form extensive and distinctive communities endemic to the Great Basin.

A drier site of mixed salt desert would include fourwing saltbush, which is usually not found within the shadscale community. The same model would apply with perhaps longer recovery times.

Indian ricegrass can dominate sites with sandy surface textures, however, the temporal nature of this condition is unknown.

Upland salt desert shrub communities are easily invaded and, in the short term at least, replaced by cheatgrass. Other nonnative problematic annuals include halogeton, Russian thistle and several mustards. Through central UT and east central NV this group is susceptible to invasion by squarrose knapweed. More mesic areas can be invaded by tall whitetop and hoary cress. All three are noxious weeds in Great Basin states.

Native Uncharacteristic Conditions

If shrub cover is >20%, it is uncharacteristic due to overgrazing.

Scale Description

In MZ21, this type is found in small occurences (10s of acres).

BpS 1081 forms vast communities easily >100000ac in valley bottoms. Disturbance scale was variable during presettlement. Droughts and extended wet periods could be region wide, or more local. A series of high water years or drought could affect whole basins.

Most fires were rare and less than one acre, but may exceed hundreds of acres with a good grass crop.

Issues/Problems

Comments

This model for MZ21 is adopted from the LANDFIRE model for the same BpS 1081 from MZ10 created by Gary Medlyn, Crystal Kolden and Don Major, and reviewed by Mike Zielinski. It was adopted by Bill Baker, John Simons and Reggie Clark. Only minor changes to the description from MZ10 were made. Other reviewers for MZ21 included Klara Varga (klara@ida.net) and Tristan Fluharty (tfluharty@fs.fed.us).

For MZs 10 and 19, this model is identical to the model from MZ18 with minor modifications to the description.

For 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.

MZ18 accepted BpS 1081 from MZs 12 and 17. The model was reviewed for MZ18 by Eric Limbach. D. Major reviewed model for MZ18 with significant revisions; including: 1) removal of budsage dominated class C, 2) addition of insect DRI's (this modified overall class percentages as follows: A from 5 to 15%; B 85% and 3) modified adjacency to reflect the Wyoming big sagebrush typical for this mapzone.

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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 severity.

BpS 1081 for MZs 12 and 17 was modified from BpS 1081 for MZ16. 1) Pinyon-juniper steppe was removed as potential adjacent type in vegetation description. 2) The model was clearly defined following the dynamics of shadscale and bud sagebrush where mortality of shadscale in class B causes a transition to bud sagebrush dominant class C for a short period before abundant shadscale seed allows the return to class B. 3) In this revised model it is not possible to have an alternate succession from class A to C.

BpS 1081 for MZ16 was initially based on R2SDSH. Greasewood box was removed from R2SDSH by Jolie Pollet, Annie Brown and Stanley Kitchen to build BpS 1081 for MZ16. The model was greatly simplified at this time. Original descriptions by Bill Dragt were kept. Reviewers of R2SDSH were Stanley Kitchen (skitchen@fs.fed.us), Mike Zielinski (mike_zielinski@nv.blm.gov) and Jolie Pollet (jpollet@blm.gov).

Vegetation Classes

Class A 15%

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

ACHY	Upper
ATCO	Upper
KRLA	Lower
ELEL5	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.

This model was originally modeled with shrubs at 0-10% cover, 0-0.5m, as the upper layer lifeform (adopted from previous mapzones). However, because this is not mappable, the upper layer lifeform was changed to herbaceous 0-20% cover, 0-0.5m, as was done for MZ22.

Description

Dominated by scattered and young shrubs (shadscale). After five years, vegetation moves to class B as the primary successional pathway. Extended wet period (every 55yrs) will have a stand replacing effect, with an ecological setback of five years. Insect outbreaks (grasshoppers, scale insects, etc.) can result in partial/complete setback (DRI 20yrs).

NOTE: This model was originally modeled with shrubs at 0-10% cover, 0-0.5m, as the upper layer lifeform (adopted from previous mapzones). However, because this is not mappable, the upper layer lifeform was changed to herbaceous 0-20% cover, 0-0.5m, as per MZ22.

Class B 85%

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

KRLA	Lower
ATCO	Upper
ELEL5	Lower
PIDE4	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11%	20%
Height	Shrub 0m	Shrub 0.5m
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 severity.

Dominated by shadscale. Extended wet periods (every 55yrs on average) will cause a stand replacing transition to class A. Extended severe drought periods or insect outbreaks (DRI 40yrs, respectively) will shift to class A. Replacement fire is rare (mean FRI of 1000yrs).

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

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	1250			0.0008	98
Mixed					
Surface					
All Fires	1247			0.00082	

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.

*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 severity.

Additional Disturbances Modeled

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

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2110860 Rocky Mountain Lower Montane-Foothill Shrubland

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

General Information

Contributors (also see the Comments field) **Date** 3/17/2005

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Modeler 2	Bryan Bracken	Bryan_Bracken@blm.gov	**Reviewer**		
Modeler 3			**Reviewer**		

Vegetation Type
Upland Shrubland

Map Zone
21

Model Zone

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

Dominant Species*
SYMPH
AMELA
PRUNU
HOLOD

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range
This ecological system is found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern NM extending north into WY, and west into the Intermountain region.

Biophysical Site Description
These shrublands occur between 1500-2900m elevations and are usually associated with exposed sites, rocky substrates and dry conditions, which limit tree growth. It is common where Quercus gambelii is absent such as the northern CO Front Range and in drier foothills and prairie hills.

Vegetation Description
Scattered trees or inclusions of grassland patches or steppe may be present, but the vegetation is typically dominated by a variety of shrubs including Amelanchier utahensis, Cercocarpus montanus, Purshia tridentata, Rhus trilobata, Ribes cereum or Symphoricarpos oreophilus. In UT, true mountain mahogany (Cercocarpus montanus) is a resprouting shrub that sometimes dominates this ecological system, whereas Ribes, Acer, mountain ash (Sorbus scopulina) and Chrysothamnus are less common. Artemisia tridentata var. vaseyana and Holodiscus are more common shrubs on dry sites in UT and the Great Basin. Grasses are represented as species of Muhlenbergia, Hesperostipa and Pseudoroegneria spicata. Fire plays an important role in this system as the dominant shrubs usually have a severe die-back, although some plants will stump sprout. Cercocarpus montanus requires a disturbance such as fire to reproduce, either by seed sprout or root crown sprouting. Fire exclusion may have allowed an invasion of trees into some of these shrublands, but in many cases sites are too xeric for tree growth. When trees are present, they include pinyon pine, juniper and limber pine, white fir and lodgepole pine may be found on more mesic sites.

*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 severity.

Disturbance Description

Fire: This ecological system could be in Fire Regime Group III or IV. This is a fire-dependent system, and is strongly influenced by the fire regime of the surrounding shrublands. Dominant species are resprouters (FEIS references 2004). Average FRIs for replacement fire vary between 100-200yrs with longer intervals for older stands. The average mixed severity FRI varies between 25yrs for younger stands to 100yrs for older stands with greater tree encroachment.

Avalanche/rockslide: Sites on steep slopes experience rockslides and avalanches that favor resprouting shrubs.

Weather/stress: Severe weather event, such as frost, can cause replacement type mortality every 200yrs on average.

Adjacency or Identification Concerns

Native Uncharacteristic Conditions

Scale Description

Usually, this community occurs on a small scale, on mesic sites near or within the mountain big sagebrush zone. However, it may occur on mesic sites outside this zone.

Issues/Problems

In Great Basin (west desert of UT and NV) mountain shrublands, the potential for tree invasion by pinyon, juniper, white fir, limber pine, and, incidentally, lodgepole pine is greater than in the Rocky Mountains (MZ16 and east). This system is generally drier than Rocky Mountain Gambel Oak-Mixed Montane Shrubland (BpS 1107) in the eastern part of MZ17, but may include mesic montane shrublands where Quercus gambelii does not occur.

This type occurs in association or complex with mountain big sagebrush, although mountain shrublands are differentiated here by greater diversity.

Dwarf aspen, willows and alder may be present on moist sites. If those species are dominant, an aspen or riparian model would be more appropriate.

Comments

For MZ21, this BpS was adopted as-is by MFSL from MZ18.

BpS 1086 for MZs 12 and 17 is essentially the same as the model for MZ16, but with two modifications to class D. 1) Mixed severity thins encroaching trees and causes a transition to class C. 2) Weather-related mortality to shrubs favors conifer encroachment. BpS 1086 for MZ16 was developed by Beth Corbin (ecorbin@fs.fed.us) and Stanley Kitchen (skitchen@fs.fed.us). BpS 1086 for MZ16 was based on original PNVG model and description R2MSHBwt - Mountain Shrubland with trees developed by Michele Slaton (mslaton@fs.fed.us), Joanne Baggs (jbaggs@fs.fed.us) and Cheri Howell (chowell@fs.fed.us) for the western and eastern Great Basin. Reviewers of R2MSHBwt were Stanley Kitchen (skitchen@fs.fed.us), Crystal Golden (kolden@unr.edu) and Clinton Williams (cwilliams03@fs.fed.us).

Vegetation Classes

*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 severity.

Class A 5 %

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 6

Indicator Species* and Canopy Position

SYMPH	Upper
AMELA	Upper
PRUNU	Upper
HOLOD	Upper

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Description

Grasses and forbs are abundant, as are resprouting shrubs. Shrub seedlings are also present. Replacement fire every 100yrs and severe weather related mortality (mean return interval of 200yrs) will reset the ecological clock to zero. Succession from classes A to B after five years.

Class B 20 %

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 6

Indicator Species* and Canopy Position

SYMPH	Upper
AMELA	Upper
HOLOD	Upper
PRUNU	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	10 %	30 %
Height	Shrub 0.6m	Shrub 3.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Shrubs are dominant, and grasses and forbs may be present, especially in gaps between shrubs. Many shrubs are small and immature. Both replacement fire every 100yrs and severe weather related mortality every 200yrs will cause a transition to class A. Mixed severity fire every 25yrs will maintain vegetation in class B. Succession to C after 15yrs.

Class C 70 %

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 6

Indicator Species* and Canopy Position

SYMPH	Upper
AMELA	Upper
PRUNU	Upper
HOLOD	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31 %	60 %
Height	Shrub 0.6m	Shrub 3.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Shrubs are dominant, with little decadence. Grasses and forbs may be present. Small tree seedlings may be present. Shrubs are larger and many are reproducing. Fire and severe weather events return interval are as in class B. Class C is the succcessional endpoint. However, vegetation will transition to class D in the absence of fire for 60yrs (three FRIs).

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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 severity.

Class D 5 %

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 6

Indicator Species* and Canopy Position

JUNIP	Upper
PIFL2	Upper
ARTR2	Middle
HOLOD	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	5 %	15 %
Height	Tree 0m	Tree 25m
Tree Size Class		

☑ Upper layer lifeform differs from dominant lifeform.

Description

Dominant lifeform medium shrubs (Symphoricarpos, Amelanchier, Prunus and Holodiscus), as in class C, but being overtopped by trees. Minimum canopy 25%, maximum canopy 50%; minimum height short shrub, maximum height medium shrub.

Shrubs are dominant, with more decadence. Trees are over-topping the shrub canopy. Vegetation is considered open because trees do not form a closed canopy. FRIs are longer in this class. Replacement fire is every 200yrs on average. Mixed severity fire (mean FRI of 100yrs) thins trees and returns vegetation to class C. Severe weather every 200yrs on average thins shrubs and favors trees, thus maintaining vegetation in class D, which is the endpoint for succession without stand replacement fire.

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 10
Max 500

Sources of Fire Regime Data

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Intervals

	Avg FI	*Min FI*	*Max FI*	*Probability*	*Percent of All Fires*
Replacement	103	100	200	0.00971	21
Mixed	27	25	100	0.03704	79
Surface					
All Fires	21			0.04676	

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)

*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 severity.

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111060 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** 1/27/2006

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Modeler 3			**Reviewer**	anonymous	

Vegetation Type
Upland Shrubland

Map Zone
21

Model Zone

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

Dominant Species*
AMELA
PURSH
SYMPH
PRUNU

General Model Sources
☐ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
In MZ21, this is likely not a permanent type, but is a successional stage of a Douglas-fir type.

Minor but relatively widespread. Occurs throughout the Intermountain West and Northern Rockies.

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%). 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. This BpS will have significant variation in plant response to disturbance.

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.

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Adjacency or Identification Concerns

In MZ21, we expect that the plots found for this type are successional stages of a Douglas-fir type.

It has been suggested that this BpS be removed and merged with one of the Douglas-fir types, as Mueggler and Stewart do not have this BpS as a type, but rather a successional stage of PSME.

The fire regime of adjacent BpS will dominate the fire regime here. 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.

Native Uncharacteristic Conditions

Scale Description

Variance in scale is a result of topography and localized moisture variability.

Issues/Problems

In MZ21, we expect that the plots found for this type are successional stages of a Douglas-fir type.

It has been suggested that this BpS be removed and merged with one of the Douglas-fir types, as Mueggler and Stewart do not have this BpS as a type, but rather a successional stage of PSME.

Extreme variability in fire regime, scale and adjacency make this type difficult to model.

Comments

For MZ21, this model is adopted from the LANDFIRE model for this BpS 1106 from MZs 10 and 19 created by Mike Babler and reviewed by Don Bedunah, C.R. Kyte and an anonymous reviewer. Revisions to description were made by John Simons, Reggie Clark and an anonymous reviewer, and model was reviewed by Bill Romme on 1/30/06; name is not added to reviewers of original model below. No quantitative changes were made.

For MZs 10 and 19, additional reviewers were Susan Miller (smiller03@fs.fed.us), Lois Olsen (lolsen@fs.fed.us) and Robert Wooley (rwooley@fs.fed.us). Derived from the Rapid Assessment model R0MTSB (Mountain Shrub, non-sagebrushes). The model was taken as-is.

One reviewer for MZs 10 and 19 felt that the overall MFI should be reduced to 10-60yrs, dominated by mixed severity fire. The other reviewers agreed with the fire frequency and severity in the model, and it was unchanged.

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). Peer review resulted in the addition of some mixed severity fire in classes B and C. There were disparate opinions about the frequency of fire in this type, ranging from an average fire return interval of 60-100yrs. Adjusting the MFI either direction resulted in only slight adjustments (+/-5%) in the resulting percent in each class. The model was left at an 80yr MFI.

Vegetation Classes

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Class A **10 %**

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

AMELA	Upper
SYMPH	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub >3.1m
Tree Size Class	None	

☑ Upper layer lifeform differs from dominant lifeform.

Description

Grasses and forbs will dominate, with scattered shrubs in overstory. Grass cover may reach 100%.

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%.

Replacement fire occurs every 100yrs.

This class succeeds to B after ~10yrs.

Class B **50 %**

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

AMELA	Upper
SYMPH	Upper
LUPIN	Lower

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 succeeds to C after ~70yrs unless replacement fire occurs (causing a transition to class A), occurring every 100yrs. Mixed severity fires only occur every 400yrs and will not cause a transition to another class.

Class C **40 %**

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

AMELA	Upper
SYMPH	Upper
LUPIN	Lower

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

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 or mixed severity fire) cause a transition (to classes A and B, respectively).

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Replacement fire occurs every 100yrs, and mixed severity fires occur every 400yrs.

Note that there is a question as to whether any mixed severity fire occurs here. Fire, if it gets in this kind of vegetation is going to topkill the shrubs, not burn beneath them. There are lots of studies that document that when burned, these shrub fields topkill with little or no survival (eg, Leege publications on managing shrubfields for elk).

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

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 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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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111150 Inter-Mountain Basins Juniper Savanna

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

General Information

Contributors (also see the Comments field) **Date** 5/7/2006

Modeler 1	Kathy Roche	kroche@fs.fed.us	**Reviewer**
Modeler 2	Carolyn Meyer	meyerc@uwyo.edu	**Reviewer**
Modeler 3			**Reviewer**

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

21

Model Zone

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

Dominant Species*

JUOS
JUOC
BOGR2

General Model Sources

☑ Literature
☐ Local Data
☐ Expert Estimate

Geographic Range

This system is thought not to occur in MZ21. This widespread ecological system occupies dry foothills and sandsheets of western CO, northwestern NM, northern AZ and UT, and west into the Great Basin of NV and southern ID.

Biophysical Site Description

This ecological system is typically found at lower elevations, ranging from 1500-2300m. Occurrences are found on lower mountain slopes, hills, plateaus, basins and flats often where juniper is expanding into semi-desert grasslands and steppe.

12-14in precipitation zone and above.

Vegetation Description

The vegetation is typically open savanna, although there may be inclusions of more dense juniper woodlands. This savanna is typically dominated by Juniperus osteosperma trees with high cover of perennial bunch grasses and forbs (Koeleria macrantha, Heterostipa comata, Pseudoroegneria spicata, Poa secunda and Elymus elemoides make a bunchgrass understory.) These may vary in abundance in different classes but remain present. Sagebrush comes in, in class B and grass cover is reduced. Festuca idahoensis may be present on more mesic sites.

Disturbance Description

Uncertainty exists about the fire frequencies of this ecological system, though it is predominantly Fire Regime Group III. Fire regime was primarily determined by fire occurrence in the surrounding matrix vegetation. Fire regime primarily determined by adjacent vegetation and spread from the adjacent types into this community. Lightning-ignited fires were common but typically did not affect more than a few individual trees. Replacement fires were uncommon to rare (average FRI of 100-500yrs) and occurred primarily during

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extreme fire behavior conditions. Mixed severity fire (average FRI of 100-500yrs) was characterized as a mosaic of replacement and surface fires distributed through the patch at a fine scale (<0.1ac). Surface fires could occur in stands where understory grass (FEID) cover is high and provides adequate fuel. Surface fire were primarily responsible for producing fire scars on juniper trees (average FRI of 100yrs).

FRIs vary between this 1115 system and BpS 1049 Limber Pine-Juniper Woodland. The Inter-Mtn Basins Juniper Savanna has a different moisture regime than the Foothill Limber Pine-Juniper Woodland --the moisture tends to come at a different time of year. In the Foothill Limber Pine-Juniper Woodland that occurs on the Medicine Bow Routt National Forests we can get extensive fog at any time of the year which leads to extensive white pine blister rust in the limber pine but also would influence the moisture content of fine fuel and subsequently the fire regime. There also tend to be more shrubs in the Limber Pine-Juniper Woodland than the Inter-Mtn Basins Juniper Savanna.

Adjacency or Identification Concerns

This system is generally found at lower elevations and more xeric sites than Great Basin Pinyon-Juniper Woodland (1019) or Colorado Plateau Pinyon-Juniper Woodland (1016). It is also ecologically similar to (and the model is similar to) Colorado Plateau Pinyon-Juniper Shrubland (1102).

In modern days, surrounding matrix vegetation has changed to young mid-aged woodlands that burn more intensely than the former sagebrush matrix. Many lay-people confuse these younger pinyon and juniper woodlands with true woodlands dependent on naturally fire-protected features.

Presence of cheatgrass can increase the fire frequency and keep the system in class A.

It was discussed among MZ22 reviewers as to whether or not this BpS truly occurs historically, or if rather it is a seral component, class A or B, of BpS 1049. It is thought that this system, 1115, in late seral condition, would develop toward a denser stand. Original models feel that Juniper Savanna is indeed a system within this mapzone and that it should not be combined with the Limber Pine-Juniper Woodland. More juniper savanna would occur in the SW portion of this map zone and more limber pine juniper type in the eastern and northern portions of this map zone.

Native Uncharacteristic Conditions

Scale Description

Juniper Steppe was usually distributed across the landscape in patches that range from 10s-100s of acres in size. In areas with very broken topography and/or mesa landforms this type may have occurred in patches of several hundred acres.

Issues/Problems

We have low degree of certainty on the percentages of canopy closure for the classes. Cheatgrass invasion may result in high cover measurements.

Comments

This model for MZ21 was adopted as-is from the same BpS from MZ22 created by Kathy Roche and Carolyn Meyer and reviewed by Tim Kramer, Mark Williams, Kirk Strom and others listed below. Since this type is thought not to occur in MZ21, it received no review for MZ 21.

This model for MZ22 was adapted from the same BpS from MZ23 developed by Bob Unnasch and reviewed by Tim Christiansen. For MZ22, descriptive, species and quantitative changes were made to more closely resemble MZ22. Model was changed to a four-box model. Other reviewers for MZ22 were Eve

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Warren and Ken Stinson.

This model for MZ23 is identical to the model for the same BpS in MZ16 (Utah High Plateaus) with minor descriptive changes based on peer review for MZs 23 and 24. This is essentially the same model as the Rapid Assessment PNVG R2PIJU developed by Steve Bunting (sbunting@uidaho.edu), Krista Waid-Gollnick (krista_waid@blm.gov) and Henry Bastian (henry_bastian@ios.doi.gov) for juniper and/or pinyon savanna. Reviewers of R2PIJU were George Gruell (ggruell@charter.net), Jolie Pollet (jpollet@blm.gov) and Peter Weisberg (pweisberg@cabnr.unr.edu). It is almost identical to the model for Colorado Plateau Pinyon-Juniper Shrubland for MZ16 (161102).

Vegetation Classes

Class A 5%

Early Development 1 Open

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

PSSP6	Upper
KOMA	Upper
POSE	Upper
JUOS	Upper

Structure Data (for upper layer lifeform)

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

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

JUOS is dominant, 0-10% cover and 0-2m height.

Description

Dominated by perennial forbs and grasses. Total cover remains low due to shallow, unproductive soil. Duration 20yrs with succession to B unless infrequent replacement fire (FRI of 100yrs) returns the vegetation to A. Mixed severity fire (average FRI of 100yrs) thins the tree seedlings

Class B 15%

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

ARTRW8	Middle
ARAR8	Middle
PSSP6	Lower
JUOS	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	20 %
Height	Tree 0m	Tree 5m
Tree Size Class	Pole 5-9" DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Shrub dominated community with young juniper seedlings becoming established. Duration 70yrs with succession to C unless replacement fire (average FRI of 200yrs) causes a transition to A. . Mixed severity fire as in A.

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Class C 35 %

Mid Development 2 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 2

Indicator Species* and Canopy Position

JUOS	Upper
ARAR8	Middle
ARTRW	Middle
PSSP6	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	20 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Community dominated by young juniper and pine of mixed age structure. Juniper and pinyon becoming competitive on site and beginning to affect understory composition. Duration 300yrs with succession to D unless replacement fire (average FRI of 500yrs) causes a transition to A. Mixed severity fire is less frequent than in previous states (200yrs), whereas surface fire every 100yrs on average becomes more important at this age in succession.

Class D 45 %

Late Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 2

Indicator Species* and Canopy Position

JUOS	Upper
PSSP6	Upper
ELEL5	Lower
HECO26	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Description

Site dominated by widely spaced old juniper. Grasses (eg, Hesperostipa comata) present on microsites sites with deeper soils (>20in) with restricting clay subsurface horizon. Potential maximum overstory coverage is greater in those stands with pinyon as compared to those with only juniper. Replacement fire and mixed severity fires are rare (average FRIs of 500yrs). Surface fire every 100yrs on average will scar ancient trees. Duration 600yrs+.

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:** III

Historical Fire Size (acres)

Avg 10
Min 1
Max 100

Sources of Fire Regime Data

- ☐ Literature
- ☐ Local Data
- ☑ Expert Estimate

Additional Disturbances Modeled

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

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	350	100	1000	0.00286	18
Mixed	200	100	1000	0.005	31
Surface	120	100	200	0.00833	51
All Fires	62			0.01619	

Fire Intervals (FI):

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

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

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111240 Columbia Plateau Low Sagebrush Steppe

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

General Information

Contributors (also see the Comments field) **Date** 1/19/2006

Modeler 1	Jon Bates	jon.bates@oregonstate.edu	**Reviewer**	Klara Varga	klara@ida.net
Modeler 2	Elena Contreras (model fixes)	econtreras@tnc.org	**Reviewer**	Tristan Fluharty	tfluharty@fs.fed.us
Modeler 3			**Reviewer**	Dave Tart	dtart@fs.fed.us

Vegetation Type
Upland Savannah/Shrub Steppe

Map Zone
21

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

Dominant Species*
ARAR8 FEID
ARARL CHVI8
ACTH7
PSSP6

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range
Jackson Hole area, southern and eastern edges of zone in WY.

Biophysical Site Description
This type describes low sagebrush on shallow soils where a clay pan produces a seasonally perched water table. Occurs on lowlands, erosional fan remnants, pediments of volcanic, granitic or quartzite base material, rock pediment remnants, side slopes and summits of mountains, and foothills. Subsoils swell on wetting and crack on drying, depth to a fine-textured subsoil ranges from 5-10in, and tend to have a high percentage of course fragments (gravels, cobbles, rocks or stones). Where soils are influenced by aeolian calcareous dust additions originating from local playas or another source, black sage can occur. Low sage tends to grow where claypan layers exist in the soil profile and soils are often saturated during a portion of the year. Elevations range from 1000m at higher latitudes to 3000m in lower latitudes. Where concave areas or drainages occur, Wyoming or basin big sagebrush (at lower elevations) and mountain big sagebrush (at higher elevations) will dominate. Precipitation is 10-16in.

Vegetation Description
This type includes communities dominated by low sagebrush (Artemisia arbuscula), low gray sagebrush (Artemisia arbuscula ssp. arbuscula), and in some cases early sagebrush (Artemisia arbuscula subsp. longiloba) replaces low sagebrush. Although these types do not usually grow in combination, they do share similar fire regimes. Other shrubs growing on site may include antelope bitterbrush (Purshia tridentata) and/or Douglas rabbitbrush (Chrysothamnus viscidiflorous). Dwarf sagebrushes generally have relatively low fuel loads with low growing and cushion forbs and scattered bunch grasses such as bluebunch wheatgrass (Pseudoroegneria spicata), needlegrasses (Achnatherum spp), Sandberg bluegrass (Poa secunda), Idaho fescue (Festuca idahoensis), Prairie junegrass (Koeleria macrantha), Thurber's needlegrass

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(Achnatherum thurberanium) and Indian ricegrass (Achnatherum hymenoides). The presence of Idaho fescue does not occur in more southerly and easterly dwarf-sage sites. Forbs often include buckwheats (Eriogonum spp), fleabanes (Erigeron spp), phloxs (Phlox spp), paintbrushes (Castilleja spp), goldenweeds (Haplopapus spp), hawksbeard (Crepis spp) and lupines (Lupinus spp).

Disturbance Description

For MZs 10 and 19, modelers stated that low sagebrush generally supports less fire than black sagebrush. This type generally burns more frequently with mixed severity (average FRI of 75-125yrs) because of the dominance of fine fuel on the site. (Mixed severity fire was questioned in this system and was later removed from MZ21). Less bare ground than black sagebrush sites, allowing for more frequent mixed fire and less stand-replacing. Stand-replacing fires (average FRI of 230-250yrs) can occur in this type when successive years of above average precipitation are followed by a dry winter, dry spring and high winds are present with dry lightning (Miller and Rose 1999). Stand-driven replacing fires are primarily wind-driven and only cover small areas. This type fits best into Fire Group III. (Note that mixed severity fire was removed from this model for MZ21 due to a new understanding of the definition of severity types. Therefore, FRG III is no longer applicable and interval is FRG V.)
Past fire regimes in low sagebrush are not well quantified (Bates, pers comm). Most low sagebrush burns with high winds that can drive fire through areas without much fuel continuity. The impacts are patchy to extensive replacement fires (Bates, pers comm).)

Generally burned very infrequently (325-450yr rotation) as replacement fire (MZ21 original modelers). This return interval and description differs from that within MZs 10 and 19.

Another reviewer for MZ21 stated that the MFI methodology used above is in question.

Kitchen (personal correspondence) states that black or low sagebrush shrubland burns at approximately 100-200+ intervals.

No mixed severity fire in this mapzone for this BpS type (MZ21 modelers/reviewers).

Fire intervals (less fire) for MZ21 were originally decreased approximately 4x (from 90yrs to 400yrs). There were differences of opinion between the original modelers and the reviewers. 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. The original MZ21 model was therefore altered to reflect majority opinion/interpretation of literature regarding the fire regime of this sagebrush system and that used in MZs 10,19 and 18 and model 2311262. A FRI of 250yrs replacement fire was used. Mixed fire was removed from the model adapted from MZs 10,19 and 18 due to a new understanding of severity types. This interval also agreed with Kitchen's intervals of black/low sage.

Grazing by wild ungulates occurs in this type due to its high palatability (mostly for A. nova and A. arbuscula) compared to other browse. Native browsing tends to open up the canopy cover of shrubs but does not often change the successional stage. However, this was not modeled.

Adjacency or Identification Concerns

The low sagebrush type tends to occur over broad areas, with pockets of black sagebrush where there is a calcareous substrate, and Wyoming or mountain big sagebrush (in northern latitudes) in drainages or small concave pockets of deeper soils. In NV, where low sagebrush occurs at higher elevations, in rocky, open stands, pockets of curlleaf mountain mahogany with an understory of mountain sagebrush occur along the

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drainages.

Cheatgrass (Bromus tectorum) is likely to invade this site after disturbance, although not at higher elevations.

Medusahead invasion into low sagebrush is cited as a potential problem (eg, Jordan Valley in OR and Owyhee uplands) after fire.

Current and future fire regimes will be very different because of weed introductions. There has been extensive replacement of low sagebrush by annual grass after fire in parts of eastern OR.

Native Uncharacteristic Conditions

If shrub cover is >30% or greater than 0.5m, it is uncharacteristic.

Scale Description

Low sagebrush communities can occur in small to 10000ac areas on mountains ranges. Disturbance patch size for this type is not well known but is estimated to be 10s-100s of acres due to the relatively small proportion of the sagebrush matrix it occupies and the limited potential for fire spread. In MZ21, these are relatively small occurrences of 10s-100s of acres.

Issues/Problems

Comments

This model for MZ21 was modified from the LANDFIRE model for this BpS 1124 for MZs 10 and 19 created by Jon Bates. Adjustments were made for MZ21 to adjust scale and fire frequency and fire type as well as descriptive changes. Changes to original model and description changed by original MZ21 modelers: Reggie Clark (rmclark@fs.fed.us), John Simons (john_simons@blm.gov) and an anonymous contributor. Reviewers for MZ21 were Klara Varga, Tristan Fluharty, Dave Tart and Steve Kilpatrick. Fire intervals (less fire) for MZ21 were originally increased approximately 4x. There were differences of opinion between the original modelers and the reviewers. 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. The original MZ21 model was therefore altered to reflect majority opinion/interpretation of literature regarding the fire regime of this sagebrush system and that used in MZs 10,19 and 18, and model 2311262. However, mixed severity fire was removed from the model from MZs 10,19 and 18, based on new understanding of severity definitions. RL implemented model changes based on guidance.

For MZs 10, and 19 Jon Bates (jon.bates@oregonstate.edu) adopted the model from MZ18. For MZs 10 and 19, D Major made changes to vegetation class structural values in response to MTD v3.1 updates (K Pohl 7/18/05 request).

Jon Bates (jon.bates@oregonstate.edu) accepted BpS 1124 from MZs 12 and 17 (developed by Crystal Golden, ckolden@gmail.com, and Gary Medlyn, gmedlyn@nv.blm.gov) with very few changes made to the description.
Reviewers of BpS 1124 for MZs 12 and 17 were Mike Zielenski (mike_zielinski@nv.blm.gov) and Terri Barton (terri_barton@nv.blm.gov), whose revisions changed appreciably the model and description.

BpS 1124 for MZs 12 and 17 was based on R2SBDW developed by Gary Medlyn (gmedlyn@nv.blm.gov) and Sarah Heidi (sarah_heidi@blm.gov). Reviewers of R2SDDW were Mike Zielinski (mike_zielinski@nv.blm.gov), Gary Back (gback@srk.com) and Paul Tueller (ptt@intercomm.com).

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Vegetation Classes

Class A 10%

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

PSSP6	Middle
CHVI8	Upper
FEID	Middle
POSA	Middle

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.

Dominant life form is herbaceous (15-25% cover), however rabbitbrush will be the upper layer life form at less than six percent cover.

Description

Early seral community dominated by herbaceous vegetation, with lots of bare ground; less than six percent sagebrush canopy cover; up to 24yrs post-disturbance. Succession to B after 24yrs.

As per new guidance from MFSL, the lifeform and canopy closure indicated is that of the dominant lifeform, not the upper lifeform. The upper layer lifeform is rabbitbrush at less than fivemeters with approximately six percent cover.

Replacement fire occurs every 250yrs.

Class B 30%

Late Development 1 Open

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

ARAR8	Upper
CHVI8	Middle
PSSP6	Middle
	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11%	20%
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

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

Dominant life form is herbaceous with cover 15-25%. Height 0.2-0.4m.

Description

Mid-seral community with a mixture of herbaceous and shrub vegetation; 6-15% sagebrush canopy cover present; between 20-59yrs post-disturbance. In the absence of fire for 120yrs, the site will follow a successional path to C.

Replacement fire occurs every 250yrs.

Class C 60%

Late Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

ARAR8	Upper
FEID	Middle
ARARL	Upper
PSSP6	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21%	30%
Height	Shrub 0m	Shrub 0.5m
Tree Size Class	None	

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

Herbaceous component is co-subdominant with shrub cover. Canopy cover 16-30%. Height 0.2-

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0.4m.

Description

Late seral community with a mixture of herbaceous and shrub vegetation; >15% sagebrush canopy cover present. Succession will keep the site in class C without fire.

Replacement fire occurs every 250yrs.

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:** **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	250	100	450	0.004	100
Mixed					
Surface					
All Fires	250			0.00402	

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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Miller, R.F. and J.A. Rose. 1999. Fire history and western juniper encroachment in sagebrush steppe. Journal of Range Management 52: 550-559.

Miller, R.F., T.J. Svejcar and J.A. Rose. 2000. Impacts of western juniper on plant community composition and structure. Journal of Range Management 53: 547-585.

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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111260 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** 1/19/2006

Modeler 1	Dave Tart	dtart@fs.fed.us	**Reviewer**	Steve Kilpatrick	steve.kilpatrick@wgf.state.wy.us
Modeler 2	Stan Kitchen	skitchen@fs.fed.us	**Reviewer**	Klara Varga	klara@ida.net
Modeler 3			**Reviewer**		

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

21

Model Zone

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

Dominant Species*

ARTRV SYMPH
PSSP6 BASA
FEID
POSE

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Scattered throughout the zone.

Biophysical Site Description

In MZ21, this type ranges from 6000ft and can occur up to 9900ft (Bridger-Teton National Forest) in the southern portion of the zone. In southwest MT, it could occur up to 9600ft (Lesica et al. 2005). The elevation range over multiple mapzones might be 4000-9900ft. It has been suggested, however, by a reviewer for MZ21, that this BpS 1126 perhaps end at approximately 9500ft so as to indicate that the grassland systems, with a few shrubs interspersed, might start above that elevation.

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

This vegetation type is found on all aspects, although it rarely occurs on northerly slopes. 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. Precipitation ranges from 12-20in/year. Soils are deep, well drained. Soil moistures are udic (not dry for as long as 90 cumulative days) and soil temperatures cryic (very cold soils of the Rocky Mountain Region).

In the high valleys of southwestern MT, sagebrush was probably the historical dominant on sites having either coarse or clayey soils (Morris et al. 1976 in Arno and Gruell 1983). Grasses are poorly adapted to these soils, which have droughty surface conditions, whereas deep-rooting big sagebrush is well-adapted (Arno and Gruell 1983). On the widely distributed loamy soils, prior to 1900, sagebrush might have been restricted to small patches or widely spaced plants. The fine-textured soils have good potential to support

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dense stands of grass (Arno and Gruell 1983).

Vegetation Description

Mountain sagebrush steppe dominated by mountain big sagebrush, with a frequent presence of mountain snowberry, with a continuous grass and forb understory is believed to be a major presettlement vegetation type for 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), antelope bitterbrush (Purshia tridentata, in MZ10) and mountain snowberry (Symphoricarpos spp.). Other common shrubs include serviceberry (Amelanchier alnifolia), wild cherry (PRVI), rose, currant and rabbitbrush (CHRYS9). Other shrubs may be locally common.

Herbaceous cover is moderate to abundant ranging from 40-85%. Common grasses include: Festuca idahoensis, Agropyron spicata, Elymus elymoides, Elymus trachycaulus, Hesperostipa comata, Koeleria cristata and Poa secunda. Common forbs include Eriogonum umbellatum, Antennaria microphyla, Balsamorhiza sagittata, Lupinus spp, Delphinium spp, Castilleja spp, Geranium viscosissimum and Astragalus purshii.

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 (FRI) 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 FRI 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.

20-50 YEAR INTERVAL
Tart (personal correspondence) states that the studies most relevant to MZ21 are Houston (1973) and Arno and Gruell (1983). Neither reported the composite fire interval (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 a (mean fire interval) MFI 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 MFI 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-

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fir/shrub/grass ecotone, based on tree fire scars adjacent to shrubland. They both report MFI values for either single trees or small areas (Tart personal correspondence).

However, an anonymous contributor (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 7 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 and for unburned area.

An anonymous contributor (personal correspondence) also states that Arno and Gruell also used an extreme form of targeting and a very insufficient sample size (n = 1) at 8 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 (an anonymous contributor, personal correspondence; Baker in press), and neither used cross-dated scars.

An anonymous contributor 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 cross-dated 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.

35-40 YEAR 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 MFIs 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 the years 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 MFI 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 MFI for large fires for the period 1650 to 1890, the results are: Miller and Rose (1999) between 27-34yrs MFI; Houston (1973) between 30-40yrs MFI. Using the more restrictive definitions of large fire for the period 1700-1890 gave an MFI of 32yrs for both study areas.

50 YEAR INTERVAL
According to Miller and Rose (1999) and Wright and Bailey (1982), there is a 50yr MFI. However, those

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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 MFI for mountain big sagebrush steppe is between 40-80yrs (Kitchen, personal correspondence).

50+ YEAR INTERVAL
Welch and Criddle (2003) report greater than 50yr interval. They also report the following "10 biological and ecological characteristics of mountain big sagebrush do not support the idea that mountain big sagebrush evolved in an environment of frequent fires of 20-30yrs: (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; (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."

70-200 YEAR 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 (personal correspondence) suggested a 70-200 year MFI interval. Recent data from long term vegetation transects collected over a twenty year 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 FRI 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.

CORRECTION FACTORS – 60 VS 240yrs
An anonymous contributor (personal correspondence) advocates use of correction factors for most of the

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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 ha for a total of 865 ha, but each fire has unburned area. Using the 21% correction for sagebrush fires gives an estimated total of 683 ha burned in a study area of 1030 ha (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 1030 ha (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 1340 ha 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 515 ha 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 1800's 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 mapzone was occupied by a mosaic of grassland and varying densities of big sagebrush. The FRI of sagebrush PNV 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 PNV of mountain big sagebrush or sites invaded by sagebrush. The anonymous contributor 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.

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

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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 FRI when compositing, there is also an opposing risk of estimating a longer than real FRI 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 MFI 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 (early 0-13; mid 14-40; late 41--):
30-year interval: 35/45/20
50-year interval: 25/45/30
80-year interval: 15/45/40
100-year interval: 10/45/45

When the longer fire interval parameters were used in VDDT, the proportion of the landscape in the earlier classes declined. Tart and other experts felt that those percentages of the landscape successional classes were not indicative of what would have been found historically. Succession class A needed to incorporate

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grass/forbs, and it should have been more prevalent on the landscape. Whereas the anonymous contributor 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 26 FRI, and MZ22 used a 80 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.

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. Shallow clay soil inclusions also support Artemisia arbuscula.

In MZ21, there is most commonly Douglas-fir and sometimes lodgepole pine encroachment. Douglas-fir 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. These grassland systems might today have mountain big sage, and in 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.

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. Sagebrush might be invading grasslands due to fire exclusion, overgrazing by livestock and/or climate change.

Fire exclusion is a major effect of livestock grazing 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).

Furthermore, in MZ21, there are non-native species such as Phleum pratense, Cynoglossum officinale and many others.

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Currently, there's probably more in class C - denser cover. This would be similar to MZs 10 and 19 succession classes and departure.

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 very large (possibly hundreds of thousands of acres).

In MZ21, occurences are on the scale of 10s-100s of acres, as opposed to other mapzones, where landscape-scale assessments could be in the order of 10000ac for mountain sagebrush steppe communities because of the mosaic nature of vegetation communities, the moderate to long fire mean return intervals and the extent of the vegetation community.

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). There is much controversy surrounding FRIs within this system and how to define this system adjacent to grassland systems.

Comments

This model for MZ21 is based on the LANDFIRE (LF) 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 Bill Baker (bakerwl@uwyo.edu), Tim Klukas (tim_klukas@nps.gov), Reggie Clark (rmclark@fs.fed.us) and John Simons (john_simons@blm.gov). 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, LF 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 (RA) model R0SBMT (Mountain Sagebrush) 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).

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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 (RA) 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, suggesting MFIs ranging from 25-135yrs. The model was originally developed with an MFI of 50yrs; based on peer review it was increased to 70yrs during the RA. See RA models for resulting changes.

Vegetation Classes

Class A 25%

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model 1

Description

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.

As per new instruction from MFSL, dominant lifeform is indicated in drop-down boxes, not upper layer. Grasses and forbs are the dominant lifeform in this class. They have a cover between 0-30% with a height of between 0-0.5m. Shrubs are the upper-layer lifeform and have <10% cover, as this class is dominated by grasses and recovering early shrubs.

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

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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.

Class B **45%**

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 6

Indicator Species* and Canopy Position

ARTRV	Upper
FEID	Lower
PSSP6	Lower
ARTR4	Upper

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).

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.

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.

Purshia tridentata may be present.

Class C **30%**

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 2

Indicator Species* and Canopy Position

ARTRV	Upper
PSSP6	Lower
FEID	Lower
ARTR4	Upper

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.

Description

Sagebrush cover is from 26-45%. Sagebrush cover rarely exceeds 40% cover, and >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-

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100yrs. If no disturbance occurs, this condition can persist.

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

Purshia tridentata may be present.

Replacement fire occurs every approximately 50yrs.

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

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	30	200	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)

References

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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111270 Inter-Mountain Basins Semi-Desert Shrub-Steppe

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

General Information

Contributors (also see the Comments field) **Date** 1/18/2006

Modeler 1 Reggie Clark	rmclark@fs.fed.us	**Reviewer**
Modeler 2 John Simons	john_simons@blm.gov	**Reviewer**
Modeler 3 anonymous		**Reviewer**

Vegetation Type
Upland Savannah/Shrub Steppe

Map Zone
21

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

Dominant Species*
GRSP
TETRA3
ARTR2
ATCO

General Model Sources
☐ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
This ecological system occurs throughout the intermountain western US. In MZ21, it is uncommon to rare, maybe found in the southeastern corner of the zone.

Biophysical Site Description
Found at elevations ranging from 4000-5000ft. The climate where this system occurs is generally hot in summers and cold in winters with low annual precipitation, ranging from 5-10in and high inter-annual variation. Much of the precipitation falls as snow, and growing-season drought is characteristic. Temperatures are continental with large annual and diurnal variation. Sites are generally alluvial fans and flats with moderate to deep soils. Substrates are generally calcareous derived from alluvium, medium to coarse-textured alluvial soils. Soils may be alkaline and typically moderately saline (West 1983).

This group generally lies above salt desert shrub and below sagebrush types. Both to the north and upslope it is bordered by low elevation big sagebrush groups, commonly ARTRWY, ARAR8 and ARNO4 communities. To the south this group is bordered by Mojave Desert transition communities.

Vegetation Description
The plant associations in this system are characterized by a somewhat sparse to moderately dense (10-70% cover) shrub layer of Grayia spinosa, Artemisia tridentata, Ephedra nevadensis, Ephedra viridis, Chrysothamnus viscidiflorus, Sarcobatus vermiculatus or Atriplex canescens. Shrub Tetradymia canescens may be occasionally present. The herbaceous layer is dominated by bunch grasses which occupy patches in the shrub matrix. The most widespread species are Heterostipa comata and Achnatherum hyminoides. Other locally dominant or important species include Leymus cinereus, Pascopyrum smithii, Pleuraphis jamesii, Elymus lanceolatus, Elymus elymoides, Koeleria macrantha, Hesperostipa comata and Poa secunda. Forbs

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are generally of low importance and are highly variable across the range, but may be diverse in some occurrences. Species that often occur are Astragalus, Oenothera, Eriogonum and Balsamorhiza. Mosses and lichens may be important ground cover.

Disturbance Description

Disturbance is unpredictable in these systems. However, drought, insects and fire may all occur here. Drought periods occurred approximately every 150yrs.

Documented Mormon cricket/grasshopper outbreaks since settlement have corresponded 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. Herbaceous communities and the herbaceous component of mixed communities were more susceptible to cricket grazing.

Fire was infrequent and somewhat dependent on fire importation from the upper sagebrush zone. Replacement fire was the primary fire with mean FRI (200-300yrs) increasing with shrub development intermixed with grass (reference?).

Adjacency or Identification Concerns

This BpS is transitional between salt desert shrub (1081) and Inter-Mountain Basins Big Sagebrush Shrublands (1080) and is truly considered a higher elevation type of salt desert shrublands. Intermingling of both ecological systems on different lifeforms and aspects on alluvial fans creates this BpS.

This ecological system 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. A wide range of salt desert shrubs can occur in this group.

Indian ricegrass can dominate sites with sand sheets, or surfaces, however, the temporal nature of this condition is unknown.

Upland shrub communities are easily invaded and, in the short term at least, replaced by cheatgrass. Other nonnative problematic annuals include halogeton, Russian thistle, and several mustards. Through central UT and east central NV this group is susceptible to invasion by squarrose knapweed. More mesic areas can be invaded by tall whitetop and hoary cress. All three are noxious weeds in Great Basin states.

Native Uncharacteristic Conditions

Scale Description

Grayia spinosa communities occupy a narrow elevation band that can be extensive in many valleys (>10000ac). Disturbance scale was variable during presettlement. Droughts and extended wet periods could be region wide, or more local. A series of high water years or drought could affect whole basins.

Most fires were rare and less than one acre, but may have exceeded hundreds of acres with a good grass crop.

Issues/Problems

Comments

This model for MZ21 was adopted from the LANDFIRE model for the same BpS 1127 for MZ10 created by Don Major (dmajor@tnc.org) and Louis Provencher (lprovencher@tnc.org) and reviewed by Mike Zielinski

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and Terri Barton. Changes in descriptions and the model were made, such as drought periods. Changes in cover were also made. There were no further reviewers for the MZ21 model iteration.

For MZs 10 and 19, this model is identical to the model from MZ18 with minor modifications to the description.

Originally, BpS 1127 for MZs 12 and 17 was based on the model results for BpS 1081 (salt desert shrub) developed by Gary Medlyn (gmedlyn@nv.blm.gov) and Don Major (dmajor@tnc.org) because 1127 and 1081 are both salt desert shrub systems. Reviewers recommended significant changes to the description and model to adapt this model to the spiny hopsage ecological site description. Spiny hopsage, a salt desert species, does not respond to drought and extended wet periods as does shadscale (BpS 1081). Moreover, spiny hopsage communities support a higher cover of Indian ricegrass than shadscale (little grass cover) and contain Wyoming and basin big sagebrushes. Therefore, class C was removed from the model, MFRIs shortened, and the explicit effect of wet extended periods removed from the model. Descriptions for 1127 are from NatureServe and modified according to the NRCS ecological site descriptions for spiny hopsage. Annie Brown (annie_brown@blm.gov), Jolie Pollet (jpollet@blm.gov) and Stanley Kitchen (skitchen@fs.fed.us) developed 1081 for MZ16, which was based on PNVG R2SDSH from the Great Basin Rapid Assessment. Greasewood box was removed from R2SDSH by Jolie Pollet, Annie Brown and Stanley Kitchen to build this model. Model was greatly simplified at that time. Original descriptions by Bill Dragt were kept. Reviewers of R2SDSH were Stanley Kitchen (skitchen@fs.fed.us), Mike Zielinski (mike_zielinski@nv.blm.gov) and Jolie Pollet (jpollet@blm.gov).

Vegetation Classes

Class A 20%

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

ACHY	Mid-Upper
HECO26	Upper
GRSP	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	70%
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

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

Shrub cover within the first 20yrs, might be between 10-20%, max. But instead of putting that in the structural data boxes, grass cover is captured within the boxes.

Description

Dominated by continuous Indian ricegrass with widely scattered shrubs and relatively younger shrubs than in Class B . Shrub cover within the first 20yrs, might be between 10-20%, max. But instead of putting that in the structural data boxes, grass cover is captured within the boxes. Over 20yrs, vegetation moves to Class B.

Replacement fire occurs every 300yrs on average, and will set back succession to year zero. Climate (every 150yrs) will also have a stand replacing effect.

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Class B 80%

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 2

Indicator Species* and Canopy Position

GRSP	Upper
ARTR2	Upper
ACHY	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	70 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Discontinuous grass patches, and higher shrub canopy cover than in class A. Spiny hopsage dominates. Climate (every 150yrs) will shift vegetation back to class A. Replacement fire is infrequent (mean FRI of 200yrs).

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

Disturbances

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Fire Regime Group:** V

Historical Fire Size (acres)

Avg 10
Min 1
Max 1000

Sources of Fire Regime Data

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

Additional Disturbances Modeled

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

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	215	100	500	0.00465	100
Mixed					
Surface					
All Fires	215			0.00467	

Fire Intervals (FI):

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111390 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** 4/28/2006

Modeler 1	Dave Tart	dtart@fs.fed.us	**Reviewer**	Bill Romme	romme@warnercnr.colostate.edu
Modeler 2			**Reviewer**	Jim Ozenberger	jozenberger@fs.fed.us
Modeler 3			**Reviewer**	Andy Norman	anorman@fs.fed.us

Vegetation Type
Upland Grassland/Herbaceous

Map Zone
21

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	ELTR7
FEID	ACLE9
ERIOG	PHLOX
ACNE9	GEVI2

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Northern Rockies throughout MT, northern ID, northeastern WA (Okanogan Highlands), eastern ID and northwestern WY. May occupy river valleys, including the Salmon, Snake and Clearwater Rivers, and the Upper Madison River, Upper Yellowstone River, Upper Salt River, Upper Snake River, Upper Green River, Upper Wind River, Shoshone River and Centennial Valley. Drier portions of this type will resemble bluebunch wheatgrass communities in Columbia Basin.

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 4000-7000ft.

There is discrepancy as to how to distinguish BpS 1126 mountain big sagebrush and this BpS in terms of biophysical gradients. It has been suggested that they be distinguished by elevation, soil and precipitation. Other Forest Service (Tart, personal correspondence) data lists the elevation of this BpS (FEID) at up to over 9000ft. It is thought that this BpS might start at the higher elevation, whereas the mountain big sage would be at the lower elevation (Tart, personal correspondence).

Mueggler and Stewart state that the FEID/AGSP habitat type is found at elevations ranging from 4500-7500ft and tends to occur more on northerly exposures at the lower elevations and on southerly exposures at the higher elevations. The ARTR/FEID occurs from 6000-8000ft. The FEID grasslands on the Pinedale RD more closely resemble FEID/CAFI and FEID/AGCA types which range from 6500-9200ft.

In the high valleys of southwestern MT, sagebrush was probably the historical dominant on sites having

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either coarse or clayey soils (Morris et al. 1976 in Arno and Gruell 1983). Grasses are poorly adapted to these soils, which have droughty surface conditions, whereas deep-rooting big sagebrush is well-adapted (Arno and Gruell 1983).

Vegetation Description

This type is dominated by bluebunch wheatgrass with Idaho fescue as dominant associate. Rough fescue is only in the Centennial Valley in MZ21. Bluebunch wheatgrass is more prevalent in drier areas. Mueggler and Stewart (1980) have described these types as: FEID/AGSP and FESC/AGSP. The FEID grasslands on the Pinedale RD in MZ21 more closely resemble FEID/CAFI and FEID/AGCA. Additional species include needle and thread, Sandberg bluegrass, arrowleaf balsamroot and western needlegrass and a variety of mesic forbs (eg, showy cinquefoil, sticky geranium, phlox, lupine and yarrow). In MZ21, there is also Achnatherum nelsonii, Achnatherum letermanii, Elymus trachycaulus, Trisetum spicata, Elymus lanceolatus, Koeleria macrantha, Eriogonum spp, Antennaria spp, Poa secunda and Poa pratensis.

Disturbance Description

For MZ21, fire rotation was roughly estimated at 66yrs, ranging from 50-80yrs. This was estimated by taking an estimate composite frequency of 33yrs and multiplying it by 2 to arrive at 66yrs (Baker in press).

Another reviewer for MZ21 stated that the MFI methodology used above is in question.

Where these systems occur within forested ecosystems, fire frequency will be strongly influenced by the surrounding forest's fire regime (eg, 10-20yrs). Where these systems occur below lower treeline, fire frequencies may be longer (eg, 20-30yrs).

It is debatable as to whether fire is needed at moderately high frequencies to keep sagebrush out of these grassland systems, or whether sagebrush is invading in current times due to overgrazing and/or climate change.

Baker (personal correspondence) states that Sindelar (1981) in western MT did not think that grasslands invaded by ARTRV were primarily fire maintained and instead implicated livestock grazing removal of competition from grasses in ARTRV invasion. Mountain big sagebrush has colonized some mountain grasslands in present day, but not all.

For those areas with mountain big sage that might be maintained as grassland along ponderosa pine or Douglas-fir ecotones, FRI (questionable as to whether 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).

Baker (in press) states that nearby CFI estimates need to be corrected for adjacency and for unburned area. Grasslands are about 2 to 2 1/2 times less likely than forests to ignite and the fire density (#fires per unit area) is about 4 times lower in grasslands than in forests. Correcting Houston (1973) estimate of 20-25yrs, Arno and Gruel (1983) of 35-40yrs and Arno and Gruel (1986) estimate of 25yrs using a 2.0 adjacency correction and assuming a mean unburned area similar to that in sagebrush (21%), the estimated fire rotations would be 51-63yrs, 89-101yrs, and 63yrs, respectively. Thus, about 50-100yrs from these estimates.

After an extensive model review process, LF 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 for MZ21. An interval of 30yrs was chosen for MZ21, based on expert opinion as well as based on intervals of adjoining systems; the interval for BpS 1139 is thus lower than that for 1126 and 1145. This new interval of 30yrs was consistent with the 17yrs FRI for MZs 10 and

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19, and 40yrs FRI used by MZ18.

Adjacency or Identification Concerns

Since this is a broad type, the dry bluebunch wheatgrass-needle and thread variant will probably have more bareground and a slightly higher MFI. Response to fire may differ slightly also.

Non-native species present today can include spotted knapweed, leafy spurge, smooth brome and cheatgrass. Historical livestock grazing may lower fuel loads and lengthen MFI, allowing sagebrush and conifers to invade.

This type is now limited on the Bridger-Teton, as most sites like this have been converted to non-native grasses like Phleum pratense or Bromus.

Poa pratensis is a debatable native/non-native most likely found in this BpS.

Some grassland systems are invaded by sagebrush today in larger quantities. These grassland systems might today have mountain big sage, 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 sage systems. It might be difficult to distinguish this type from the first successional stage/seral stage of BpS 1126 mountain big sage. Elevational range should be considered when trying to distinguish this grassland from 1126.

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

Sindelar (1981) in western MT did not think that grasslands invaded by ARTRV were primarily fire maintained and instead implicated livestock grazing removal of competition from grasses in ARTRV invasion. Mountain big sagebrush has colonized some mountain grasslands in present day, but not all.

Native Uncharacteristic Conditions

Shrub or tree cover over 10% is uncharacteristic.

Scale Description

This type can occupy broad expanses and also narrow bands below the lower montane forest. It may occur as small patches within forested ecosystems as a topoedaphic climax. In large valleys, fires may have been expansive historically, up to thousands of acres.

Issues/Problems

This is a highly variable type, which includes most of Mueggler and Stewart's habitat types. The literature in FEIS suggests a MFI of between 10-30yrs for this type. The Lewis and Clark range type classification needs to be incorporated into this model also.

This type is now limited on the Bridger-Teton, as most sites like this have been converted to non-native grasses like Phleum pratense or Bromus.

Poa pratensis is a debatable native/non-native most likely found in this BpS.

Comments

This model is based on the LANDFIRE model for the same BpS 1139 for MZs 10 and 19 created by Katie Phillips (cgphillips@fs.fed.us), Randall Walker (rmwalker@fs.fed.us) and Larry Kaiser

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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 severity.

(larry_kaiser@blm.gov) and reviewed by Lois Olsen (lolsen@fs.fed.us). Original model and descriptions were changed for MZ21. Original modelers for MZ21 were Bill Baker, Reggie Clark, Clayton Marlow, Tim Klukas and John Simons. Additional reviewers for MZ21 were Sarah Canham, Brenda Fiddick, Rod Dykehouse and Dave Tart. After an extensive model review process, LF 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 for MZ21. The MZ21 model was altered to reflect majority opinion/interpretation of literature regarding the fire regime of this system, as well as to be in line and consistent with those adjacent systems within this mapzone.

MZs 10 and 19 models were 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 5%

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

PSSP6	Upper
KOMA	Upper
POSA	Upper
Forbs	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 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 prairie junegrass. In the absence of fire or heavy animal impact, this condition succeeds to a mid-development condition (class B). Age ranges from 0-2yrs. Idaho fescue may be present, but will recover more slowly than the bluebunch wheatgrass after fire.

Canopy cover can be variable.

Replacement fire occurs between 30-35yrs.

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.

Class B 65%

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

PSSP6	Upper
FEID	Upper
POSA	Upper
STCO	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

*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 severity.

Mid-development with moderate canopy closure dominated by bunchgrasses with forb cover generally higher than pre-burn. This class lasts up to 35yrs.

Replacement fire occurs every 30-35yrs.

Class C **30 %**

Late Development 1 Closed

Upper Layer Lifeform

☑ Herbaceous
☐ Shrub
☐ Tree

Fuel Model 1

Indicator Species* and Canopy Position

PSSP6	Upper
FEID	Upper
POSA	Upper
STCO	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

Late-development, closed canopy of grasses and forbs. Bunchgrasses dominate with low densities of shrubs (<10%) in some areas, particularly where this BpS transitions to shrub or tree-dominated communities. Shrub species may include Artemisia tridentada, Ceanothus, bitterbrush and Symphorocarpus. Some Douglas-fir and Rocky Mt. juniper could be present after 50yrs without fire, but <10%. Other forbs include Eriogonum (buckwheats).

Replacement fire occurs every 30-35yrs.

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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*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 severity.

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

Additional Disturbances Modeled

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

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	30	20	80	0.03333	100
Mixed					
Surface					
All Fires	30			0.03335	

Fire Intervals (FI):

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

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*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 severity.

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111400 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** 1/18/2006

Modeler 1	Reggie Clark	rmclark@fs.fed.us	**Reviewer**	Bill Romme	romme@warnercnr.colostate.edu
Modeler 2	Clayton Marlow	cmarlow@montana.edu	**Reviewer**	Jim Ozenberger	jozenberger@fs.fed.us
Modeler 3	John Simons	john_simons@blm.gov	**Reviewer**	Andy Norman	anorman@fs.fed.us

Vegetation Type
Upland Grassland/Herbaceous

Map Zone
21

Model Zone

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

Dominant Species*
Forbs BROMU
FEID DANTH
ASTER
ERIOG

General Model Sources
☐ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range
Southern MT, northwestern WY and eastern ID.

Biophysical Site Description
This is a high-elevation (>6000ft), dry grass-forb system dominated by perennial grasses and forbs, on dry sites particularly south-facing slopes. 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. Larger sites are often wind-swept, resulting in lack of snowpack and summer drought, but smaller ones can have deeper snowpack and more forbs.

This is also more of a mid-to-high elevation, rather than high elevation type. Coarse soils should also be included. The mesic meadow BpS will encompass finer soils.

Vegetation Description
Typical dominant species include Festuca idahoensis, Aster spp, Eriogonum spp, Lupinus spp, Carex spp, Phleum alpinum, Bromus marginatus, Danthonia spp, Geranium spp, Potentilla spp, Pseudoroegneria spicata, Balsamorhiza sagittata, Helianthella uniflora, Hesperochloe kineii, Antennaria spp, Poa secunda, Elymus trachycaulus, Elymus lanceolatus, Agastache urticifolia, Wyethia amplexicaulis, Pedicularis spp and Melica spectabilis.

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

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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 severity.

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.

Disturbance Description

Fire regimes are probably similar to adjacent forested vegetation, and will generally be long interval, stand replacement regimes (Fire Regime Group IV), modeled at approximately every 200yrs. Fires may finger into this system from adjacent forests. Conifer encroachment is not common due to the disturbance by pocket gophers and competition with grasses.

It is debatable as to whether fire is needed at moderately high frequencies to keep sagebrush out of these grassland systems, or whether sagebrush is invading in current times due to overgrazing and/or climate change.

Adjacency or Identification Concerns

Historical sheep grazing may have occurred in these systems. The cumulative effects are unknown.

Some grassland systems are invaded by sagebrush today in larger quantities. Pre-European settlement they would have been grassland systems, whereas today they might be confused for some big sagebrush systems.

Native Uncharacteristic Conditions

Scale Description

Patches are typically tens to hundreds of acres.

Issues/Problems

Comments

This model was based on the LANDFIRE model for BpS 1140 in MZs 10 and 19 created by Katie Phillips (cgphillips@fs.fed.us), Randall Walker (rmwalker@fs.fed.us) and Larry Kaiser (larry_kaiser@blm.gov). Original model and description changed completely - FRI's changed. For MZ21, additional modelers include Tim Klukas and an anonymous contributor. Additional reviewers for MZ21 included Rod Dykehouse, Sarah Canham, Brenda Fiddick, and Dave Tart.

Vegetation Classes

Class A **5%**

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

FORBS	Upper
FEID	Upper
PSSP6	Upper
ASTER	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 grasses including Idaho fescue, bluebunch wheatgrass or Epilobium spp. Class A on average lasts from year 0-3yrs.

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

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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 severity.

elected to not identify specific forb species response.

Class B 95%

Late Development 1 Closed

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

FORBS	Upper
FEID	Upper
PSSP6	Upper
ASTER	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 Idaho fescue, bluebunch wheatgrass. Erigonum spp, Phlox spp, Carex spp, Bromus marginatus and Danthonia spp. Class B lasts from year 4 onward.

Replacement fire occurs every 200yrs.

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

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 severity.

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- ☐ Literature
- ☐ Local Data
- ☑ Expert Estimate

Additional Disturbances Modeled

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

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	200	100	500	0.005	100
Mixed					
Surface					
All Fires	200			0.00502	

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.

References

NOTE: References imported from previous modeled mapzones for this BpS.

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111430 Rocky Mountain Alpine Fell-Field

☐ *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
Modeler 2
Modeler 3

Reviewer Anonymous
Reviewer Jim Ozenberger jozenberger@fs.fed.us
Reviewer Andy Norman anorman@fs.fed.us

Vegetation Type
Upland Grassland/Herbaceous

Map Zone
21

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

Dominant Species*
SIAC CLME
TRNA2 DROCH
PHCO11
FEBR

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
This ecological system is found discontinuously at alpine elevations throughout the Rocky Mountains.

Biophysical Site Description
These are wind-scoured fell-fields that are free of snow in the winter, such as ridgetops and exposed saddles, exposing the plants to severe environmental stress. Soils on these windy unproductive sites are shallow, stony, low in organic matter and poorly developed; wind deflation often results in a gravelly pavement. Fell is Gaelic for stone, and these are stone fields. Sites are stable for 100s to 1000s of years as soils develop. These are essentially scree slopes.

Vegetation Description
Most fell-field plants are cushioned or matted, frequently succulent, flat to the ground in rosettes and often densely haired and thickly cutinized. Plant cover is 15-50%, while exposed rocks make up the rest. Fell-fields are usually within or adjacent to alpine tundra dry meadows.

Disturbance Description
Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost and a short 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, which exposed bare ground.

Very small burns of a few square meters (replacement fire) caused by lightning strikes were included as a rare disturbance, although lighting 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

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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 severity.

1000 possible locations per year, thus 0.005. Fire return interval is modeled at approximately 525yrs. 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.

Alpine rodents (pikas, marmots, etc.) cause common, but generally small-scale disturbances in these systems. 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.

Adjacency or Identification Concerns

Over the next decades, several experts claim that the alpine is one of the more threatened community types by global climate change. Essentially, the treeline is moving up. There is also acid rain concern, especially in the Wind River Range for MZ21.

Native Uncharacteristic Conditions

Cover of vegetation >50% would indicate a system other than Rocky Mountain Alpine Fell Field, as rock cover will be 50% or more in this community.

Scale Description

This ecological system can occupy large areas of the alpine. Patch size varies from a few acres to 1000 acres 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

No data on fire or effects of lightning strikes. No data on recovery time after stand-replacing events. This model for MZs 10 and 19 had no peer review. Species were derived from literature review. Uncertain if succession from A to B is 10yrs. Moss Campion flowers at 10yrs.

Comments

This model for MZ21 was adopted as-is from MZ19, with a few additions in the descriptions. Additional reviewers for MZ21 included Sarah Canham (scanham@fs.fed.us) and Brenda Fiddick (bfiddick@fs.fed.us).

For MZ19, this model is identical to the model from MZ28 with minor modifications to the description. This model is based on 1144 by Louis Provencher. Input to the 1144 model was based on discussion with Kimball Harper (retired USFS scientist; UT), an alpine specialist of the Utah High Plateau. Mike Babler modified species and geographic range to reflect fell field plants in MZ28.

Quality control for MZs 28, 10 and 19 resulted in slightly changed canopy cover values (A changed from 0-5% to 0-20%; B changed from 6-50% to 20-60%) to adhere to LANDFIRE mapping requirements.

Vegetation Classes

*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 severity.

Class A 5 %

Early Development 1 All Structures

Upper Layer Lifeform

☑ Herbaceous
☐ Shrub
☐ Tree

Fuel Model 1

Indicator Species* and Canopy Position

SIAC	Upper
TRNA2	Upper
FEBR	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 disturbance. Rock may dominate the area. Forbs (cushion plants) are more common than grasses. Succession to class B after 10yrs.

Class B 95 %

Late Development 1 Closed

Upper Layer Lifeform

☑ Herbaceous
☐ Shrub
☐ Tree

Fuel Model 1

Indicator Species* and Canopy Position

SIAC	Upper
TRNA2	Upper
FEBR	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	50 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Alpine community is dominated by low growing perennials, some graminoids. Plant cover may vary from five percent to as much as 50%. Infrequent replacement fire in the form of lighting strikes (mean FRI of 500yrs), severe summer droughts (mean return interval of 500yrs) and animal disturbance (1/500) cause a transition to class A.

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

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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 severity.

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

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	525			0.00190	99
Mixed					
Surface					
All Fires	524			0.00192	

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) Rodent disturbances
☐ 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 severity.

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111440 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**	Anonymous	
Modeler 2	Andy Norman	anorman@fs.fed.us	**Reviewer**	Sarah Canham	scanham@fs.fed.us
Modeler 3	Rod Dykehouse	rdykehouse@fs.fed.us	**Reviewer**	Brenda Fiddick	bfiddick@fs.fed.us

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

21

Model Zone

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

Dominant Species*

ARAR9 CANA2
CAEL3 CARU3
CASI12 DECA18
CASC10 FEBR

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.

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 arctica, Carex elymoides, Carex siccata, Carex scirpoidea, Carex nardina, Carex rupestris, Deschampsia caespitosa, Festuca brachyphylla, Festuca idahoensis, Geum rosii, 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.

Disturbance Description

Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost and a short 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).

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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.

However, this BpS is probably not departed from HRV.

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 MZ21 was adapted from MZs 19, 10, 18 and 16, created by Louis Provencher (lprovencher@tnc.org). However, the FRI for those MZ's 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.

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 scientist; UT), an alpine specialist of the Utah High Plateau.

Vegetation Classes

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Class A **5%**

Early Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

CAREX	Upper
DECA18	Upper
FEBR	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. 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
ARAR9	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. 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.

An outside reviewer after the model was already created, commented that there should be much higher cover in B. The model upper limit should be 100% cover. It's a landscape/scale issue with modelers vs mappers. Modelers were thinking of the whole landscape area, which would include barren/sparsely vegetated areas, which would mean a portion of the landscape would have little cover. However, of those areas that are covered with grass, there is higher grass cover.

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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

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 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) avalanches
☐ 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 severity.

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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111450 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** 1/19/2006

Modeler 1	Cherie Howell	chowell02@fs.fed.us	**Reviewer**	Bill Romme	romme@warnercnr.colostate.edu
Modeler 2	Julia Richardson	jrichardson@fs.fed.us	**Reviewer**	Jim Ozenberger	jozenberger@fs.fed.us
Modeler 3	Elena Contreras (model fixes)	econtreras@tnc.org	**Reviewer**	Andy Norman	anorman@fs.fed.us

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

21

Model Zone

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

Dominant Species*

ERIGE2 LUPIN
MERTE SOLID
PENST DELPH
CAMPA KOELE

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.

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.

This is a tall forb, lush wet system.

Vegetation Description

Vegetation is typically forb-rich, with forbs contributing more to overall herbaceous cover than graminoids. Important taxa include Agastache urticifolia, Chamerion angustifolium, 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.

Burrowing mammals can increase density.

Disturbance Description

Fires are primarily replacement and occur at rotations related to adjacent vegetation - aspen, herbaceous and sagebrush communities. Where near mountain big sagebrush, this may be 135yrs (MZ21 original modelers),

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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, ponderosa pine and aspen.

Also, 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.

Hailstorms are another disturbance in this system.

It is debatable as to whether fire is needed at moderately high frequencies to keep sagebrush out of these grassland systems, or whether sagebrush is invading in current times due to overgrazing and/or climate change.

Sindelar (1981) in western MT did not think that grasslands invaded by ARTRV were primarily fire maintained and instead implicated livestock grazing removal of competition from grasses in ARTRV invasion. Mountain big sagebrush has colonized some mountain grasslands in present day, but not all.

Fire intervals (less fire) for MZ21 were originally decreased approximately 7x (from 30yrs to 200yrs). After an extensive model review process, LF 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.

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.

Some grassland systems are invaded by sagebrush today in larger quantities. Pre-European settlement they would have been grassland systems, whereas today they might be confused for big sage systems.

Expansion of Douglas-fir along the perimeter of the habitat has produced some encroachment in MZ21.

With heavy grazing these sites can convert to undesirable forbs and grasses such as Cirsium spp (thistle), Galium spp (bedstraw), Rudbeckia occidentalis (coneflower), Helenium hoopesii (Orange sneezeweed), Polygonum spp (knotweed), Rumex spp (sorrel or dock), Taraxacum officinale (dandelion), Madia glomerata (mountain tarweed), Descurainia spp. (tansymustard), Nemophila brevifolia (basin blue eyes), 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.

In MZ21, there is some invasion of spotted knapweed, Centaurea biebersteinii, along with dalmatian

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toadflax, Linaria Dalmatica, These occur along recreational use activity corridors in the Yellowstone National Park area.

This system will appear departed due to grazing and species composition shifts/changes. Grazing could even shift this BpS to a grassland type currently. Weed spraying currently also could shift this community to tarweed.

Native Uncharacteristic Conditions

Scale Description

Range in size from less than ten acres to 300ac. In MZ21, larger meadows are present in the Absaroka-Beartooth Range, 500-1000ac 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

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, LF 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 understanding of severity definitions; therefore, original modeler names from MZs 10 and 19 were retained. Mixed fire was removed from the model by RL.

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

Description

Indicator Species* and Canopy Position

ERIGE2	Upper
LUPIN	Upper
DELPH	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.

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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 severity.

Vegetation is typically forb-rich, 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 40yrs.

Outside reviewer commented, after models already created, that A should have been distinguished from B by canopy cover, not height.

Class B **40 %**

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model 1

Description

Indicator Species* and Canopy Position

ERIGE2	Upper
LUPIN	Upper
DELPH	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 percent 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.

Vegetation is typically forb-rich, with forbs contributing more to overall herbaceous cover than graminoids. Some increase in shrub component, shrubs young and less than five percent cover and less than 0.5m. Succession to C after 20yrs.

Replacement fire removes shrubs and occurs every 40yrs.

Class C **55 %**

Late Development 1 Open

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

ASTER	Middle
LUPIN	Middle
ROWO	Middle
RIBES	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub >3.1m
Tree Size Class	Seedling <4.5ft	

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

Forbs dominate. Trees (Populus tremuloides) or shrubs (Artemisia cana, Artemisia tridentata, Rosa woodsii, Ribes spp and Amelanchier spp.) may be the upper layer lifeform, with low canopy cover (<10%) and between 0.6m to greater than 3.1m.

As per mapping rules/violations, the shrub

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cover in box C had to be raised to 0-20%, instead of to 10%. The 20% cover will be that viewed via aerial/satellite, which should be similar to 5-10% on-the-ground cover.

Herbaceous cover may go up to 100%, height .6-1 meter.

Description

Vegetation is typically forb-rich, with forbs contributing more to overall herbaceous cover than graminoids. Five to 10% of cover in late seral may be woody species from adjacent plant communities such as Populus tremuloides, Artemisia cana, Artemisia tridentata, Rosa woodsii, Ribes spp and Amelanchier spp. Replacement fire sets site back to class A.

Replacement fire occurs every 40yrs. Mixed fire was modeled in MZs 10 and 19; however, due to a new understanding of severity types, mixed fire was taken out of the MZ21 model. This changed percentages in classes B and C by five percent.

This class is distinguished from class B mostly by species instead of structure, although taller shrubs and trees will be seen in this stage.

Outside reviewer commented, after models already submitted, that 55% in this class is too high.

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

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

Historical Fire Size (acres)

Avg 50
Min 1
Max 250

Sources of Fire Regime Data

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

Additional Disturbances Modeled

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

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	40	30	300	0.025	100
Mixed					
Surface					
All Fires	40			0.02502	

Fire Intervals (FI):

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

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*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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111530 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** 1/18/2006

Modeler 1	Sandy Gregory	s50grego@nv.blm.gov	**Reviewer**	anonymous	
Modeler 2	Bryan Bracken	Bryan_Bracken@blm.gov	**Reviewer**	Klara Varga	klara@ida.net
Modeler 3	Jack Sheffey	Jack_Sheffey@blm.gov	**Reviewer**	Tristan Fluharty	tfluharty@fs.fed.us

Vegetation Type
Upland Shrubland

Map Zone
21

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

Dominant Species*
SAVE4
DISTI
LECI4
ATCO

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Occurs throughout much of the western US in intermountain basins. Common in southern ID, NV and UT. In MZ21, this is a minor type in the zone, occurring occasionally on the edges of the zone, more likley in the east and south, if at all.

Biophysical Site Description
This site occurs on alluvial flats or lake plains usually adjacent to 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. Slope gradients of less than two percent are most typical. Elevations are between 3800-5800ft. Average annual precipitation is 5-8 inches, mean temperature is 45-50 degrees F and average growing season is 100-120 days. The surface layer will normally crust inhibiting water infiltration and seedling emergence.

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) 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) and Distichilis spicata (saltgrass). Vegetation on this site is normally restricted to coppice mound areas that are surrounded by playa-like depressions or nearly level, usually barren, inner spaces. Potential vegetative composition is about 15% grasses, 5% forbs and 80% shrubs. As ecological condition declines herbaceous understory is reduced or eliminated and the site becomes a community of halophytic shrubs dominated by greasewood.

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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 severity.

Disturbance Description

Historically, fire was extremely infrequent. May be killed by standing water that lasts greater than 40 days based on observation of inundations of Lake Bonneville flats in 1983 (personal. observe., Gary Medlyn, Ely BLM) (mean return interval of 150yrs). 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.

Adjacency or Identification Concerns

Halogeton is likely to invade this site.

Native Uncharacteristic Conditions

Scale Description

Tens to 100000 of acres.

Issues/Problems

Comments

For MZ21, the LANDFIRE model for the same BpS 1153 from MZ19, created by Sandy Gregory, Bryan Bracken and Jack Sheffey and reviewed by Eric Limbach, was adopted with only minor changes to description. Minor changes made by an anonymous reviewer. Reviewers for MZ21 were Klara Varga and Tristan Fluharty. However, they were unsure as to whether this type occurs in MZ21.

For MZ19, this model is identical to the model from MZ18 with minor modifications to the description.

For MZs 19 and 18, 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.

This model was reviewed for MZ18 by Eric Limbach. It was accepted without changes.

MZs 12 and 17 reviewers recommended extended the MFRI from 200yrs to 1000yrs and adding extended flooding to 150yrs return interval. Duration of class A was extended to five years from two years.

Vegetation Classes

Class A **5%**

Early Development 1 All Structures

Upper Layer Lifeform

- ☑ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model 2

Indicator Species* and Canopy Position

ELEl4	Upper
LECI4	Lower
SPAI	Lower
SAVE4	Middle

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

Some grasses, with greasewood sprouts present. Some representation of other sprouting species may be present (rabbitbrush). Grass species varies geographically, but include the following for UT and NV: inland saltgrass, bottlebrush squirreltail and alkali sacaton. Succession to class B after five years.

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Class B 95%

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 2

Indicator Species* and Canopy Position

SAVE4	Upper
DISTI	Lower
SPAI	Middle
LECI4	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	30%
Height	Shrub 0m	Shrub 3.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Greasewood shrubs are mature. Rabbitbrush may be found with greasewood. May occur with various sagebrush species and salt desert shrub vegetation (shadscale, saltbushes and budsage). Greasewood communities stay in this class indefinitely. Replacement fire is rare (mean FRI of 1000yrs). Prolonged flooding events (>40 days) will cause a transition to class A (return interval of 150yrs).

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

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 severity.

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	1000	500	2000	0.001	98
Mixed					
Surface					
All Fires	998			0.00102	

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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111540 Inter-Mountain Basins Montane Riparian Systems

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

General Information

Contributors (also see the Comments field) **Date** 1/18/2006

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Modeler 2	anonymous		**Reviewer**	Andy Norman	anorman@fs.fed.us
Modeler 3			**Reviewer**	Sarah Canham	scanham@fs.fed.us

Vegetation Type
Wetlands/Riparian

Map Zone
21

Model Zone

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

Dominant Species*

POBAT	POTR5
SALIX	CELAR
ALRH2	CRDO2
BEOC2	PHLE4

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
The range in MZ21 includes the northern half of the zone on major rivers. This system does not occur in the southern part of MZ21. This must be only on the edges of this mapzone in the northern portion.

Biophysical Site Description
This ecological system is found within a broad elevation range from about 750m (2460ft) in the central and northern part of MZ18 to over 2135m (7000ft) in northern NV (eg, Little Humboldt River). Riparian systems are found in low-elevation canyons and draws, on floodplains, or in steep-sided canyons or narrow V-shaped valleys with rocky substrates. This low-elevation riparian system includes major tributaries of the Columbia River. Soils are typically alluvial deposits of sand, clays, silts and cobbles that are highly stratified with depth due to flood scour and deposition.

As per NatureServe, this montane riparian system group is found on the periphery of the Northern Rockies in the Columbia River Basin, along major tributaries and the main stem of the Columbia at relatively low elevations, and at higher elevations in mountain ranges of the Great Basin and along the eastern slope of the Sierra Nevada within a broad elevation range from about 1220m to over 2135m (4000-7000ft). This system group often occurs as a mosaic of multiple communities that are tree-dominated with a diverse shrub component. The variety of plant associations connected to this system reflects elevation, stream gradient, floodplain width and flooding events.

It is questionable as to whether this occurs in this MZ21.

Vegetation Description
This ecological system occurs as a mosaic of multiple communities that are tree, shrub, or herbaceous-

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dominated. Shrub and tree dominated patches were more common. In the Columbia Plateau section, important and diagnostic trees include Populus balsamifera ssp. trichocarpa, Alnus rhombifolia, Populus tremuloides, Celtis laevigata var. reticulata, Betula occidentalis or Pinus ponderosa. Important shrubs include Crataegus douglasii, Philadelphus lewisii, Cornus sericea, Salix lucida ssp. lasiandra, Salix eriocephala, Rosa nutkana, Rosa woodsii, Amelanchier alnifolia, Prunus virginiana and Symphoricarpos albus.

The variety of plant associations connected to this system reflects elevation, stream gradient, floodplain width and flooding events. Dominant trees for this entire BpS (per NatureServe) may also include Abies concolor, Alnus incana, Populus angustifolia, Populus fremontii, Alnus rhombifolia, Populus tremuloides, Pinus ponderosa, Salix laevigata and Salix gooddingii. Dominant shrubs include Artemisia cana, Salix exigua, Salix lasiolepis, Salix lemmonii or Salix lutea. Herbaceous layers are often dominated by species of Carex and Juncus, and perennial grasses and mesic forbs such Deschampsia caespitosa, Elymus trachycaulus, Glyceria striata, Iris missouriensis, Maianthemum stellatum or Thalictrum fendleri.

Disturbance Description

These are disturbance-driven systems that require flooding, scour and deposition for germination and maintenance. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding with flooding of increasing magnitude causing some stand replacement events every 200yrs. Beaver (Castor canadensis) crop younger cottonwoods (Populus spp) and willows (Salix spp), and frequently influence the hydrologic regime through construction of dams, etc. Beaver will move from areas where tree availability is depleted. Younger stands of cottonwood and willow will be affected by beaver every 200yrs, whereas mid-development and late-development trees will be affected, respectively, every 200yrs for stand-replacing events and every 40yrs as thinning events, and 1000yrs (strong thinning disturbance). Fire disturbances occur, but are infrequent catastrophic events (FRI of 175yrs) that are caused by either fire importation from sagebrush steppe (BpS 1125) or set by Native Americans for hunting and first-year willow production for basketery. Ice scouring damages boles of larger trees and can cause mild thinning in older stands. The return interval of ice scouring was set at every seven years in the late succession class to match El Nino cycles.

For MZ21, the maximum fire interval was lengthened to 275yrs and intervals for flooding, beavers and ice scour were modified and made much longer.

Adjacency or Identification Concerns

Livestock grazing is a major influence in the alteration of structure, composition and function of the community. Livestock can result in the nearly complete removal of willow and cottonwood regeneration, and bank slumping in places where water is accessible.

Floodplains of the Columbia Plateau have mostly been converted to agriculture and urbanization.

Exotic trees of Elaeagnus angustifolia are common in some stands. Introduced forage species such as Agrostis stolonifera, Poa pratensis, Phleum pratense and the weedy annual Bromus tectorum are often present in disturbed stands.

Native Uncharacteristic Conditions

Scale Description

This system can exist as small to large linear features in the landscape (eg, Owyhee, Snake, Bruneau and Humboldt Rivers). In larger, low-elevation riverine systems, this system may exist as mid to large patches. Fire disturbance patch size varies from 1-100ac, but uncertainty exist about fire size and behavior in these

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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 severity.

riparian systems.

Issues/Problems

Uncertainty exists about the return intervals and effects for beaver activity, ice scouring and historic fire in these systems.

Comments

This model is based on the LANDFIRE model for the same BpS 1154 from MZ10 created by Louis Provencher (lprovencher@tnc.org). Major quantitative and descriptive changes were made for MZ21. Beaver, weather-stress and fire intervals were altered. Class percentages changed dramatically. See descriptions for details. Additional reviewers for MZ21 were Brenda Fiddick (bfiddick@fs.fed.us). However, reviewers for MZ21 felt that this type did not occur in their southern portion of the mapzone.

The model for MZ19 is identical to the model from MZ18. This model was originally developed for MZs 12 and 17 by Don Major (dmajor@tnc.org) and modified by Louis Provencher (lprovencher@tnc.org) by incorporating dynamics and parameter values from BpS 131154 into BpS 181154. Please see those models for details.

This model attempts to combine the Columbia Basin Foothill and Lower Montane Riparian woodland and shrubland (CES304.768) and the northern part of the Great Basin Foothill and Lower Montane Riparian woodland and shrubland (CES304.045). This model is similar to BpS 181159 with only slight modifications to vegetation species composition because BpS 1154 and 1159 overlap in elevations and describe the lower part of meandering river systems of the Columbia Plateau.

Vegetation Classes

Class A 5%

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 3

Indicator Species* and Canopy Position

POPUL	Upper
SALIX	Upper
ALNUS	Upper
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-disturbance vegetation composition. Generally, this class is expected to occur 1-5yrs post-disturbance. Typically shrub dominated, but grass may co-dominate. Salix spp dominates after fire, whereas Populus spp and Salix spp co-dominate after flooding. Silt, gravel, cobble and woody debris may be common. Composition highly variable. Succession to class B after five years.

Flooding events and beaver herbivory occur every 200yrs, causing stand replacement.

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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 severity.

Class B 30 %

Mid Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 3

Indicator Species* and Canopy Position

POPUL	Upper
ALNUS	Upper
SALIX	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" 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). Modeled disturbances include: 1) weather-related stress expressed as annual flooding events occurs every five years, which maintains vegetation in class B, 2) periodic flooding events (weather-related stress) every 200yrs causing stand replacement, 3) replacement fire every 175yrs and 4) beaver (Castor canadensis) herbivory (Option1). Beaver herbivory occurs causing, respectively, a transition back to class A every 200yrs and maintenance in class B every 40yrs. Succession to class C after 20yrs.

Class C 65 %

Late Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 3

Indicator Species* and Canopy Position

POPUL	Upper
ALNUS	Mid-Upper
SALIX	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

This class represents the mature, large cottonwood, conifer, etc. woodlands.

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.

Replacement fire every 175yrs is caused by importation from surrounding systems. Beaver activity is very infrequent (0.001 probability) and causes a thinning disturbance to class B. Ice scour occurs often (0.13 probability), but rarely kills large patches of trees, and instead causes no transition to another 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

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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 severity.

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

Fire Regime Group:** **IV**

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	175	75	275	0.00571	100
Mixed					
Surface					
All Fires	175			0.00573	

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) Beaver
☑ Other (optional 2) ice scour

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111590 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** 1/18/2006

Modeler 1 John Simons john_simons@blm.gov
Modeler 2 anonymous
Modeler 3

Reviewer Chris Baker clbaker@fs.fed.us
Reviewer Jim Ozenberger jozenberger@fs.fed.us
Reviewer Andy Norman anorman@fs.fed.us

Vegetation Type
Wetlands/Riparian

Map Zone
21

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 BEOC2
COSE16 EQAR
CAREX

General Model Sources
☑ Literature
☐ Local Data
☐ Expert Estimate

Geographic Range
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.

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. 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, 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.

Vegetation Description
This ecological system occurs as a mosaic of multiple communities that are tree dominated with a diverse shrub component. Deciduous woody trees dominate, including: Populus angustifolia, P. balsamifera and P. tremuloides. Dominant shrubs include Acer glabrum, Alnus incana, Betula occidentalis, Cornus sericea, Crataegus rivularis, Prunus virginiana and numerous tall willow species: Salix lutea, S. geyeriana, S. boothii, S. drummondiana, S. lasiandra, S. bebbiana, S. wolfii and S. exigua. Generally the adjacent upland vegetation surrounding this riparian system includes grasslands to forests.
Forbs and graminoids include Carex spp, especially Carex utriculata and Carex aaquatilis, which occur in nearly pure stands, and Geum macrophyllum, Mertensia ciliatus and Equisetum arvense.

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

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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 severity.

canadensis) crop younger cottonwoods (Populus spp) and willows (Salix spp), and frequently influence the hydrologic regime through construction of dams. Beavers show considerable movement along rivers as available trees are felled. Fire is mostly occurring as a result of spread from surrounding uplands.

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 for this BpS are approximately the same as those for 211154.

Outside reviewer commented, after models already delivered, that fire return intervals for this system should be mixed severity fire at approximately 75yrs.

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 fire as a structuring agent, coupled with shade tolerant conifer establishment can lead to loss of shade intolerant deciduous woody species. In addition, 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. In addition, loss of beavers can, coupled with heavy ungulate use, shift dominance in these systems to herbaceous species.

Exotic trees of Elaeagnus angustifolia are common in some stands. Herbaceous noxious weeds, including leafy spurge, tansy and spotted knapweed readily invade and persist in these systems today.

In MZ21, fire return intervals should be about the same as in 211154 (Black cottonwood).

Native Uncharacteristic Conditions

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 size patches, as a function of valley bottom width and gradient.

Issues/Problems

Tamarisk not right now a concern, but potential exists. Grazing disturbance could be a disturbance as well, in certain locales. Trapping of beaver affects beaver presence, thus disturbance. Perennial pepperweed may be an issue as well.

Comments

This 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 match those in 211154 (black cottonwood). The disturbance model should be identical to that in 1154 (black cottonwood). Additional reviewers for MZ21 were Sarah Canham (scanham@fs.fed.us) and Brenda Fiddick (bfiddick@fs.fed.us). Even though this MZ21 model varied from other mapzones' models in FRI, LF leadership guidance to modify intervals based on majority literature and expert opinion, was not applied here, as no experts raised issue with this model or FRI. Also - riparian system modeling has varied between mapzones.

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Additional reviewer for MZ10 was Steve Barrett (sbarrett@mtdig.net). Peer review for MZ10 resulted in a more frequent MFI (from 370yrs to 50yrs) and the addition of mixed severity fire.
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

Class A 5%

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 3

Indicator Species* and Canopy Position

POPUL	Upper
SALIX	Upper
ALNUS	Upper
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, mixed severity fire, beavers and flooding will maintain this class.

Flooding events and beaver herbivory occur every 200yrs, causing stand replacement.

Class B 30%

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 3

Indicator Species* and Canopy Position

POPUL	Upper
SALIX	Mid-Upper

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).

Modeled disturbances include: 1) weather-related stress expressed as annual flooding events occurs every five years, which maintains vegetation in class B, 2) periodic flooding events (weather-related stress) every 200yrs causing stand replacement, 3) replacement fire every 175yrs and 4) beaver (Castor canadensis) herbivory (Option1). Beaver herbivory occurs causing, respectively, a transition back to Class A every 200yrs and maintenance in class B every 40yrs. Succession to class C after 20yrs.

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Class C 65 %

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 3

Indicator Species* and Canopy Position

POPUL	Upper
PINUS	Upper
SALIX	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.

Description

This class represents the mature, large cottonwood, conifer, etc. woodlands.

Generally, this class persists until a replacement disturbance (beavers, flooding and 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.

Ice scour occurs often, but rarely kills large patches of trees.

Replacement fire every 175yrs is caused by importation from surrounding systems. Beaver activity is very infrequent (0.001 probability) and causes a thinning disturbance to class B. Ice scour occurs often (0.13 probability), but rarely kills large patches of trees, and instead causes no transition to another 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

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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	175	75	275	0.00571	100
Mixed					
Surface					
All Fires	175			0.00573	

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) Beaver
- ☑ Other (optional 2) ice scour

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LANDFIRE Biophysical Setting Model

Biophysical Setting: **2111600** **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** 1/19/2006

Modeler 1	Tim Klukas	tim_klukas@nps.gov	**Reviewer**	Jim Ozenberger	jozenberger@fs.fed.us
Modeler 2	John Simons	john_simons@blm.gov	**Reviewer**	Andy Norman	anorman@fs.fed.us
Modeler 3	anonymous		**Reviewer**	Sarah Canham	scanham@fs.fed.us

Vegetation Type
Wetlands/Riparian

Map Zone
21

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
CAREX

General Model Sources
☑ Literature
☑ Local Data
☐ Expert Estimate

Geographic Range
Higher elevations in the zone down to valley riverbottoms.

Biophysical Site Description
This ecological system represents the combination of numerous riparian types occurring in the upper montane/sub-alpine zones. Found at 900-3000m (3000-10000ft). This ecological system typically exists as relatively small linear stringers, but can occupy relatively wide and flat valleys. This is a widely dispersed type in MZ21 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 included both montane to subalpine and alpine elevations and therefore descriptions were kept broad.

Although reviewers recommended a minimum altitude of 8000ft, it was decided that the minimum of 3000ft would be kept in order to adhere to the original Ecological System description and to encompass a broader range of elevational types, not only subalpine.

These wetlands typically are in small upper-elevation watersheds that periodically experience high rainfall in short periods from convective thunderstorms.

Vegetation Description
This ecological system encompasses a broad array of riparian species. These systems are highly variable and generally consist of willows and other shrubs, sedges and other herbaceous vegetation, or conifers (primarily spruce and sub-alpine fir). Shrubs include bog birch, bog blueberry and willows (eg, Salix

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planifolia, S. wolfii, S. boothii, S. drummondii, S. geyeriana and S. bebbiana) among others. Graminoids include tufted hairgrass, bluejoint reedgrass, beaked sedge and water sedge, among others.

Other species for MZ21 include Salix Eastwoodiae, S. glauca, S. tweedyi, Carex brunnscens, Carex canescens, Carex aurea, Carex hoodii, Carex illota, Carex luzulina, Carex nigricans, Carex norvegica, Carex podocarpa, Carex praticola, Carex scopulorum, Mertensia ciliata and Saxifraga odontoloma.

Unlike the lower elevation riparian types (1159, Rocky Mountain Subalpine Lower Montane Riparian Systems), this type does not typically include cottonwood species, but may include paper birch and aspen. (On the Bridger-Teton NF, there is no paper birch.)

In MZ21, high elevation meadows in the Greater Yellowstone Ecosystem also have the spruce-fir component interspersed in the wetlands along with the addition of lodgepole pine. This is primarily in low-gradient, alluvial settings. In the case of Yellowstone National Park, the setting occurs in the Bechler Meadows, Gibbon Meadows, Pelican Valley, Indian Creek and Thorofare. Habitat in the Bridger Teton is also part of the system.

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 reset succession to early development, depending on vegetation.

Reviewers felt that this BpS 1160 is more consistently wet with deep root systems, deep bogs, springs and small streams so that flooding events wouldn't be the major influence. Short growing season, temperature, radiation, avalanches, snow events, ice and scouring, herbivory and posssibly long-interval fire regimes are major disturbances, but more data is still needed (Ozenberger, personal communication).

These wetlands typically 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 allumvium may not show up as rushing streams scouring banks, bur 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).

Sites are probably fairly lush, so fires may skip over them. This would be a patchy replacement fire, topkilling all the vegetation.

Fire intervals for MZ21 are modeled at 3x longer than those in MZs 10 and 19.

Outside reviewer for MZ21 commented that the fire return intervals are modeled at too long intervals.

Adjacency or Identification Concerns

This BpS includes narrow to moderately wide meadows, shrublands and woodlands of conifers and aspen.

Over-grazing and irrigation use have had major impacts on some of these systems. Exotics in this setting are primarily Kentucky bluegrass, timothy, orchardgrass and dandelion.

Reviewers for MZ21 felt that the above information did not apply significantly to this MZ21. However, the statements were not removed, in order to retain consistency between models.

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Native Uncharacteristic Conditions

Scale Description

These systems are small linear or relatively wide features in the landscape.

Per NatureServe, these are montane to subalpine riparian shrublands occurring as narrow bands of shrubs lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels.

Issues/Problems

There is a paucity of fire information on this system and the very heterogeneous nature of the systems is challenging for model building. However, most of the shrubs and graminoids respond favorably to fire by resprouting from the root crown.

Reviewers state that sites are probably fairly lush, so fires may skip over them. Domestic sheep may be an issue in the Wyoming and Wind River Ranges. Global warming and acid rain may affect vegetation.

Comments

This model for MZ21 was adapted from the LANDFIRE models for the same BpS 1160 from MZs 10, 19, 12, 17 and 16; models for MZs 10 and 19 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). Additional reviewer for MZ21 was Brenda Fiddick (bfiddick@fs.fed.us). Even though this MZ21 model varied from other mapzones' models in FRI, LF leadership guidance to modify intervals based on majority literature and expert opinion, was not applied here, as no experts raised issue with this model or FRI. Also - riparian system modeling has varied between mapzones.

Peer review for MZs 10 and 19 resulted in changes to the fire regime (mixed severity fire was added, surface fire was eliminated and the overall MFI was lengthened) and overall proportions in classes A and B.

Vegetation Classes

Class A **5%**

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 3

Indicator Species* and Canopy Position

SALIX	Upper
CAREX	Upper
	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	40%
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. This class is shrub or grass dominated. Composition varies both within/among reaches.

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 fire was typically rare, every 300yrs, and mixed fire occurs every 175yrs.

Native grazing occurs very infrequently (probability 0.001).

Succession to class B after 1-3yrs, however this is highly variable due to high moisture levels and high species variability.

Class B **95%**

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model 3

Indicator Species* and Canopy Position

SALIX	Upper
CAREX	Upper
	Upper
	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Shrub 0m	Shrub >3.1m
Tree Size Class	None	

☐ 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. Composition of adjacent uplands is the determining factor for future fire events.

Replacement fire occurs every 300yrs. 100-year flood events reset vegetation to early class. Every 33yrs, beavers, and every 10yrs, non-scouring flooding occur but have no effect on succession classes.

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

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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

Fire Regime Group:** **V**

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	89
Mixed	2500			0.0004	11
Surface					
All Fires	268			0.00374	

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) Beaver
☑ Other (optional 2) 100-year flood events

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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 severity.

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111610 Northern Rocky Mountain Conifer Swamp

☐ *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	Spencer Johnston	sdjohnston@fs.fed.us	**Reviewer**
Modeler 2	Jim Ozenberger	jozenberger@fs.fed.us	**Reviewer**
Modeler 3	Liz Davy	edavy@fs.fed.us	**Reviewer**

Vegetation Type
Wetlands/Riparian

Map Zone
21

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
THPL

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Northern Rocky Mountains from western WY and eastern ID. Scattered areas within M331Aa, M331Ae, M331Db and M331Ab.

Biophysical Site Description
Poorly drained soils that are saturated a significant portion of the growing season may have seasonal flooding in the spring. Soils conditions may include exposed rock and gravel at the surface or, more rarely, organic matter. Stands generally occupy sites on benches, toeslopes or valley bottoms along mountain streams. May occupy upland sites (especially on northerly aspects) where high water table allows saturation part of the growing season. Lodgepole pine areas are mainly found in Island Park area.

Vegetation Description
Composition will vary geographically, but is generally dominated by large, old Picea engelmannii. Large downed logs are often common (50 tons/acre possible). Lodgepole pine may be present in some areas. Large dead snags are present.

Understory associates will vary widely geographically, but include Actaea rubra, Equisetum arvense, Senecio triangularis, Epilobium angustifolium, Streptopus amplexifolius and Calamagrostis canadensis (colder and wetter end of the range).

Disturbance Description
Fire regime group V with rare stand replacement fires (>300yrs+). Fire frequency is highly dependant on adjacent vegetation and relative patch size compared to the surrounding matrix. In the subalpine zone, these systems act as fuel breaks. However, frequency of fire is increased where drainage is oriented with prevailing wind. Fuel loading in adjacent vegetation may sometimes be important. Small patch fire events (individual lightning strikes) may occur within patches, but do not meet the threshold of mixed severity fire.

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Openings in the overstory canopy often results in windthrow (Williams et al. 1995).

Spruce beetle outbreaks may occur and be linked to subsequent fire events.

Adjacency or Identification Concerns

The wetland types are generally distinguishable from other upland forests and woodlands by shallow water tables and mesic or hydric undergrowth vegetation.

Native Uncharacteristic Conditions

Scale Description

Linear features and smaller patches. 1-10s of acres in size.

Issues/Problems

This is typically a small patch system and may be difficult to map.

This is a relatively stable ecosystem dominated by positive feedback mechanisms so were highly variable over space and time. Variability was dependent on patch size, native burning and adjacent vegetation.

Comments

This model for MZ21 was adapted from the same BpS 1161 in MZs 10 and 19, created by Katie Phillips, Randall Walker and Larry Kaiser and reviewed by Steve Barrett and Cathy Stewart. Quantitative and descriptive changes were made. Disturbances were added and changed. Class percentages changed significantly. No further review was received for MZ21.

For MZs 10 and 19, Art Zack (azack@fs.fed.us) and Craig Glazier (cglazier@fs.fed.us) provided input to an earlier version of this model. Katie Phillips (cgphillips@fs.fed.us), Randall Walker (rmwalker@fs.fed.us), Larry Kaiser (larry_kaiser@blm.gov) developed model in MZ19.
In general, modelers and reviewers for MZs 10 and 19 had trouble with the NatureServe description of this type, as it combines two very different systems-- upland redcedar groves and lowland, seasonally flooded conifer (spruce) bogs. The upland redcedar type was split into a separate model for zones 10 and 19 (10472), and this "conifer swamp" type was modeled differently than the NatureServe description. As a result of peer review, mixed severity fire was removed from the model.

Peer review for MZs 10 and 19 resulted in general concern that this system is too small in concept compared to other BpS and should not be included in LANDFIRE.

Vegetation Classes

Class A **25 %**

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Description

Indicator Species* and Canopy Position

PIEN	Mid-Upper
PICO	Mid-Upper

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.

Riparian sprouting species may be considered trees or shrubs. Nurse crops of white pine, lodgepole, or cottonwood may comprise this

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class, in which case tree heights would be very tall (>30m).

Engelmann spruce and some other conifers may be regenerating.

The probability of fire is highest in this class and fires will often creep in from adjacent vegetation types. Stand replacing fires would occur 300-500yrs (Bradley 1992).

Competition/maintenance was used in the model to represent high water tables that may maintain this class for up to 80yrs.

Loss of large trees post-burn can alter the water table and reduce subsequent tree regeneration, causing this class to last many years. This class succeeds to a mid-closed state after 40yrs.

Class B **50%**

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIEN	Upper
PICO	Upper

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

Typically closed overstory of Engelmann spruce. Riparian deciduous species present but not dominant. Lodgepole pine communties in this class would be open, however, as the fluctuating water table is going to keep densities low. Trees might be greater than 10m and go up to the 25m height class, but due to modeling rules, the max height was set at 10m.

Stand replacing fires occur every 300-500yrs.

This class was originally modeled in MZs 10 and 19 with canopy closure from 0-100%. However, closure changed for model to reflect nature of "closed" system.

Some trees would begin to fall over from windthrow with the probability of 0.004, but that would not cause a transition to another class.

Lodgepole pine sites will die off and go back to A; this was modeled as alternate succession, moving lodgepole back to class A with a probability of 0.005.

After approximately 110yrs, this class will transition to a late closed state.

Outside reviewer for MZ21 commented, after models already delivered, that there probably should have been a mid-development open stage of 11-30% cover. Also - having 50% in B seems high for reference conditions.

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Class C 25 %

Late Development 1 Closed

Indicator Species* and Canopy Position

PIEN Upper

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.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Description

Typically closed, old Engelmann spruce trees. Canopy closure tends to be >60%. Stand replacing fires is 300-500yrs. Spruce beetle outbreaks and windthrow will play a role in disturbance, with a probability of 0.005, setting this class back to A.

This class was originally modeled in MZs 10 and 19 with canopy closure from 0-100%. However, closure changed for model to reflect nature of "closed" system.

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.
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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	400	250	750	0.0025	99
Mixed					
Surface					
All Fires	400			0.00252	

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
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [x] 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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111650 Northern Rocky Mountain Foothill Conifer Wooded Steppe

☐ *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	Jeff Jones	jjones@fs.fed.us	**Reviewer**	Mary Manning	mmanning@fs.fed.us
Modeler 2			**Reviewer**	Cathy Stewart	cstewart@fs.fed.us
Modeler 3			**Reviewer**	Carly Gibson	cgibson@fs.fed.us

Vegetation Type
Forest and Woodland

Map Zone
21

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

Dominant Species*
PSME JUCO
PIPO JUSC
PIFL PSSP6
ARTRV FEID

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
Primarily found east of the Continental Divide in northern MT, eastern ID, and WY, but west of Billings, MT.

Biophysical Site Description
These savannas occur at the lower treeline/ecotone between grassland or shrubland and more mesic coniferous forests typically in warm, dry, exposed sites. Elevations range from <500m in British Columbia to 1600m in the mountains of central Idaho. Occurrences are found on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops are most common. This ecological system generally occurs on glacial till, glacio-fluvial sand and gravel, dune, basaltic rubble, colluvium, to deep loess or volcanic ash-derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acid pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. These savannas in the eastern Cascades, Okanagan and northern Rockies regions receive winter and spring rains, and thus have a greater spring "green-up" than the drier woodlands and savannas in the central Rockies.

Vegetation Description
Generally dominated by Douglas-fir with incidental ponderosa pine and/or limber pine. 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 MFI of approximately 30yrs. Mixed-severity fires occur with a typical frequency of 30-50yrs primarily in dense stands (classes B and E). Native American burning may have occurred in many of these low-elevation forests.

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Limber pine may be affected by blister rust.

Adjacency or Identification Concerns

This PNVG corresponds with cool, dry Douglas-fir and limber pine habitat types (Pfister et al. 1977), including PSME/ARUV, PSME/AGSP, PIFL/AGSP, PIFL/FEID/FESC, PIFL/AGSP and PIFL/FEID. Ecotone with mountain grasslands/sagebrush.

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

For MZ21, this BpS was adopted as-is by MFSL from MZ18.

Additional reviewers were John DiBari (jndibari@yahoo.com), Steve Barrett (sbarrett@mtdig.net) and Lee Clark (lwclark@fs.fed.us).

Based on the Rapid Assessment model R0PSMEdy, by Jeff Jones and reviewed by Cathy Stewart (cstewart@fs.fed.us) and Steve Barrett (sbarrett@mtdig.net).

Rapid Assessment peer review comments incorporated on 3/16/2005, resulting in clarification in description and slightly more surface fires and higher MFI overall.

As a result of final QC for LANDFIRE National by Kori Blankenship it was noticed that the time since disturbance function in the VDDT model for BpS 1165 was not attributed correctly. Because two probabilistic transitions (alternate succession in class A and C) in the model are contingent on time since disturbance, the “use time since disturbance” function should have been select on the RUN SETTINGS – OPTIONS tab in VDDT for the model to run correctly. When “use time since disturbance” is not selected the percent of the landscape in classes A-D are 1, 84, 3 and 12 respectively, as shown in this description document. When “use time since disturbance” is selected the percent of the landscape in classes A-D changes to 10, 2, 5 and 83 respectively. Based on the assumption that the modelers achieved the results they wanted without the “use time since disturbance” function selected, it was decided to leave this function off. However, it should be noted that the model will produce very different results when the function is turned on. For future use this model should be reassessed.

10/18/07: As a result of final QC for LANDFIRE National by Kori Blankenship the user-defined min and max fire return intervals for surface severity fire were deleted because they were not consistent with the modeled fire return interval for this fire severity type.

Vegetation Classes

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Class A **1%**

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PSME	Upper
FEID	Lower
ARTRV	Lower
PIFL	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	30%
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Dominated by bunchgrasses,mountain sagebrush and seed/sapling sized Douglas-fir. Limber pine and ponderosa pine may be present in varying amounts.

Class B **84%**

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PSME	Upper
PIFL	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	31%	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 and/or large sized Douglas-fir. Limber pine and ponderosa pine may be present in varying amounts. Sagebrush has largely dropped out of the stand. Mixed severity fire may open up the canopy.

Class C **3%**

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PSME	Upper
FEID	Lower
ARTRV	Lower
PIFL	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	30%
Height	Tree 5.1m	Tree 10m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Open poles of Douglas-fir with bunchgrass and sagebrush understory. Limber pine and ponderosa pine may be present in varying amounts. Surface fires maintain the open condition.

Class D **12%**

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PSME	Upper
FEID	Lower
ARTRV	Lower
PIFL	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0%	30%
Height	Tree 10.1m	Tree 50m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

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Widely spaced, open canopy of medium to large diameter Douglas-fir with bunchgrass and sagebrush understory. Canopy fuel is discontinuous. Limber pine and ponderosa pine may be present in varying amounts. Surface fires maintain the open condition.

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

Fire Regime Group:** I

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	200	100	300	0.005	16
Mixed	50	30	100	0.02	63
Surface	147			0.00680	21
All Fires	31			0.03180	

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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NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

Pfister, R.D., B.L. Kovalchik, S.F. Arno and R.C. Presby. 1977. Forest habitat types of Montana. General Technical Report INT-34. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 174 pp.

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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 severity.

LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111660 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** 1/18/2006

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Modeler 2	LaWen Hollingsworth	lhollingsworth@fs.fed.us	**Reviewer**	Nathan Korb	nkorb@tnc.org
Modeler 3			**Reviewer**	Anonymous	

Vegetation Type
Forest and Woodland

Map Zone
21

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

Dominant Species*
PSME SYOR
PICO PHMA5
POTR5 BERE2
SYAL CAGE

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range
This BpS is the most common low-elevation forest type in the Greater Yellowstone Ecosystem and occurs across eastern ID, southwestern MT and northwestern WY.

Biophysical Site Description
Douglas-fir forests occupy a broad elevational range, between the limber pine type and grasslands/shrublands on lower foothills and the cool/dry subalpine vegetation types. This BpS often occurs at higher elevations on slopes with southern aspects where it can be codominant with whitebark pine or limber pine. Slopes with northern aspects tend to be more mesic and can support a mixed conifer community including a number of subalpine tree species. This can also occur in the mid-elevation ranges (6000-8000ft) in southwestern WY.

Vegetation Description
Generally dominated by Pseudotsuga menziesii with an understory of graminoids, shrubs, and/or other conifer species. Shrub cover varies from sparse to dense and typically includes Symphoricarpos spp, Physocarpus malvaceus, Juniperus communis, Artemesia tridentata var. vaseyana and Holodiscus discolor. Codominant species include Pinus flexilis, Juniperus scopulorum and Populus tremuloides at lower elevations and lodgepole pine (Pinus contorta var. latifolia), subalpine fir (Abies bifolia), Engelmann spruce (Picea engelmanii) and whitebark pine (Pinus albicaulis) at higher elevations. Composition can vary widely based on disturbance history and site conditions. Stand structure ranges from young even-age stands to multiple age class old-growth stands.

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Disturbance Description

Fire regime is predominantly mixed severity (Fire Regime III) with a MFI of approximately 20-50yrs (Arno and Gruell 1983, Fischer and Clayton 1983, Houston 1973, Korb et al. in preparation, Littell 2002). Mixed-severity fires are generally characterized by spatially heterogeneous burning that results in a complex and dynamic mosaic of low-severity surface fires and high-severity surface or crown fires. Large, stand-replacing fire occurs to a lesser degree, mostly in dense stands and/or with severe fire weather. There seems to be a general absence of fire in the last 100yrs (Arno and Gruell 1983, Houston 1973, Littell 2002), most likely due to successful fire suppression and livestock grazing.

One anonymous reviewer (personal correspondence) stated that MFI for mixed severity fire should not be 70yrs but rather 200yrs, using a CFI correction for Korb (in preparation). Korb (personal correspondence) states that the influence of small fires was removed by removing any fire dates that were recorded on less than 25% of samples. Therefore, when the same fire year is recorded on several scarred trees over a large area, it is assumed that the fire burned throughout most of that larger area. The interval for the 25% filter composite mean fire interval reported was 26-34yrs (with tremendous variability around those means) for the xeric and mesic types of 1166 respectively. Including all the small fires that did occur, any given point likely burned more frequently on average. Also, the composite fire intervals for the two study areas were 9yrs and 15yrs (xeric and mesic forests respectively) which, if a multiplier (Baker in press) of 4.0 is applied, results in "corrected" mean intervals of 36 and 60yrs (xeric and mesic).

As the anonymous reviewer is assuming lack of fire where scars are not found, Korb is assuming lack of historical record of the fires that did occur where scars are not found. An MFI for mixed was chosen at 50, based on all stated above and original modelers' descriptions.

Some modelers proposed inclusion of low severity fires into the model, at a low frequency. However, surface fires were not added into the model, as the consensus among other modelers and reviewers was that mixed fire captured any of the low-severity fire component, and more fire did not need to be modeled in this system.

The most common insects causing mortality include Douglas-fir bark beetle in Douglas-fir and mountain pine beetle in lodgepole pine. Medium to large trees are most susceptible although poles may be infrequently infected. Spruce budworm is present in pockets within the zone. While it often weakens Douglas-fir and may make them more susceptible to bark beetles, direct mortality from budworm is uncommon. The most common disease affecting older Douglas-fir stands is Schweinitzii.

Dwarf mistletoe might also be present on south facing slopes, according to reviewers. However, in the Gallatin National Forest, dwarf mistletoe is not seen on south slopes or anywhere in the Douglas-fir system.

Wind/weather/stress may infrequently affect stands and were therefore given low probabilities.

The 20th century is moister than the 19th, which has affected disturbance conditions.

Adjacency or Identification Concerns

This BpS has gradual, fuzzy boundaries at its upper elevation boundary with subalpine forests and its lower elevational boundary with apen and sagebrush grasslands.

This BpS corresponds with cool, dry Douglas-fir and limber pine habitat types (Pfister et al. 1977), including PSME/CAGE, PSME/SYOR, PSME/SYAL, PSME/ARCO, PSME/PHMA and PSME/JUCO.

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This type often forms an ecotone with mountain grasslands/sagebrush. Class A in this model is equivalent with a class A in neighboring grassland/shrubland types. Higher elevations of this type border subalpine fir systems and persistent lodgepole pine in frost pockets and cooler areas of the map zone.

Douglas-fir increases in canopy density in the absence of fire. Much of this landscape today has canopy cover denser than the historic range of variability.

The modelers and reviewers developed the BpS 1166 model with the intent to include all Douglas-fir dominant forests in the Greater Yellowstone Ecosystem. Although there have been several fire history studies in the Douglas-fir forest type within the Greater Yellowstone Ecosystem, there is little information about variation in fire regimes and reference structure within the forest type. For this reason, it has been proposed that lumping all Douglas-fir forests in MZ21 is appropriate for this effort. Modelers and reviewers for MZ21 felt that BpS 1045 is not present in MZ21, and that this BpS 1166 should account for the Douglas-fir in this mapzone. Most of the indicator species for 1045 do not occur in the NW part of the Greater Yellowstone Ecosystem.

Currently, most of this system is probably in the late-closed stage because trees are greater than 10m. There's probably about 30% in the mid closed and 60% in the late closed stage. There shouldn't be much late open stage today. There should be very little in open stage currently. This would probably fall into FRCC 3.

Native Uncharacteristic Conditions

Scale Description

This type is dominated by mixed severity fires. A disturbance such as fire tends to create numerous small patches (holes) within the stand due to the mortality often associated with mixed severity fire. Fire sizes are generally variable but may be linked to time of season and available fuel. Patches of severe fire within pre-European settlement mixed severity fire perimeters have been documented in western Greater Yellowstone Ecosystem to be generally <40ha in extent.

Issues/Problems

Douglas-fir will often encroach from this BpS into adjacent shrublands or grasslands with fire exclusion and during moist climatic periods.

Comments

This model for MZ21 is based on the LANDFIRE model for the same BpS 1166 for MZs 10 and 19 developed by Steve Rust (srust@idfg.idaho.gov) and Kathy Geier-Hayes (kgeierhayes@fs.fed.us) with additional review by Susan Miller (smiller03@fs.fed.us). The model for MZ21 incorporated changes based on literature and input from different geographical areas. Quantitative and descriptive changes were made - to fire intervals and other disturbance intervals. Quantitative and descriptive changes for MZ21 reflect the cooler and drier climate east of the continental divide. Other reviewers for MZ21 included Liz Davy (edavy@fs.fed.us), Tim Belton (tbelton@fs.fed.us), Heidi Whitlatch, David Barron (dbarron@fs.fed.us), Spencer Johnston (sjohnston@fs.fed.us), Candi Eighme (ceighme@fs.fed.us) and Lisa Heiser (lheiser@fs.fed.us).

Model for MZs 10 and 19 received additional review from Rolan Becker (rolanb@cskt.org), Ed Lieser (elieser@fs.fed.us) and Cathy Stewart (cstewart@fs.fed.us) and was adapted from Rapid Assessment model R0PSMEdy, by Jeff Jones and reviewed by Steve Barrett and Cathy Stewart. Review comments for MZs 10 and 19 incorporated on 3/16/2005, resulting in clarification in description and slightly more surface fires and higher MFI overall.

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Vegetation Classes

Class A 10%

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 2

Indicator Species* and Canopy Position

PSME	Upper
PICO	Upper
SYAL	Lower
CARU	Lower

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.

Graminoids are the dominant lifeform in this class.

Description

Dominated by graminoids and seedling/sapling Douglas-fir and possibly lodgepole pine. Understory may be dominated by Calamagrostis rubescens and/or Carex spp. Shrub species such as Symphoricarpos spp may be present.

Succession occurs in approximately 40yrs, and the class moves to a mid-open state.

Replacement fire occurs every 500yrs, and mixed fire occurs every 200yrs. If this class experiences no fire in 20yrs, it will move to class B, a mid-closed state.

Wind/weather events occur infrequently (probability of 0.001), but the class is maintained in this state.

Class B 10%

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PSME	Upper
PICO	Upper
SYAL	Lower
CARU	Lower

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 and some medium Douglas-fir and possibly lodgepole pine. The understory is open and relatively depauperate. Understory may be dominated by Calamagrostis rubescens and/or Carex spp. This class persists for 80yrs, then moves to a late closed stage.

Replacement fire occurs every 200yrs, and mixed fire every 50yrs, causing a transition to a mid-open stage.

Insect/disease outbreaks occur with a probability of 0.005, and can move the class to a mid-open state. Also, wind/weather stress causes a change to a mid-open state with a probability of 0.001.

Although reviewers recommended removing insects/disease from this class, it was decided by Region 1 insect experts that some insect damage is likely for the class B forest types. The insects to be concerned about at low levels are Douglas-fir pole beetle and western spruce budworm.

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Class C 10 %

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PSME	Upper
PICO	Upper
SYAL	Lower
CARU	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Open pole and medium Douglas-fir that may have lodgepole pine with patchy graminoid cover and dispersed shrubs such as Symphoricarpos spp. Understory may be dominated by Calamagrostis rubescens and/or Carex spp. Conifer heights range between 5-20m but adjusted to eliminate class overlap. This class can persist for 60yrs, then moves to a late open stage.

Replacement fire occurs every 200yrs, and mixed fire every 40yrs. Without fire for 58yrs, this class can move to a mid-closed state.

Insect/disease outbreaks and wind/weather events occur with a probability of .005, and maintain this class in a mid-open state.

Class D 50 %

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PSME	Upper
PICO	Upper
SYAL	Lower
CARU	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Description

Open canopy of medium to large Douglas-fir with a graminoid and shrub understory with highly variable understory cover. Lodgepole pine may be present. Understory may be dominated by Symphoricarpos spp, Calamagrostis rubescens, and/or Carex spp. Heights can exceed 25m up to approximately 30m.

Replacement fire occurs every 500yrs, and mixed fire every 50yrs. Without fire for 45yrs, this class can move to a late-closed state.

Insect disturbance occurs every 10yrs but does not move this class to another class. Wind/weather stress also occurs, with a probability of 0.008, but does not cause a transition to another class.

Class E 20 %

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 10

Indicator Species* and Canopy Position

PSME	Upper
PICO	Upper
SYAL	Lower
CARU	Lower

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.

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Description

Multi-storied Douglas-fir, sometimes with lodegpole pine present. Understory with variable cover often dominated by Calamagrostis rubescens, Carex spp, Symphoricarpos spp, and/or Physocarpus malvaceous. Heights can exceed 25m up to approximately 30m.

Replacement fire occurs every 200yrs, and mixed fire every 30yrs, causing a transition back to a late open state.

Insect outbreaks occur frequently, probability of 0.01, and cause a transition to an open state. Wind/weather stress occurs with a probability of 0.005 and also causes a transition to a late open state.

Disturbances

Fire Regime Group:** III

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	300	200	300	0.00333	14
Mixed	50	20	80	0.02	86
Surface		200	400		
All Fires	43			0.02334	

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting: 2111670 Rocky Mountain Poor-Site Lodgepole Pine Forest

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

General Information

Contributors (also see the Comments field) **Date** 1/18/2006

Modeler 1	Eric Miller	eric_miller@nps.gov	**Reviewer**	Bill Romme	romme@warnercnr.colostate.edu
Modeler 2			**Reviewer**	Liz Davy	edavy@fs.fed.us
Modeler 3			**Reviewer**	Spencer Johnston	sjohnston@fs.fed.us

Vegetation Type
Forest and Woodland

Map Zone
21

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 CARO5
CAGE2
VASC
CARU

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range
Northern Rockies, northwestern WY, Wind River Range, Teton Range and eastern ID subsections M331Aa and M331Ae.

Biophysical Site Description
This type occurs on coarse, nutrient poor soils derived largely from silicic rocks, (rhyolite, granite and some sterile sandstone). This type may be considered an edaphic climax. These are subalpine forests where the dominance of Pinus contorta is related to topo-edaphic conditions and nutrient-poor soils. These include excessively well-drained pumice deposits, glacial till and shallow moisture-deficient soils with a significant component of volcanic ash. Soils on these sites are typically well-drained, gravelly, coarse-textured, acidic and rarely formed from calcareous parent materials. Annual precipitation averages 600-900mm with fairly even distribution across the months.

Vegetation Description
Following stand-replacing fires, Pinus contorta rapidly colonizes and develops into dense, even-aged stands. Regeneration is accelerated where serotiny is characteristic. Following stem exclusion, understory trees increase and may include subalpine fir and Engelmann spruce, in wetter areas, or commonly whitebark pine at higher elevations and drier sites. Lodgepole pine occurs in nearly pure stands throughout all successional stages (ie, lodgepole pine plays early-seral and quasi-climax roles in this system). These stands can be dense (80-100 sq. ft basal area) and can have densities greater than 150 sq. ft basal area. Understory herbaceous and advanced regeneration layers will typically be sparse except in canopy gaps. Species typically include: Geyer's sedge, Ross' sedge, grouse whortleberry,and pine grass. Early succession stands can be dense with lodgepole pine seedlings and saplings that thin over time to widely spaced trees with a

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multi-aged structure. However, reviewers state that very dense lodgepole pine stands can remain at high densities throughout their succession.

Disturbance Description

Most fires remain small (less than one hectare) and naturally extinguish. The stand-replacing fire regime is driven more by weather events than fuel accumulation (Bessie and Johnson 1995, Schoennagel, et al. 2004). Older stands are more disposed to stand-replacing fire (Renkin and Despain 1992). Spotting and crowning are more important than surface spread during large fire events. Young stands generally lack litter or live herbaceous/shrubby fuel to sustain surface spread. Where young stands have been observed to burn, fire spread is carried by thick elk sedge culms. Surface spread in mature stands is slow, erratic and patchy in compacted needle litter and dispersed heavy fuel jackpots. The live herbaceous and live shrubby fuel component contribute little to fire spread. Romme (1982) found a fire return interval of 300-400yrs for stand-replacing events in the Little Firehole drainage in Yellowstone. Although surface and mixed severity fires are much more frequent, they remain small <50 ha and most less than one hectare. Thus any given point on the landscape is much more likely to burn in a stand-replacing fire than a surface or mixed severity fire. Another reviewer, however, commented that a 350yr replacement fire MFI might be too long for densely spaced stressed trees.

In the VDDT model, replacement fire was modeled with an average FRI of 325yrs, whereas mixed fire was modeled at 600yrs, for an overall FRI of 210yrs. This conceivably is too low of an FRI (too much fire), and the overall FRI should be approximately 300yrs, with the majority being replacement fire. This assumption is based on the rest of this disturbance description.

Mountain pine beetles kill trees in endemic and epidemic disturbance events. Large diameter trees (>20cm DBH) are preferred by mountain pine beetles but in epidemics, 13cm DBH class trees have been known to be killed. Generally younger trees are not host trees. Patches of mortality provide gaps for regeneration. Mistletoe may cause mortality in older trees and greater susceptibility to mountain pine beetle. The profusion of induced branches and partial crown mortality may predispose them to torching. Shallow root systems are prone to wind-throw.

This is generally a non-equilibrium system which is highly variable, with fire mainly controlled by the weather and climatic changes.

Reviewers suggested not modeling surface fire since the effects are minimal. They also recommended leaving out much of the insect effect and alternative succession, since little data is available.

Adjacency or Identification Concerns

May be confused with dense stands of lodgepole pine dominated seral stages of more moist or andesitic subalpine forested environments (eg, BpS 1050; Despain 1990). This type corresponds to cool habitat types dominated by lodgepole pine (Pfister et al. 1977).

This is a non-equilibrium ecosystem which is highly variable and not out of its historical range of variability (Romme, personal correspondence).

Currently, there is probably less class A than would have been historically. This system might be in condition class 1 today.

Native Uncharacteristic Conditions

None.

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Scale Description

Patch size ranges from a few hectares to a few hundred on sandstone outcrops to areas of thousands to tens of thousands on rhyolite and granitic substrates. The Yellowstone Fires of 1988 included 50000ha+ of this forest type, however 1000ha would be a large fire.

Issues/Problems

Comments

This model for MZ21 is based on the LANDFIRE model for the same BpS 1167 from MZ10 created by Dana Perkins (dana_perkins@blm.gov), Carly Gibson (cgibson@fs.fed.us) and John DiBari (jdibari@email.wsu.edu) and reviewed by Lynn Bennett (lmbennett@fs.fed.us), Steve Barrett (sbarrett@mtdig.net) and Roy Renkin (roy_renkin@nps.gov). Quantitative and descriptive changes were made to the model for MZ21; fire intervals and other disturbance intervals were modified. There was one additional anonymous reviewer for MZ21.

Additional reviewer for MZ10 was Ward McCaughey (wmccaughey@fs.fed.us). Peer review in MZ10 resulted in a longer overall MFI (from 175yrs to 300yrs) and a significant reduction in the amount of mixed severity fire (from ~40% to ~10%). There was some debate among reviewers about the exact nature of this BpS compared to subalpine, seral lodgepole pine. Additional adjustments were made in the model description to clarify these differences.

Model for MZs 10 and 19 was based on the Rapid Assessment model R0PICO by Don Despain (don_despain@usgs.gov) and reviewed by Steve Barrett (sbarrett@mtdig.net) and Cathy Stewart (cstewart@fs.fed.us).

Vegetation Classes

Class A **15%**

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PICO	Upper
CAGE2	Lower
CARO5	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Description

Sparse to dense lodgepole pine seedlings to young pole-sized trees. Herbaceous ground cover mostly of Carex geyeri, C. rossii and early successional annuals and colonizers. Lodgepole pine are slow growing, and succession to class B, mid-closed stage, occurs after 40yrs.

Some poorer sites may succeed to a mid-open state, but this was not modeled due to lack of data.

Replacement fire occurs every 300yrs, and mixed fire occurs with a probability of 0.001 per year. Reviewers stated that mixed fire occurs more often since there is fine fuel available every 200yrs and are kept in class A.

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Class B 20 %

Mid Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PICO	Upper
CAGE2	Lower
CARO5	Lower
VASC	Lower

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.

Description

Mid- to large sized lodgepole pine with a sparse herbaceous layer and high canopy closure and stem exclusion. Most ground cover is litter. Grouse whortleberry, if present, steadily increasing.

Disturbance caused canopy gaps (modeled as wind/weather/stress) may cause a transition to class C with a probability of 0.001.

Competition in the dog-hair condition may delay succession and prolong stay in this class, with a probability of 0.001. Self-thinning might also cause a transition to C. This was also modeled as "competition/maintenance," although originally modeled as "alt succ," with a probability of 0.01, as per reviewers' suggestions.

Insect outbreaks occur with a probability of 0.001, taking this class to a mid-open state.

This class succeeds to class D after 150yrs.

Replacement and mixed fires occur with the same probability of that in class A. Mixed fires bring this stage to an open stage.

This class was originally modeled with canopy and height identical to class D, 41-100% and 10-25m height. Modelers and reviewers felt that tree height doesn't seem to change much once the lodgepole stands reach maturity and the canopy cover for both falls within the specified range of 41-100%. The differences have more to do with influx of advance regeneration, decreasing tree density with time, increasing canopy bulk density, decreasing canopy base height and increasing surface fuel loading. The sites (better sites taller trees), will determine the height of the trees. But due to modeling rules, class D height was changed.

Class C 45 %

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

PICO	Upper
CAGE2	Lower
CARO5	Lower
VASC	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Description

Mid- to large-sized lodgepole pine with a higher herbaceous and shrub component. Grouse whortleberry, if present, increasing in cover. Some poorer sites may succeed directly from an open A condition, but this was not modeled due to lack of data. At 150yrs, this class succeeds to class D, a late-closed stage.

Competition may delay succession and prolong stay in this class, with a probability of 0.001.

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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 severity.

Replacement and mixed fire occur with the same probability as in B. Although surface fires were originally modeled, they were removed due to very low frequency and effects, as per reviewers.

Class D 20 %

Late Development 1 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PICO	Upper
CAGE2	Lower
CARO5	Lower
VASC	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	100 %
Height	Tree 25.1m	Tree 50m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

Nearly homogenous even aged or uneven aged lodgepole pine stands with limited recruitment in gaps. Includes the non-pyrogenous climax lodgepole pine (Despain 1983). Understory herbaceous cover is sparse and limited to where there is sunlight.

Blowdowns result in opening and the transition to class C with a probability of 0.002.

Mountain pine beetle infestations at epidemic levels may cause transitions. Endemic population levels of beetles occur with a combined probability of 0.01; some outbreaks take the class back to an early state, with a probability of 0.005, and some outbreaks take the class back to a mid-open state, also with a probability of 0.005.

Small, patchy surface fires may occur; however, due to very low frequency and effect, they were not modeled, as per reviewers. Large, crown fires result in A every 300yrs, while mixed fires occur every 200yrs.

This class was originally modeled with canopy and height identical to class B, 41-100% and 10-25m height. Modelers and reviewers felt that tree height doesn't seem to change much once the lodgepole stands reach maturity and the canopy cover for both falls within the specified range of 41-100%. The differences have more to do with influx of advance regeneration, decreasing tree density with time, increasing canopy bulk density, decreasing canopy base height and increasing surface fuel loading. The sites (better sites taller trees), will determine the height of the trees. In order to accommodate the modeling/mapping rules, the tree height was raised in this class to 25m and higher; however, modelers and reviewers felt that this class could contain shorter trees.

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 1
Min 1
Max 800000

Sources of Fire Regime Data

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

Additional Disturbances Modeled

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

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	325	100	400	0.00308	65
Mixed	600	200	4000	0.00167	35
Surface					
All Fires	211			0.00475	

Fire Intervals (FI):

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

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