LANDFIRE Biophysical Setting Model

Biophysical Setting **3010490** **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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Vegetation Type

Forest and Woodland

Dominant Species*

PIFL2 JUSC2
PSEUD7
PIPO
JUCO6

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Map Zone

30

Model Zone

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

Geographic Range

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

Biophysical Site Description

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

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

Vegetation Description

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

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

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

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

Disturbance Description

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

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

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

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

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

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

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

Adjacency or Identification Concerns

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

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

It is also susceptible to mountain pine beetle outbreaks.

This BpS was adapted to include the transitions between Douglas fir, ponderosa and limber and Juniper.

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

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

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

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

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

Native Uncharacteristic Conditions

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

Scale Description

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

Issues/Problems

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

Comments

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

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

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

Vegetation Classes

Class A 11 %

Early Development 1 All Structure

Indicator Species* and Canopy Position

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

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Description

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

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

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

Class B **11 %**

Late Development 1 Open

Upper Layer Lifeform

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

Fuel Model 8

Indicator Species* and Canopy Position

PIFL2	Upper
PSEUD7	Upper
PIPO	Upper
JUSC2	Mid-Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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

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

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

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

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

Class C **78 %**

Late Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 8

Indicator Species* and Canopy Position

PIFL2	Upper
PSEUD7	Upper
PIPO	Upper
JUSC2	Mid-Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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

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

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

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

Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg 25
Min 1
Max 200

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

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

Fire Intervals (FI):
Fire interval is expressed in years for each fire severity class and for all types of 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)

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3010620** **Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland**

☐ *This BPS is lumped with:*

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

General Information

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

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Modeler 2			**Reviewer**	Kathy Roche	kroche@fs.fed.us
Modeler 3			**Reviewer**		

Vegetation Type

Upland Shrubland

Dominant Species*

CELE3
ARTRV
PUTR2
SYMPH

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

Map Zone

30

Model Zone

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

Geographic Range

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

Biophysical Site Description

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

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

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

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

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

Vegetation Description

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

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

Disturbance Description

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

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

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

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

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

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

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

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

Adjacency or Identification Concerns

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

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

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

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

Native Uncharacteristic Conditions

Scale Description

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

Issues/Problems

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

Comments

NOTE: 12/02/07: As a result of final QC for LANDFIRE National by Jennifer Long, 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 severity type.

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

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

This 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 pine 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).

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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.

Vegetation Classes

Class A 10 %

Early Development 1 All Structure

Upper Layer Lifeform

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

Fuel Model 5

Indicator Species* and Canopy Position

CELE3	Upper
ARTR2	Upper
CHRYS	Upper
SYMPH	Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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

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

Class B 10 %

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 9

Indicator Species* and Canopy Position

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

Structure Data (for upper layer lifeform)

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

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

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

Description

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

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

Succession to class E after 90yrs.

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Class C **15 %**

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model 5

Indicator Species* and Canopy Position

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

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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

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

Succession to class B after 40yrs.

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

Class D **20 %**

Late Development 1 Open

Upper Layer Lifeform

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

Fuel Model 9

Indicator Species* and Canopy Position

CELE3	Upper
ARTR2	Low-Mid
PUTR2	Low-Mid

Structure Data (for upper layer lifeform)

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

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

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

Description

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 MFRI 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 MFRIs 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

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reaching very old age.

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

Class E **45 %**

Late Development 1 Closed

Indicator Species* and Canopy Position

CELE3 Upper

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 6

Description

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

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

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

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg 50
Min 1
Max 100

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

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

Fire Intervals (FI):

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

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Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3010800** **Inter-Mountain Basins Big Sagebrush Shrubland**

☑ *This BPS is lumped with: 1125*

☐ *This BPS is split into multiple models: 1125 describes MZ29 better. 1080 has ARCA13, which doesn't apply in these mapzones. Production is somewhat different, but not enough to split out (Benkobi).*

General Information

Contributors (also see the Comments field **Date** 10/3/2006

Modeler 1	Steve Cooper	scooper@mt.gov	**Reviewer**	Lakhdar Benkobi	lbenkobi@fs.fed.us
Modeler 2			**Reviewer**	Jeff DiBenedetto	jdibenedetto@fs.fed.us
Modeler 3			**Reviewer**	George Soehn	george_soehn@blm.gov

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

30

Model Zone

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

Dominant Species*

ARTRW PSSP6
PASM HECO26
BOGR2 NAVI4
CHRYS9 CAFI

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This system encompasses eastern and central MT, as opposed to throughout the Rocky Mountains, etc as BpS 1125 usually refers to. (This system is lumped with BpS 1125.) 1125 is common throughout MZs 20 and 29 currently (not necessarily historically), except in western part of section 331Da. In MZ29, common historically.

For MZ29, it would occur in northeast WY section 331G, Thunder basin grasslands, northeast of 331Gg.

For MZ29, basin big sagebrush is very uncommon. Have Artemisia tridentata ssp. vaseyana (BpS 1126) at higher elevations associated with Bighorn, Pryor Mtns and Laramie ranges. Have Artemisia tridentata ssp. wyomingensis elsewhere where A. t. ssp. vaseyana doesn't occur. Mountain big sagebrush occurs in sections M331 associated with Bighorn and Laramie Ranges. A. t. ssp. wyomingensis occurs everywhere else.

In MZ29, in southeast MT, but this could be due to a soil anomaly. It probably occurred historically all through the subsections of southeast MT. Also through MZ30 in 331Mi in western Dakotas, 331Md in lower portion. As move north in 331Md, there is less of it. Probably does not occur in 331Mc. Canopy cover of sagebrush is probably <10%.

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Biophysical Site Description

This system is Great Plains Sagebrush Steppe for MZ20. For MZ29, we are describing sagebrush wheatgrass steppe, where western wheatgrass is dominant. MZs 20 and 29 are very similar for this type.

Soils are primarily dry from sedimentary processes in this system; soils are less fertile in this system, sometimes more calcareous. The Great Plains expression is found exclusively on "heavy" textured soils derived from shale and mudstones and can be strongly correlated with particular geologic formation or members thereof.

April, May and June have by far the most precipitation and this peaks in late May, early June. This pattern carries throughout the MT portion of the Great Plains though a gradient of more summer precipitation as you progress eastward but still the "spring" peak. It's not until you encounter tallgrass prairie does summer precipitation become predominant.

Wyoming big sagebrush occupies plains, foothills, terraces, slopes, plateaus, basin edges and even lower mountain slopes due to the fact that Artemisia tridentata ssp. vaseyana is not part of the mix in MZ20 nor in MZ29. Soils are shallow to moderately deep, moderate to well drained and almost exclusively fine textured soils. Wyoming big sagebrush generally occurs in the 5-15in precipitation zones. Soil depth and accumulation of snow enhances these communities in lower precipitation zones (Knight 1994).

In MZ29, A. t. ssp. wyomingensis can occur from 2200-8000ft.

Bluebunch/ARTR-wyomingensis type is probably an inclusion in this BpS occurring on steep, south aspect slopes, typically badlands slopes/topography.

Vegetation Description

Wyoming big sagebrush is the dominant mid-to late seral species within this plant assemblage.

PASM and ELLA3 are by far the dominant grasses in MZ20 expression of this BpS. In MZ29, PASM, HECO26 and BOGR2 are by far the dominant grasses. Cool season grasses such as Indian ricegrass, bluebunch wheatgrass (Indian ricegrass and bluebunch wheatgrass occur only where coarser textured soils prevail), needle-and-thread (needle and thread has a broad environmental amplitude but is more typically abundant on coarse soils; however, under heavy grazing, it does quite well on fine-textured soils.), blue grama, Sandberg bluegrass, squirreltail, threadleaf sedge and infrequently Thurber's needlegrass. Rhizomatous wheatgrasses, such as western wheatgrass and thickspike wheatgrass, and plains reedgrass, are common species within these MZs 20 and 29. Junegrass also occurs.

Common forbs are species of Astragalus, Crepis, Delphinium, Phlox and Castilleja, while associated shrubs and shrub-like species can be small green rabbitbrush, MFRInge sagewort, winterfat and broom snakeweed. Other dominant species of forbs include RACO3 and SPCO. Also, LIPU and PHHO occur.

Forbs most important for MZ20 include SPHCOC, DALPUR, PHLHOO, RATCOL and OPUPOL. Other forbs in MZs 10 and 19 include hawksbeard (Crepis acuminata), bird's beak (Cordylanthus spp.), blue bell (Mertensia spp), Rocky Mountain aster (Aster scopulorum), Phlox species, lupine (Lupinus spp) and buckwheat (Eriogonum spp). In MZ29, all of the above are probably found except for lupine, which would occur in higher precipitation areas and be associated with mountain big sage.

Herbaceous species usually dominate the site prior to re-establishment. Site re-establishment is by seed

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bank, seed production from remnant plants and seeds from adjacent (untreated) plants.

Wyoming big sagebrush in upland sites have fewer understory species relative to the mountain big sagebrush subspecies, though at higher elevations or moister areas of this vegetation community there is a higher potential for herbaceous species, relative to ARTTST (ssp tridentata) sites; no definitive statement on undergrowth herbaceous diversity can be made for ARTTSW (ssp wyomingensis) sites. Herbaceous cover increases transitioning into the mixedgrass prairie, and in open patches.

In MZ29, A.t. ssp. tridentata is not found. A.t. ssp. wyomingensis is found where A.t. ssp. vaseyana is not present. It can occur with greasewood and silver sagebrush, as well as rabbitbrush and saltbush.

Disturbance Description

Many researchers believe fire was the primary disturbance factor within this plant assemblage. Other disturbance factors may include insects, rodents and lagomorphs, drought, wet cycles, gradual changes in climate and native grazing (Wyoming Interagency Vegetation Community 2002). Drought may have been more significant disturbance than native grazing or insects, so was included. Native grazing by large ungulates (eg, bison), and insects were included as occurring every 10yrs but causing no transitions to another class. Heavy-impact grazing in the late closed stage occurs less frequently and causes a transition to an open state.

Following fire or other significant disturbance, herbaceous species will dominate the ecological site post-burning and recovery to prefire canopy cover is quite variable and may generally take 50-120yrs, but occasionally occurs within a decade (Baker, in press). Site re-establishment is by seed production from remnant plants, and seeds from adjacent (untreated) plants. Discontinuity of fuel in Wyoming big sagebrush communities can result in mosaic burn patterns, leaving remnant plants for seed, but can be large expanses of complete mortality (Bushey 1987, Baker, in press). Fire does not stimulate germination of soil-stored Wyoming big sagebrush, but neither does it inhibit its germination (Chaplin and Winward 1982). Regeneration may occur in pulses linked to high precipitation events (Maier et al. 2001).

Overall fire return intervals in Wyoming big sagebrush appear to have ranged from 100-240yrs or more (Baker, in press) for MZ22. In MZ20, some believe that intervals are shorter, with replacement fire occuring approximately every 30yrs in some of the classes (based on BLM Fire Management plans and local expert estimate, Downey). However, there was disagreement with that short interval. It is also said that we are fairly certain of the recovery time required (50-150yrs, mostly around 100yrs). With this slow recovery, if fires returned to the site in 30yrs, eventually the whole landscape would be only class A and maybe B (open) (Cooper, personal correspondence). Therefore, for MZ20, MFRI was modeled at an overall 90yr interval, similar to other adjacent mapzones and similar to BpS 1080 MFRI of 80yrs, which this BpS is thought to be very similar to.

There was some disagreement among MZ20 modelers as to the MFRI of 90yrs for this 1125 system. Up north, where there is a heavy grass component and much less cover of sagebrush than what is down south, and relatively connected topography and a lot of wind, it would burn more frequently (Downey, pers comm). Perhaps that would be considered BpS 1085 instead of BpS 1125. And even though BpS 1085, which is also comprised mainly of Wyoming big sagebrush has an MFRI of 30yrs, these two systems are different as it relates in large part to setting and precipitation patterns, and continuity of fuel. Eastern MT has few breaks, versus mountainous systems that would be much less likely to have the huge sweeping fires. Although the species are the same Artemisia tridentata ssp. wyomingensis - the systems aren't (Martin, pers comm). The longer MFRI for 1125 was therefore retained.

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Benkobi (pers comm) states that in MZ29, fire frequency could range from 36-40yrs (http:/gisdata.usgs.net). However, MZ29 reviewers did not want to change the model. However, because it was also stated that recovery occurred after at least 60yrs in MZ29, and due to the discrepancy from previous mapzones, the MFRI from MZ20 was retained.

Discontinuity of fuel in Wyoming big sagebrush communities often result in mosaic burn patterns, but large expanses can burn with complete mortality under extreme conditions (Bushey 1987, Baker, in press). Mixed severity fire was originally modeled in this BpS but due to a new understanding of definitions of severity types, it was thought that mixed severity fire does not occur in this system and rather patchy fires do occur, with replacement severity.

MZs 20 and 29, where prescribed burn: after 29yrs, there was still zero recovery of Wyoming big sagebrush (Cooper pers comm). It is thought that the Wyoming big sagebrush communities take longer than 100yrs to recover. In Bighorn battlefield, historically there was much sagebrush. It burned in the mid-80s and there is still no evidence of sagebrush re-establishment 10yrs later.

Antelope, mule deer and pygmy rabbits are native herbivores that browse sagebrush. These were also not included in the model. In MZ29, probably not pygmy rabbits. Sage grouse might also have an impact? It is questionable as to the impact/frequency of antelope and mule deer in MZ29.

Adjacency or Identification Concerns

This type is difficult to distinguish from mixed-grass prairie with a high shrub component. It is possible that with severe disturbance, a state change might occur to mixed-grass prairie - which in turn changes the potential for the site to return to sagebrush. Extensive severe burns for want of an adjacent seedbank would take extensive periods before ARTTSW was again a significant component.The reference condition might have been sagebrush, but now the abiotic facotrs and biophysical gradients indicate a mixed-grass prairie.

Secondary shrub and herbaceous components may vary considerably across the range of its extent. Wyoming big sagebrush sites may be a mosaic with or abut juniper, ponderosa pine, salt desert shrub and grassland vegetation types across its range. However, the most common accompanying vegetation is Northern Great Plains midgrass prairie.

Broom snakeweed and halogeton may dominate sites disturbed by overgrazing, oil and gas development, or other disturbances. Club moss in this system increases with the intensity and duration of grazing. BROJAP can be an increaser with burning/grazing. There is also BROTEC invasion but that doesn't occur in the Northern Great Plains, except in MZ29.

Juniper increase might be occurring due to lack of fire today, but it is not developing into a true juniper woodland, especially in MZ29.

Shrub cover increases in MZ20 and 29 with overgrazing, and herbaceous layer decreases dramatically.

Might be difficult to distinguish from BpS 1080 and BpS 1085.

Much of 1080 has been lost due to land clearing for agriculture or converted to a cheatgrass or greasewood type. For basin big sagebrush in MZ29, this is the case. For Wyoming big sagebrush in MZ29, much has

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been lost due to burning for modern grazing. The understory is currently more annual bromes due to increased grazing.

Overgrazing has also been an issue in 1080. HESCOM and KOEMAC increase (MZ20) where grazing is intense and protracted. It is questionable as to whether HESCOM increases with grazing (some areas of MZ29), and might rather decrease with overgrazing. With overgrazing in some areas of MZ29, more bluegrasses.

Plant associations are similar btwn 1125 and 1080. Shrubland is perhaps further south. Herbaceous cover is the only distinguishing factor. 1125 is definitely the more prominent historically. 1080 more prevalent in central WY. These (like mixegrass prairie) are distinguished by geography. Therefore, they're being combined for MZ29.

In Bighorns battlefield (around Hardin, MT), historic photos showed dense (up to 20%-30% cover, that is) shrub covered system, but currently, mostly grass - due to fires that burned there (Clark et al 1995 DRAFT).

If adjacent to pine systems, might be seeing more trees currently. (Also if in grass systems). This was seen in historic photographs throughout northern part of MZ29 and through western SD (Clark et al 1995 DRAFT).

Native Uncharacteristic Conditions

Over 45% shrub cover would be uncharacteristic for MZ20 and MZ29. In fact, Wyoming big sagerush in MZ29 would not exceed 40% cover. The only reason it would be this high is in cases of extreme overgrazing or in the absence of fire or changes in fire regime - frequency.

Scale Description

Occurrences may cover between hundreds and thousands of hectares.

Disturbance patch sizes range from 10s-1000s of hectares. The patch and disturbance size gets larger as this shrub BpS intergrades with the grassland BpS, and also gets larger from MZs 19 and 20 into MZ29.

Issues/Problems

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

Comments

This model for MZ29 was adapted from the same BpS from MZ20 created by Steve Cooper and Shannon Downey and reviewed by Steve Barrett. For MZs 29 and 30, descriptive additions and changes were made. Other reviewers for MZ29 were Bobby Baker and Jim Von Loh.

Model for MZ20 was adapted from the draft model for MZ22 for 1125b Inter-Mountain Basins Big Sagebrush Steppe-Wyoming Big Sagebrush, created by Mark Williams, Vicki Herren and an anonymous contributor and reviewed by Tim Kramer, Eve Warren and Destin Harrell. Changes were made to the description and model.

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

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For the Rapid Assessment, the workshop code was WYSB. This model was combined with another Rapid Assessment model, R0SBWA (workshop code was WSAG1), modeled by George Soehn (george_soehn@blm.gov) and reviewed by Sarah Heide (sarah_heide@blm.gov) and Krista Gollinick-Waid (krista_waid@blm.gov). The two were combined based on peer-review and the similarity of disturbance regimes and species composition.

The RA Model is based on the original FRCC PNVG (WYSB1) with modifications from Wyoming Interagency Vegetation Committee (2002) and expert estimates. Peer review for the RA model was incorporated 4/30/2005. Additional reviewers were Karen Clause (karen.clause@wy.usda.gov), Ken Stinson (ken_stinson@blm.gov) and Eve Warren (eve_warren@blm.gov).

Vegetation Classes

Class A 35 %

Early Development 1 All Structure

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

NAVI4	Upper
PASM	Upper
BOGR2	Lower
CAFI	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	80 %
Height	Herb 0m	Herb 0.5m
Tree Size Class		

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

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.

Description

Herbaceous dominated. In the pre-settlement condition, NAVI4 (in MZ20) and HECO26 in MZ29 would have been a major upper position component. Primarily grasses with forbs. Exact species will vary depending on location. Western wheatgrass, Sandberg bluegrass, plains reedgrass, needle-and-thread, bluebunch wheatgrass, threadleaf sedge, plains junegrass and blue grama would be dominant grasses. Forbs may include Astragalus, Crepis, Castelleja, Delphinium, Agoseris, Phlox and others. There may also be significant component of small green rabbitbrush.

Succession to class B, a mid-development open stage, occurs after 40yrs. This succession was originally modeled at 20yrs; however, it was later decided that that was a minimum age for succession, and it would take more like 40yrs to achieve 5-15% canopy cover of ARTTSW. There is one paper that shows no ARTTSW 15yrs post-fire and another paper for MZ19 that indicates no recovery after as much as 18yrs (Cooper, personal correspondence). In MZ29, recovery occurred after 60yrs.

Insect/disease (0.001 probability or 0.1% of the landscape each year), native grazing (0.1 probability or 10% of the landscape each year) and wind/weather stress (every 100yrs, 0.01 probability or 1% of the landscape each year) occur, but do not cause a transition.

Replacement fire was originally modeled at every 30yrs, based on expert estimate and local observations. - in BLM Fire Management Plans (Downey, personal correspondence). However, this was later changed to 90yrs based on recovery times of this type. This, and the other changes in age range, changed the class percentage from 20% to 35%.

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Class B 40 %

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8	Upper
PASM	Mid-Upper
NAVI4	Mid-Upper
HECO26	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is greater than five but less than 15%. Understory is well represented by herbaceous species as described for class A. (Montana Academy of Sciences publication - re: in breaks, After 15yrs after fire, no sagebrush yet.)

ARFR4 also present in lower canopy.

Succession to class C, late development closed stage, occurs after 50yrs. (60yrs for MZ29)

Insect/disease (0.001 probability of 0.1% of the landscape each year), native grazing (0.1 probability or 10% of the landscape each year) and wind/weather stress (every 100yrs, 0.01 probability or 1% of the landscape each year) occur, but do not cause a transition to another stage.

Fire was modeled more frequently than in MZ22 based on expert estimate and data from BLM Fire Mangement Plans. Originally, mixed fire was modeled at occurring every 40yrs, maintaining the class in this stage (Downey, personal correspondence). However, this was later removed due to a new understanding of definitions of mixed versus replacement fire. This, and the other changes in age range, changed the class percentage from 55% to 35%. Replacement fire occurs every 90yrs.

Class C 25 %

Late Development 1 Open

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8	Upper
PASM	Mid-Upper
NAVI4	Mid-Upper
HECO26	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is >15 percent. Understory is well represented by herbaceous species as described for class A. This class is more common on drier sites.

Shrub cover max was 30% in MZ20. In MZ29, it was increased to 65% cover by other reviewers. However, it was decided that here it could not be this amount of cover. Modal cover is 15%. The most measured was 32% cover. Some could have been higher cover but not much. Common in literature that grazing/over-grazing increases cover, not the opposite.
It is probably more common in 20% range. 40% is high, but could be a max (Cooper, diBenedetto, personal comm). Regional lead changed to 40% per comments.

ARFR4 is also present in lower canopy.

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Insect/disease (0.001 probability of 0.1% of the landscape each year), native grazing (0.002 probability or 0.2% of the landscape each year) cause a transition to the mid-open stage.

Native grazing (0.1 probability or 10% of the landscape each year) occurs, but does not cause a transition to another stage.

Drought was modeled at an overall interval of 100yrs split between maintaining this stage or taking it to the mid-development stage.

Originally, mixed fire was modeled at occurring every 40yrs, maintaining the class in this stage (Downey, personal correspondence). However, this was later removed due to a new understanding of definitions of mixed versus replacement fire. Replacement fire occurs every 100yrs. This only changed the class percentage from 25% to 30%.

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model 0

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** **IV**

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

☑ Literature
☑ Local Data
☑ Expert Estimate

Fire Intervals	*Avg FI*	*Min FI*	*Max FI*	*Probability*	*Percent of All Fires*
Replacement	90			0.01111	100
Mixed					
Surface					
All Fires	90			0.01113	

Fire Intervals (FI):

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

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Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3010810** **Inter-Mountain Basins Mixed Salt Desert Scrub**

☑ *This BPS is lumped with: 1066*

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

General Information

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

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

Vegetation Type

Upland Shrubland

Map Zone

30

Model Zone

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

Dominant Species*

ATCO	TETRA3
PIDE4	CHVI8
KRLA2	ACHY
ATCA2	GRSP

General Model Sources

☐ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

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

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

Biophysical Site Description

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

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

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

Vegetation Description

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

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

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

Achnatherum hymenoides is also a dominant.

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

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

Disturbance Description

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

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

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

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

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

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

Adjacency or Identification Concerns

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

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

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

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

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

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

Native Uncharacteristic Conditions

Over 30% shrub cover would be uncharacteristic.

Scale Description

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

Issues/Problems

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

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

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

Comments

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

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

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

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

Vegetation Classes

Class A 25 %

Early Development 1 All Structure

Indicator Species* and Canopy Position

ACHY Lower
ATCO Upper

Upper Layer Lifeform

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

Fuel Model 2

Structure Data (for upper layer lifeform)

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

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

The dominant lifeform are grasses, but shrubs are the upper level lifeform at less than five percent cover and <0.5m tall.

Description

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

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

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

Class B 75 %

Mid Development 1 Open

Indicator Species* and Canopy Position

ATCO Upper
ACHY Lower

Upper Layer Lifeform

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

Fuel Model 2

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

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Description

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

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

Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	%	%
Height		
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

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

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

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

Fire Intervals (FI):

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

Additional Disturbances Modeled

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

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement seve

LANDFIRE Biophysical Setting Model

***Biophysical Setting* 3010850 Northwestern Great Plains Shrubland**

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

General Information

Contributors (also see the Comments field **Date** 11/1/2006

Modeler 1	Jeff DiBenedetto	jdibenedetto@fs.fed.us	**Reviewer**	Jack Butler	jackbutler@fs.fed.us
Modeler 2			**Reviewer**	Steve Cooper	scooper@mt.gov
Modeler 3			**Reviewer**	Jim Von Loh	jvonloh@e2m.net

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

30

Model Zone

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

Dominant Species*

SYOC RHTR
JUHO2 SCSC
SHAR PASM
PRVI CAFI

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This type should be confined to ephemeral drainages and mesic sites and north facing slopes within mountain ranges and hillsides around the Little Rockies in MZ20. Northeastern and southeastern MT, western ND and SD, northeastern WY, western NE. This ecological system ranges from SD into southern Canada on moderately shallow to deep, fine to sandy loam soils. In MZ30, this would occur in section 331. Not much of this should be mapped; most should be mapped to 1141. This type should be very, very infrequent. This could occur in the Badlands of western ND. This type occurs in Theodore Roosevelt National Monument in ND, usually on mesic sites, benches of slopes and north-facing slopes. There are also stands at Badlands National Park and Wind Cave National Monument in SD. We mapped and described it as plant associations under the USGS-NPS National Vegetation Mapping Program and reported it in 2000 (see http://biology.usgs.gov/npsveg/).

Biophysical Site Description

Occur as small patches within northern mixedgrass prairie occupying microsites associated with higher available moisture or moderately steep slopes, north and south aspects. In ND, usually on mesic sites, benches of slopes and north-facing slopes. Occupy slope shoulders and drainage ways, draws. Sites where moisture more available. Skunkbrush more associated with south aspect slopes. Chokecherry and serviceberry and snowberry associated with drainages, draws along the foothills of the Beartooth mountains. Horizontal juniper associated with north aspect slopes. Buffaloberry associated with north aspect slopes. Each of the shrub species associated with own habitat type with moisture gradient. Skunkbrush is dry end, and snowberry/chokecherry is wet end. This BpS is capturing a broad moisture regime from dry to mesic.

Elevations range from 1300-4000ft, and up to 4500ft east side of the Judiths, and 5000ft south side of the

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Snowies. Temperatures range between extremes of hot summers and cold winters that are typical of a continental climate. Precipitation increases from west (11in) to east (16in). Two-thirds of the precipitation occurs during the growing season (Apri-June).

Soils vary, but are generally entisol in the west and mollisols in the east. Soils in the northern Great Plains, west of the Missouri River in the Dakotas, northwestern NE, northeastern WY and MT are formed from sedimentry sandstone and shales, especially the badlands type topography. These soils range from clayey, fine-loamy, to fine silty soils of mixed origin on level and undulating lands with minor contributions from loess, alluvium and mountain outwash.

Many of these shrubland types occur on moderate to steep slopes (west to northwest facing) at least in the badlands - grazing is not likely a factor. They occur on southwest and northwest facing slopes and moderate to steep slopes. The skunkbrush however, more associated with the southerly aspects.

Vegetation Description

This vegetation type is characterized by the dominance of snowberry, chokecherry, serviceberry, skunkbrush, buffaloberry and horizontal juniper. Ninebark may also be present on some sites. There is an understory of cool-season grasses such as western wheatgrass, needlegrasses, Sandberg bluegrass, little bluestem, threadleaf sedge and forbs.

(Silver sagebrush was also an important component historically; however, silver sagebrush is covered in 1162 Floodplains Systems and 1148 Western Great Plains Sand Prairie. Silver sagebrush associated with valley bottom/terraces along streams and drainageways.)

This melds into 1141 needle-and-thread and western wheatgrass.

Each of the shrub species in this BpS is associated with its own habitat type and represents a broad moisture gradient from dry to mesic. Skunkbrush is dry end, and snowberry/chokecherry and buffaloberry is mesic end. All of these species don't occur together necessarily.

Disturbance Description

The northern mixed-grass prairie and shrublands are strongly influenced by wet-dry cycles. Fire, grazing by large ungulates and small mammals such as prairie dogs and soil disturbances (ie, buffalo wallows and prairie dog towns) are the major disturbances in this vegetation type. In MZ30, many of these shrubland types occur on moderate to steep slopes (west to northwest facing).

From instrumental weather records, droughts are likely to occur about three in every 10yrs. Historically, there were likely close interactions between fire and grazing since large ungulates tend to be attracted to post-fire communities. Conversely, fire presumably was less likely in areas recently heavily grazed by herbivory - thus contributing to spatial and temporal variation in fire occurrence.

Average fire intervals are estimated at 8-25yrs, although in areas with very broken topography fire intervals may have been greater than 30yrs. The model for MZ20 reflects a 30yr MFRI. The model for MZs 29 and 30 reflects a 15-20yr interval. This system's MFRI should be very similar to 1141 mixedgrass prairie, since this system is just inclusions within 1141. It might be a little less frequent because of moisture; however, it should be similar.

Fires were most common in July and August, but probably occurred from about April to September. Seasonality of fires influences vegetation composition. Early season fires (April-May) tend to favor warm-season species, while late season fires (August-September) tend to favor cool-season species. Replacement fire in our model does remove 75% of the above ground cover as assumed in the literature. However, we don't think loss of the above ground cover by the replacement fire will necessarily induce a retrogression back to an earlier seral stage from the late stage because the main component of dominant grasses remains unharmed to insure the continuity of the seral stage. The shrub species, however, are sprouters. Fire would remove them, and they would re-sprout. The exception would be horizontal juniper and skunkbrush which would not resprout. It would take longer for them to become re-established.

We used different levels of native ungulate grazing intensities. We assumed that light grazing would not alter the community enough to change classes, but increasing grazing intensity would move the community back to earlier stages. Grazing return interval probably occured every 7-10yrs but grazing would only result in a class change maybe once every 80-100yrs. Overall - the grazing frequency was modeled at every 20yrs - that includes grazing just occuring with no transition resulting, as well as grazing taking the stage back to an earlier class. And - overall - the drought plus grazing impact frequency was modeled as every 70yrs - that includes the no-transition + transition to early stage.

This system 1085 differs in MFRI from 1125, which is composed mostly of Wyoming big sagebrush. BpS 1085 also has a higher grass component. Up north, where there is a heavy grass component and much less percent cover of sagebrush than what is down south, and relatively connected topography and a lot of wind, it would burn more frequently (Downey, pers comm). These two systems are different as it relates in large part to setting and precipitation patterns, and continuity of fuel. Eastern MT has few breaks, versus mountainous systems that would be much less likely to have the huge sweeping fires.

Ortmann in his review of the Rapid Assessment model, suggested that in addition to fire, drought and grazing, insect outbreaks (Rocky Mountain locust) would have impacted all classes.

Adjacency or Identification Concerns

Inclusions within the Mixedgrass Prairie. The Northern Great Plains Shrubland might be a subcomponent of the Northwestern Great Plains Mixedgrass Prairie BpS that was historically limited to predominantly sedimentary soil types and local microsites; resulting in a similar ecological model, but with a longer fire cycle. This 1085 might therefore be difficult to map differently from the grassland sites. Spectrally, however, this BpS will have a unique signature - esp snowberry. The sites dominated by skunkbrush might be harder to differentiate from the grasses. This melds into needle-and-thread/western wheatgrass 1141.

Rabbitbrush, may be better to fit with sagebrush BpS. They tend to occur together.

Small patches on landscape approximately one acre to maybe 10ac in size - mapped by plot not imagery.

This BpS's shrub component may be increasing within the 1141 mixedgrass prairie due to the longer current-day MFRIs.

This type might be somewhat difficult to distinguish from 1106 Northern Rocky Mountain Foothill Deciduous Shrubland in terms of species, but they should be distinguished, as 1106 shrubs are adjacent to forest/woodlands or lower treeline, whereas 1085 is adjacent to ravines, more riparian and grassland 1141 system.

There should not be much mapping to this BpS. Most should be in 1141. This should be very, very infrequent for MZs 29, 30 and 20 and should encompass less than 10% of landscape historically.

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Maybe some Kentucky bluegrass in this BpS. Maybe annual bromes such as Japanese brome.

This system might appear departed currently due to increase in class C of snowberry, mostly, shrubs today due to missed MFRIs. See class C comments.

This may not be a separate system from the prairie matrix. Those areas that have increased shrub cover due to fire suppression should be considered part of Northwestern Great Plains Mixedgrass Prairie (CES303.674).

Native Uncharacteristic Conditions

Scale Description

Fires would generally range from 1000s-10000ac, or up to 100000ac through BpS 1141. Based on topography, wind speed, fine fuel loading and fuel arrangement the fires would burn in a mosiac pattern. Extent of weather influences (wet-dry cycles) would have been very widespread.

Small patches on landscape approximately one acre to maybe 10ac in size - mapped by plot not imagery. Patches occupy microsites associated with shoulder slopes, north aspect backslopes, depressions/swales and drainage ways/draws.

Issues/Problems

Comments

This model was adapted from the same BpS in MZ20 created by Brian Martin and reviewed by BJ Rhodes, Shannon Downey, Steve Barrett and others. Some descriptive additions/changes were made.

This model for MZ20 was originally adopted from the Rapid Assessment (RA) model R4PRMGn Northern Mixed Grass Prairie created by Cody Wienk and Lakhdar Benkobi and reviewed by David Engle (dme@mail.pss.okstate.edu) and John Ortmann (jortmann@tnc.org). Descriptive changes were first made for MZ20 by BJ Rhodes (bj_rhodes@blm.gov), John Carlson (john_carlson@blm.gov), Bill Volk (william_volk@blm.gov), Rich Adams (rich_adams@blm.gov) and Amanda Keefer (akeefer@mt.blm.gov). These reviewers, however, did not feel they had a sufficient grasp or concept of the system to change the model. Some errors were found in the original RA model that violated modeling rules and were therefore changed by Regional lead for MZ20. Brian Martin then reviewed the model and made quantitative changes. It was changed from the original five-box model to a three-box model.

Vegetation Classes

Class A **55 %**

Early Development 1 Open

Upper Layer Lifeform

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

Fuel Model 1

Description

Indicator Species* and Canopy Position

SCSC	Upper
CAFI	Upper
PASM	Upper
STIPA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	50 %
Height	Herb 0m	Herb 0.5m
Tree Size Class		

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

Shrub cover would range from 0-10%.

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Graminoids such as little bluestem, western wheatgrass, stipa, bluebunch wheatgrass, side-oats grama and upland sedges dominate this class. This class is a combination of grasses and very short-stature vegetation resulting also from prairie dog disturbance (maybe only in draws - snowberry).

A variety of forb species such as fetid marigold, scarlet globemallow, scarlet gaura, skeleton weed and dotted gayfeather tend to dominate this class.

Some sprouting of snowberry, chokecherry and serviceberry.

The fuel in this class would be initially too sparse to carry fire, but then fuel increase.

This class lasts for nine years then succeeds to B, mid open state. (Although, if it were a dense stand initially and then re-sprouted, might take quicker than nine years to get to B.)

Replacement fire occurs every 15-20yrs, and sets this class back to its beginning stage.

Grazing (0.07 probability or 7% of this class each year), the combination of drought and grazing (0.02 probability or two percent of this class each year), and drought modeled as wind/weather/stress (0.05 probability or five percent of this class each year) all occur and maintain this class but don't set it back to its beginning state.

Prairie dog impact occurs with a probability of 0.0035 (0.35% of class each year) and returns this class to its beginning. The only shrub that prairie dogs might impact in this BpS would be the snowberry sites and draws/drainageways.

Class B **30 %**

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

SYOC	Upper
JUHO2	Upper
PASM	Lower
STIPA	Lower

Structure Data (for upper layer lifeform)

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

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

Herbaceous cover is approximately 30-70% and 0.5m in height.

Description

More open community than late stage. Seedling shrubs.

Dominant shrubs coming in - snowberry, chokecherry, skunkbrush, creeping juniper and buffaloberry.

Western wheatgrass, needlegrasses, little bluestem, upland sedges, are common graminoids - same as in class A. Bluebunch wheatgrass can be locally common with skunkbrush. Common forbs include scurfpea, prairie coneflower, Rocky Mountain beeplant, scarlet globemallow and dotted gayfeather.

Herbaceous cover is approximately 30-70% and approx 0.5m in height.

This class lasts nine years and then succeeds to the late development stage.

Replacement fires occur every 15-20yrs.

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Grazing (0.02 probability or two percent of this class each year) and the combination of drought and grazing (0.01 probability), occur and cause a transition back to the early stage, A. Grazing (0.02 probability), the combination of drought and grazing (0.003 probability) and drought modeled as wind/weather stress (0.1 probability) can also occur while maintaining this class in this stage.

Prairie dog impact occurs with a probability of 0.0003, taking the class back to A.

Class C **15 %**

Late Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

SYOC	Upper
JUHO2	Upper
SHAR	Upper
SCSC	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	80 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class		

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

Herbaceous cover between 50-65% and 0.5m in height.

Description

Denser, higher canopy cover. Mature canopy.

Vegetation community is similar to previous class. Forbs are present still. Litter layer tends to be relatively continuous.

Herbaceous cover 50-65% and 0.5m in height.

Snowberry average cover could be 65% (DiBenedetto). Maximum up to 75%, minimum approx 45%. Skunkbrush cover average approximately 25%. Horizontal juniper average 44%, range of 25-65% cover. Each of the shrub species associated with own habitat type with moisture gradient. Skunkbrush is dry end, and snowberry/chokecherry is wet end.

Replacement fire occurs every 15-20yrs.

The combination of grazing and drought takes this class back to A, an early state (0.001 probability), B, a mid-open state (0.001 probability) or maintains this class (0.002 probability).

Grazing alone causes a transition back to an early stage (0.002 probability), to a mid stage (0.003 probability) or maintains this class (0.005 probability).

Drought modeled as wind/weather stress also maintains this class, with a probability of 0.05 (or five percent of this class each year.

It is thought that historically, this class probably occupied even <15% of the landscape. It probably occupied approximately 5-10% of the landscape due to the frequency of fire in the adjacent mixedgrass prairie. Currently, however, there is probably much more of this class on the landscape due to missed MFRIs - especially an increase in the snowberry shrubs on more mesic drainageways, draws and depressions - areas of higher available moisture.

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Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** II

Historical Fire Size (acres)

Avg 10000
Min 1000
Max 100000

Sources of Fire Regime Data

☑ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	15	8	30	0.06667	100
Mixed					
Surface					
All Fires	15			0.06669	

Fire Intervals (FI):

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

Additional Disturbances Modeled

☐ Insects/Disease
☑ Wind/Weather/Stress
☑ Native Grazing
☐ Competition
☑ Other (optional 1) prairie dog disturbance
☑ Other (optional 2) drought + grazing

References

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting 3010860 **Rocky Mountain Lower Montane-Foothill Shrubland**

☐ *This BPS is lumped with:*

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

General Information

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

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Vegetation Type

Upland Shrubland

Map Zone

30

Model Zone

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

Dominant Species*

CEMO2
ARTRV
PSSP6
ACHY

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This occurs in the Laramie Peak Range area of MZ29 (Chumley et al.1998). Foothills, canyon slopes and lower mountains of the Rocky Mountains. The description here focuses on true mountain-mahogany. Information in the FEIS online database indicates that the central distribution of true mountain-mahogany is located on the west side of the Rocky Mountains in the foothills and mountains of UT, CO and WY. The range of true mountain mahogany also extends north into MT, east into SD and Nebraska, south from OK into Mexico, and west into AZ and NV.

It occurs in every section of MZ22. It is questionable as to whether true mountain mahogany exists in the Bighorn Basin.

Biophysical Site Description

This BpS ranges from roughly 4400-8500ft. This BpS occurs on relatively xeric sites with thinly to moderately well developed soils on moderately steep to steep southerly aspects.

Vegetation Description

Species dominance varies depending on site conditions and by geographic location. Shrubs include

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Cercocarpus montanus, Amelanchier utahensis, Purshia tridentata, Rhus trilobata, Ribes cereum, Symphoriocarpus oreophilus, Yucca glauca, sagebrush, bitterbrush, serviceberry and rabbitbrush.

Grasses may include species of Hesperostipa, Pseudoroegneria spicata, indian ricegrass and western wheatgrass.

Disturbance Description

Historically, this type may have been in a Fire Regime IV -- primarily long-interval stand replacement fires. Nearly all the dominant species other than sagebrush in this BpS have the capability to resprout after disturbance.

Drought and grazing by native ungulates also occur in this system.

Cercocarpus montanus is a vigorous sprouter after fire.

Fire size is mostly in the 10s to 100s of acres and is influenced by adjacent grass and mountain shrub types.

Adjacency or Identification Concerns

Cheatgrass is present in this system today.

There is occassionally Rocky Mountain juniper and limber pine encroachment into this system.

Native Uncharacteristic Conditions

juniper invasion is uncharacteristic.

Scale Description

Erhard's observations suggest that the scale of the most common disturbance extent is relatively small. Patch size of the system is in the hundreds of acres.

Fire size is mostly in the 10s-100s of acres and is influenced by adjacent grass and mountain shrub types.

Issues/Problems

Comments

This model for MZ29 was adopted as-is from the same model for MZ22.

The model for MZ22 was adapted from the model for the same BpS from MZ28 created by Dean Erhard (derhard@fs.fed.us) and reviewed by Vic Ecklund, Chuck Kostecka and an anonymous reviewer. Other modelers for MZ22 were Jay Esperance, Carl Bezanson and Tim Kramer. The model and description for MZ22 differs quantitatively and descriptively from MZ28, as the model for MZ22 is split between true mountain mahogany and other shrubs. The model being discussed here is that for true mountain mahogany. MZ22 10861 is also lumped with 1106 for MZ22.

The model for MZ28 was based on the Rapid Assessment model R3MSHB. Mike Babler made edits 6/16/2005. R3MSHB reviewers were Barry Johnston, bcjohnston@fs.fed.us; Brenda Wilmore, bwhilmore@fs.fed.us; Tim Christiansen, christta@wsmr.army.mil; and Bill Baker, bakerwl@wyo.edu.

Vegetation Classes

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Class A 5 %

Early Development 1 Open

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

CEMO2 Upper
PSSP6 Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Early seral community. Grasses and sprouting shrubs. Resprouts well after fire. This class lasts approximately five years.

Herbaceous cover might be approximately 15%. Grasses and shrubs would probably be same height in this class. Shrub cover might be 0-5%. (The canopy cover of true mountain mahogany resprouts was less than three percent, as per plot data 18 months after a prescribed fire.)

Some grasses that might be present are needle-and-thread, bluebunch wheatgrass, Sandberg bluegrass, blue grama and western wheatgrass. Hairy Golden Aster was the most dominant of a wide variety of forbs.

Replacement fire occurs every 200yrs.

Drought and grazing can also occur and affect a small portion (0.5% each year, or 0.005 probability) of this class each year, and do not cause a transition to another stage.

Class B 10 %

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model 5

Indicator Species* and Canopy Position

CEMO2 Upper
PSSP6 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	20 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Greater shrub cover; grasses/forbs dominant in scattered openings. Herbaceous cover stays the same as in A.

This class lasts approximately 10yrs.

Replacement fire occurs every 150yrs.

Drought can also occur and affect a small portion (0.5% each year, or 0.005 probability) of this class each year, but does not cause a transition to another stage.

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Class C 85 %

Late Development 1 Open

Indicator Species* and Canopy Position

CEMO2 Upper
PSSP6 Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model 6

Description

Late development stage with greater shrub cover. There are more dead and decadent shrubs. Herbaceous cover stays the same as in earlier classes. (In current conditions, tree encroachment might be occurring in this stage due to lack of fire.)

Replacement fire occurs every 100yrs. There are more fuel in this class; therefore, there is more frequent fire.

Drought can also occur and affect a small portion (0.3% each year, or 0.003 probability) of this class each year, but does not cause a transition to another stage.

Class D 0 %

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class E 0 %

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Disturbances

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Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

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

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	100			0.01	100
Mixed					
Surface					
All Fires	100			0.01002	

Fire Intervals (FI):

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

Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3011170** **Southern Rocky Mountain Ponderosa Pine Savanna**

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

General Information

Contributors (also see the Comments field **Date** 6/12/2006

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Vegetation Type

Forest and Woodland

Map Zone

30

Model Zone

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

Dominant Species*

PIPO PASM
JUSC2 CAREX
RHAR4 SCSC
PSSP6 QUMA2

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

This BpS is located in the Bighorns of WY, Laramie Range. This might describe areas in MZs 29 and 20. Could occur in MZ29 in sections M331B, M331I, 342A and subsection 342Fb.

Biophysical Site Description

The geology is typically sedimentary in origin. Often found on buttes, hogbacks, rocky outcrops, and steep, rocky slopes. Elevations range from 3200-4400ft, but in the Bighorns may be found up to 5700ft on southern aspects. In eastern MT and northeast WY, it is also found on southern aspects.

Vegetation Description

This type is dominated by interior ponderosa pine and is often the only tree present. Understory composition varies but Rocky Mountain juniper, skunkbush sumac, mountain mahogany (in southern Black Hills and the eastern Pine Ridge), snowberry and yucca are common woody species. (One reviewer noted that under the historic fire regime, the occurrence of Yucca would have been a bit lower than at present.) Currant and chokecherry are found in the MT portion of the BpS's range.

Regional lead asked about JUSC2 as an indicator... JUSC2 can be considered an indicator for Laramie Peak Range. Rocky Mountain juniper is listed as present in late successional communities for ponderosa pine/Idaho fescue, ponderosa pine/sun sedge, and ponderosa pine/bluebunch wheatgrass habitat types by Hanson and Hoffman (1988) for southeastern MT. But it's not mentioned as present in the other ponderosa pine habitat types (ponderosa pine/common juniper, ponderosa pine/chokecherry). Rocky Mountain juniper is not an indicator for ponderosa pine habitat types in southeastern MT or western ND.

Herbaceous species include needlegrasses, gramma grasses, little bluestem, western wheatgrass, sedges

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and bluebunch wheatgrass. There is Idaho fescue as far east as Ashland, MT.

Disturbance Description

Generally frequent fires of low severity (Fire Regime Group I). Mixed severity fire occurs in the closed canopy conditions, and stand replacement fire is very infrequent (300+yrs). Low-severity fires are frequent and range from <10yrs to more than 20yrs (Brown and Sieg 1999, Fisher et al. 1987), but probably not more than 40yrs at the high end (3-70yrs range). The MFRI is approximately 12-15yrs for low severity fires.

There is considerable debate over the role of mixed severity and surface fires in the historical range of variability in this and other ponderosa pine forests in the northern and central Rockies (Baker and Ehle 2001, 2003; Barrett 2004; Veblen et al. 2000). Brown (2006) argues that surface fire was the dominant mode of fire disturbance and that the role of mixed-severity fires is overstated.

In the Rapid Assessment (RA), workshop review indicated more mixed fire should occur in the early stage and surface fire should be modeled in all structural stages. Peer review comments during the RA disagreed on the role of mixed and surface fire in this type. The majority of review agreed with the original model's parameters for mixed fire, but thought surface fire could be slightly less frequent. One review contended that there is no evidence of mixed severity fire in this type at all, and that the overall MFRI should be around 25yrs.

For MZs 29 and 30, it was suggested that mixed fire be removed from this model; reviewers agreed, and therefore mixed fire is not in the model.

Variation in precipitation and temperature interacting with fire, tip moths and ungulate grazing affects pine regeneration. Windthrow, storm damage and mountain pine beetles were minor disturbances in this type unless stands reach high densities. The interactions among drought, insects and disease are not well understood.

Ips spp of bark beetles can cause significant mortality among pole-sized and larger diameter pines, especially those weakened by drought, fire injury and the hail-related native disease diplodia. This serves to maintain the late-development open stage (class D) and move the late-development closed stage (class E) to the late-development open stage (class D).

Adjacency or Identification Concerns

This type is either surrounded by Northern Plains grasslands and shrublands or is a transition between Northern Plains grasslands and shrublands and higher-elevation coniferous forests. Ponderosa pine in this BpS has encroached into the Northern Plains grassland and shrubland types in many areas due to fire suppression and grazing.

As this system model and description is copied to the BpS: Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna, this system will be difficult to distinguish from that one, and is only distinguished by geography.

Invasive species in this system include cheatgrass, Japanese brome, crested wheatgrass, Kentucky bluegrass and intermediate wheatgrass. Crested wheatgrass and cheatgrass are at lower elevations mostly. Cheatgrass has altered the fire frequency and extent (although not on the Pine Ridge).

Currently, there have probably been at least five to 10 fire cycles that have been missed due to suppression,

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grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 50-80% canopy closure - uncharacteristic. Also - encroachment into prairies by pine and juniper is an issue today (juniper becomes more of an issue further east; it's primarily ponderosa pine that is encroaching in the NE area), although JUSC2 is an indicator at least in the Black Hills. Generally, the juniper that is an issue with the prairies east of the Black Hills is the eastern red-cedar. As it continues to be incorporated into windbreaks, it is continuing to increase into new areas.

Hardwoods exist in drainages, which encompasses a separate BpS. In NE, there is green ash, chokecherry, hackberry and American elm, which get crowded out by ponderosa pine.

Currently expanding into grasslands because of fire suppression, grazing and natural expansion from Holocene rebound (Norris 2006).

Native Uncharacteristic Conditions

Currently, there have probably been at least 5-10 fire cycles that have been missed due to suppression, grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 50-80% canopy closure - uncharacteristic. Some areas have been thinned to "even spacing," rather than the "clumpier" arrangement that is shown in early photos.

Scale Description

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

System would be a patchy mosaic of 10s-1000 of acres. It could be a range of patches, such as in Missouri Breaks where it could be up to 10000ac patches.

Issues/Problems

Comments

This BpS was originally modeled for MZ29 and MZ30 including the Black Hills. However, post-model-review-and-delivery, the new Northwestern Great Plains-Black Hills Ponderosa Pine BpS was created by NatureServe. Therefore, this model 1117 was retained as-is for a portion of MZs 29 and 30, based on geography, and this model 1117 was also copied as-is for a different portion of MZs 29 and 30, based on geography, and used for the BpS Northwestern Great Plains-Black Hills Ponderosa Pine Savanna split.

This model for MZs 29 and 30 was adapted from the Rapid Assessment (RA) model R0PIPOnp developed by Breck Hudson and reviewed by Bill Baker, Dennis Knight and Brad Sauer. Other modelers for MZs 29 and 30 were Paul Mock, David Overcast, and Kim Reid. Other reviewers for MZs 29 and 30 were Carolyn Sieg and Mary Lata.

RA Workshop code was PPIN11.

Additional authors for the RA include Deanna Reyher, Carolyn Sieg, Breck Hudson, Cody Wienk, Peter Brown and Blaine Cook. This type was modeled based on earlier work done by an expert panel (Morgan and Parsons 2001). Collapsing of stages were necessary to fit the five-box model used for this process.

Vegetation Classes

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Class A 5 %

Early Development 1 All Structure

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

NAVI4	Mid-Upper
PASM	Mid-Upper
PSSP6	Mid-Upper
CAREX	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	90 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	Seedling <4.5ft	

- [ ] Upper layer lifeform differs from dominant lifeform.

Shrubs are the upper layer, perhaps, but cover is <20%.

Description

This community is dominated by herbaceous and woody species, including the graminoids needlegrasses, western wheatgrass, bluebunch wheatgrass, sedges, Idaho fescue, and little bluestem in moister areas, and various shrubs including skunkbush and snowberry. Ponderosa pine seedlings are scattered and found in small clumps.

Little bluestem will also be indicator species.

Number of years in this class is variable depending on climatic patterns and fire disturbances. This class typically ends at 30yrs in this model. Without fire for 25yrs, this class can move to a mid-closed stage.

Needlegrasses can be tall up to one meter, but other graminoids are typically less than 0.5m.

Low severity surface fires occur every 30yrs. Replacement fires (since this is mostly grassland in this class) occur every 50yrs.

Class B 2 %

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Multi-story stand of small and medium trees with saplings and seedlings coming in as clumps. Understory is sparse. Some juniper might be present - could be an outlier. Grasses and shrubs are shaded out.

This class lasts approximately 70yrs, then moves to a late closed stage.

Low severity surface fires occur every 15yrs and move this stage to a mid open stage. Replacement fires occur infrequently approximately every 300yrs.

Insect/disease was modeled at approximately occurring every 50yrs, not causing a transition.

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement sev

Class C **8 %**

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
NAVI4	Lower
PASM	Lower
PSSP6	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Graminoids could have up to 60-80% cover (Hansen and Hoffmann 1988). Grasses co-dominate.

Description

Predominantly single story stands with a few pockets of regeneration. Low shrubs such as snowberry and skunkbush and poison ivy are dominant as well as grass and forbs. Graminoids could have up to 70-80% cover. Rocky Mountain juniper present in patches.

Carex spp and little bluestem will also be indicator species.

This class lasts approximately 50yrs then goes to a late open stage. Without fire for 40yrs, this could transition back to a mid closed stage.

Low severity surface fires occur every 15yrs, maintaining this class. Replacement fires occur very infrequently (modeled at 0.0015 probability).

Class D **80 %**

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
NAVI4	Lower
PASM	Lower
PSSP6	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Graminoids could have up to 60-80% cover. Grasses co-dominate.

Description

Predominantly single story stands of large ponderosa pine with pockets of smaller size classes (replacement). Snowberry, skunkbush and patches of Rocky Mountain juniper. Understory is dominated by shrub species and grasses and poison ivy. Graminoids could have up to 70-80% cover.

Carex spp and little bluestem will also be indicator species.

It is thought that class D, the late open stage, should occupy approximately 80% of the historical landscape.

Low severity fires occur every 15yrs and maintain this stage. Replacement fires occur very infrequently (0.0015 probability). If no fire occurs after 40yrs, this class could transition to the late closed stage.

Insect/disease occurs every 50yrs and maintains this stage.

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Class E **5 %**

Late Development 1 Closed

Indicator Species* and Canopy Position

PIPO Upper

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Description

This is a somewhat uniform late-development stage, multi-story stands of large, medium, small and seedling ponderosa pine. Shrubs and grasses are sparse. This type generally exceeds 70% canopy cover. DBH is less in this class than late-open.

Low severity surface fires occur every 15yrs and cause a transition back to the late open stage. Replacment fires occur every 300yrs.

Insect/disease occurs every 250yrs, causing a transition back to the late open stage. Drought can also occur - every 500yrs, causing a transition to the late open stage.

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg
Min 1
Max 50000

Sources of Fire Regime Data

☑ Literature
☑ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	380			0.00263	4
Mixed		0			
Surface	15	3	70	0.06667	96
All Fires	14			0.06931	

Fire Intervals (FI):

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

Additional Disturbances Modeled

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

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

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3011250** **Inter-Mountain Basins Big Sagebrush Steppe**

☑ *This BPS is lumped with: 1080*

☐ *This BPS is split into multiple models: 1125 describes MZ29 better. 1080 has ARCA13, which doesn't apply in these mapzones. Production is somewhat different, but not enough to split out (Benkobi).*

General Information

Contributors (also see the Comments field **Date** 10/3/2006

Modeler 1	Steve Cooper	scooper@mt.gov	**Reviewer**	Lakhdar Benkobi	lbenkobi@fs.fed.us
Modeler 2			**Reviewer**	Jeff DiBenedetto	jdibenedetto@fs.fed.us
Modeler 3			**Reviewer**	George Soehn	george_soehn@blm.gov

Vegetation Type

Upland Savannah/Shrub Steppe

Map Zone

30

Dominant Species*

ARTRW	PSSP6
PASM	HECO26
BOGR2	NAVI4
CHRYS9	CAFI

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Model Zone

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

Geographic Range

This system encompasses eastern and central MT, as opposed to throughout the Rocky Mountains, etc as BpS 1125 usually refers to. (This system is lumped with BpS 1080) 1125 is common throughout MZs 20 and 29 currently (not necessarily historically), except in western part of section 331Da. In MZ29, common historically.

For MZ29, it would occur in northeast WY section 331G, Thunder basin grasslands, northeast of 331Gg.

For MZ29, basin big sagebrush is very uncommon. Have Artemisia tridentata ssp. vaseyana (BpS 1126) at higher elevations associated with Bighorn, Pryor Mtns and Laramie ranges. Have Artemisia tridentata ssp. wyomingensis elsewhere where A. t. ssp. vaseyana doesn't occur. Mountain big sagebrush occurs in sections M331 associated with Bighorn and Laramie Ranges. A. t. ssp. wyomingensis occurs everywhere else.

In MZ29, in southeast MT, but this could be due to a soil anomaly. It probably occurred historically all through the subsections of southeast MT. Also through MZ30 in 331Mi in western Dakotas, 331Md in lower portion. As move north in 331Md, there is less of it. Probably does not occur in 331Mc. Canopy cover of sagebrush is probably <10%.

Biophysical Site Description

This system is Great Plains Sagebrush Steppe for MZ20. For MZ29, we are describing sagebrush

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wheatgrass steppe, where western wheatgrass is dominant. MZ20 and 29 are very similar for this type.

Soils are primarily dry from sedimentary processes in this system; soils are less fertile in this system, sometimes more calcareous. The Great Plains expression is found exclusively on "heavy" textured soils derived from shale and mudstones and can be strongly correlated with particular geologic formation or members thereof.

April, May, June have by far the most precipitation and this peaks in late May, early June. This pattern carries throughout the MT portion of the Great Plains though a gradient of more summer precipitation as you progress eastward but still the "spring" peak. It's not until you encounter tallgrass prairie does summer precipitation become predominant.

Wyoming big sagebrush occupies plains, foothills, terraces, slopes, plateaus, basin edges and even lower mountain slopes due to the fact that A. t. vaseyana is not part of the mix in MZ20 nor in MZ29. Soils are shallow to moderately deep, moderate to well drained and almost exclusively fine textured soils. Wyoming big sagebrush generally occurs in the 5-15in precipitation zones. Soil depth and accumulation of snow enhances these communities in lower precipitation zones (Knight 1994).

In MZ29, A.t. wyomingensis can occur from 2200ft up top 8000ft.

Bluebunch A.t. wyomingensis type is probably an inclusion in this BpS occurring on steep, south aspect slopes, typically badlands slopes/topography.

Vegetation Description

Wyoming big sagebrush is the dominant mid-to late seral species within this plant assemblage.

PASM and ELLA3 are by far the dominant grasses in MZ20 expression of this BpS. In MZ29, PASM, HECO26 and BOGR2 are by far the dominant grasses. Cool season grasses such as Indian ricegrass, bluebunch wheatgrass (Indian ricegrass and bluebunch wheatgrass occur only where coarser textured soils prevail), needle-and-thread (needle and thread has a broad ecoligical amplitude but more typically abundant on coarse soils; however, under heavy grazing, it does quite well on fine-textured soils.), blue grama, Sandberg bluegrass, squirreltail, threadleaf sedge and infrequently Thurber's needlegrass. Rhizomatous wheatgrasses, such as western wheatgrass and thickspike wheatgrass and plains reedgrass, are common species within these MZs 20 and 29. Junegrass also occurs.

Common forbs are species of Astragalus, Crepis, Delphinium, Phlox and Castilleja, while associated shrubs and shrub-like species can be small green rabbitbrush, MFRInge sagewort, winterfat and broom snakeweed. Other dominant species of forbs include RACO3 and SPCO. Also, LIPU and PHHO occurs.

Forbs most important for MZ20 include SPHCOC, DALPUR, PHLHOO, RATCOL and OPUPOL. Other forbs in MZs 10 and 19 include hawksbeard (Crepis acuminata), bird's beak (Cordylanthus spp), blue bell (Mertensia spp), Rocky mountain aster (Aster scopulorum), Phlox species, lupine (Lupinus spp) and buckwheat (Eriogonum spp). In MZ29, all of the above are probably found except for lupine, which would occur in higher precipitation areas and associated with mountain big sagebrush.

Herbaceous species usually dominate the site prior to re-establishment. Site re-establishment is by seed bank, seed production from remnant plants, and seeds from adjacent (untreated) plants.

Wyoming big sagebrush in upland sites have fewer understory species relative to the mountain big sagebrush subspecies, though at higher elevations or moister areas of this vegetation community there is a higher potential for herbaceous species, relative to ARTTST (ssp tridentata) sites; no definitive statement on undergrowth herbaceous diversity can be made for ARTTSW (ssp wyomingensis) sites. Herbaceous cover increases transitioning into the mixed-grass prairie, and in open patches.

In MZ29, tridentata ssp not found. Wyomingensis found where vaseyana not present. It can occur with greasewood and silver sage, as well as rabbitbrushes, and saltbush.

Disturbance Description

Many researchers believe fire was the primary disturbance factor within this plant assemblage. Other disturbance factors may include insects, rodents and lagomorphs, drought, wet cycles, gradual changes in climate and native grazing (Wyoming Interagency Vegetation Community 2002). Drought may have been more significant disturbance than native grazing or insects, so was included. Native grazing by large ungulates (eg, bison), and insects were included as occurring every 10yrs but causing no transitions to another class. Heavy-impact grazing in the late closed stage occurs less frequently and causes a transition to an open state.

Following fire or other significant disturbance, herbaceous species will dominate the ecological site post-burning and recovery to prefire canopy cover is quite variable and may generally take 50-120yrs, but occasionally occurs within a decade (Baker, in press). Site re-establishment is by seed production from remnant plants, and seeds from adjacent (untreated) plants. Discontinuity of fuel in Wyoming big sagebrush communities can result in mosaic burn patterns, leaving remnant plants for seed, but can be large expanses of complete mortality (Bushey 1987, Baker, in press). Fire does not stimulate germination of soil-stored Wyoming big sagebrush, but neither does it inhibit its germination (Chaplin and Winward 1982). Regeneration may occur in pulses linked to high precipitation events (Maier et al. 2001).

Overall fire return intervals in Wyoming big sagebrush appear to have ranged from 100 - 240yrs or more (Baker, in press) for MZ22. In MZ20, some believe that intervals are shorter, with replacement fire occuring approximately every 30yrs in some of the classes (based on BLM Fire Management plans and local expert estimate, Downey). However, there was disagreement with that short interval. It is also said that we are fairly certain of the recovery time required (50-150yrs, mostly around 100yrs). With this slow recovery, if fires returned to the site in 30yrs, eventually the whole landscape would be only class A and maybe B (open) (Cooper, personal correspondence). Therefore, for MZ20, MFRI was modeled at an overall 90yr interval, similar to other adjacent mapzones and similar to BpS 1080 MFRI of 80yrs, which this BpS is thought to be very similar to.

There was some disagreement among MZ20 modelers as to the MFRI of 90yrs for this 1125 system. Up north, where there is a heavy grass component and much less percent cover of sagebrush than what is down south, and relatively connected topography and a lot of wind, it would burn more frequently (Downey, pers comm). Perhaps that would be considered BpS 1085 instead of BpS 1125. And even though BpS 1085, which is also comprised mainly of Wyoming big sagebrush has an MFRI of 30yrs, these two systems are different as it relates in large part to setting and precipitation patterns, and continuity of fuels. Eastern MT has few breaks, versus mountain systems where there would be much less likely to have the huge sweeping fires. Although the species are the same Wyoming big sagebrush - the systems aren't (Martin, pers comm). The longer MFRI for 1125 was therefore retained.

Benkobi (pers comm) states that in MZ29, fire frequency could range from 36-40yrs (http:/gisdata.usgs.net). However, MZ29 reviewers did not want to change the model. However, because it was also stated that recovery occurred after at least 60yrs in MZ29, and due to the discrepancy from previous mapzones, the MFRI from MZ20 was retained.

Discontinuity of fuel in Wyoming big sagebrush communities often result in mosaic burn patterns, but large expanses can burn with complete mortality under extreme conditions (Bushey 1987, Baker, in press). Mixed severity fire was originally modeled in this BpS but due to a new understanding of definitions of severity types, it was thought that mixed severity fire does not occur in this system and rather patchy fires do occur, with replacement severity.

MZs 20 and 29, where prescribed burn: after 29yrs, there was still zero recovery of Wyoming big sagebrush (Cooper pers comm). It is thought that the Wyoming big sagebrush communities take longer than 100yrs to recover. In Bighorn battlefield, historically there was much sagebrush. It burned in the mid-80s and there is still no evidence of sagebrush re-establishment 10yrs later.

Antelope, mule deer and pygmy rabbits are native herbivores that browse sagebrush. These were also not included in the model. In MZ29, probably not pygmy rabbits. Sage grouse might also have an impact. It is questionable as to the impact/frequency of antelope and mule deer in MZ29.

Adjacency or Identification Concerns

This type is difficult to distinguish from mixed-grass prairie with a high shrub component. It is possible that with severe disturbance, a state change might occur to mixed-grass prairie - which in turn changes the potential for the site to return to sagebrush. Extensive severe burns for want of an adjacent seedbank would take extensive periods before ARTTSW was again a significant component. The reference condition might have been sagebrush, but now the abiotic facotrs and biophysical gradients indicate a mixed-grass prairie.

Secondary shrub and herbaceous components may vary considerably across the range of its extent. Wyoming big sagebrush sites may be a mosaic with or abut juniper, ponderosa pine, salt desert shrub and grassland vegetation types across its range. However, the most common accompanying vegetation is Northern Great Plains midgrass prairie.

Broom snakeweed and halogeton may dominate sites disturbed by overgrazing, oil and gas development or other disturbances. Club moss in this system increases with the intensity and duration of grazing. BROJAP can be an increaser with burning/grazing. There is also BROTEC invasion but that doesn't occur in the Northern Great Plains, except in MZ29.

Juniper increase might be occurring due to lack of fire today, but it is not developing into a true juniper woodland, especially in MZ29.

Shrub cover increases in MZ20 and 29 with overgrazing, and herbaceous layer decreases dramatically.

Might be difficult to distinguish from BpS 1080 and BpS 1085.

Much of 1080 has been lost due to land clearing for agriculture or converted to a cheatgrass or greasewood type. For basin big sagebrush in MZ29, this is the case. For Wyoming big sagebrush in MZ29, much has been lost due to burning for modern grazing. The understory is currently more annual bromes due to increased grazing.

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Overgrazing has also been an issue in 1080. HESCOM and KOEMAC increase (MZ20) where grazing is intense and protracted. It is questionable as to whether HESCOM increases with grazing (some areas of MZ29), and might rather decrease with overgrazing. With overgrazing in some areas of MZ29, more bluegrasses.

Plant associations are similar btwn 1125 and 1080. Shrubland is perhaps further south. Herbaceous cover is the only distinguishing factor. 1125 is definitely the more prominent historically. 1080 more prevalent in central WY. These (like mixegrass prairie) are distinguished by geography. Therefore, they're being combined for MZ29.

In Bighorns battlefield (around Hardin in MT), historic photos showed dense (up to 20%-30% cover, that is) shrub covered system, but currently, mostly grass - due to fires that burned there (Clark et al 1995 DRAFT).

If adjacent to pine systems, might be seeing more trees currently. (also in grass systems). This was seen in historic photographs throughout the northern part of MZ29 and through western SD (Clark et al 1995 DRAFT).

Native Uncharacteristic Conditions

Over 45% shrub cover would be uncharacteristic for MZ20 and MZ29. In fact, Wyoming big sagebrush in MZ29 would not exceed 40% cover. The only reason it would be this high is in cases of extreme overgrazing or in the absence of fire or changes in fire regime - frequency.

Scale Description

Occurrences may cover between hundreds and thousands of hectares.

Disturbance patch sizes range from 10s-1000s of hectares. The patch and disturbance size gets larger as this shrub BpS intergrades with the grassland BpS, and also gets larger from MZs 19 and 20 into MZ29.

Issues/Problems

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

Comments

This model for MZ29 was adapted from the same BpS from MZ20 created by Steve Cooper and Shannon Downey and reviewed by Steve Barrett. For MZs 29 and 30, descriptive additions and changes were made. Other reviewers for MZ29 were Bobby Baker and Jim Von Loh.

Model for MZ20 was adapted from the draft model for MZ22 for 1125b Inter-Mountain Basins Big Sagebrush Steppe-Wyoming Big Sagebrush, created by Mark Williams, Vicki Herren and an anonymous contributor and reviewed by Tim Kramer, Eve Warren and Destin Harrell. Changes were made to the description and model.

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

For the Rapid Assessment, the workshop code was WYSB. This model was combined with another Rapid Assessment model, R0SBWA (workshop code was WSAG1), modeled by George Soehn

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(george_soehn@blm.gov) and reviewed by Sarah Heide (sarah_heide@blm.gov) and Krista Gollinick-Waid (krista_waid@blm.gov). The two were combined based on peer-review and the similarity of disturbance regimes and species composition.

The RA Model is based on the original FRCC PNVG (WYSB1) with modifications from Wyoming Interagency Vegetation Committee (2002) and expert estimates. Peer review for the RA model was incorporated 4/30/2005. Additional reviewers were Karen Clause (karen.clause@wy.usda.gov), Ken Stinson (ken_stinson@blm.gov) and Eve Warren (eve_warren@blm.gov).

Vegetation Classes

Class A 35 %

Early Development 1 All Structure

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

NAVI4	Upper
PASM	Upper
BOGR2	Lower
CAFI	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	80 %
Height	Herb 0m	Herb 0.5m
Tree Size Class		

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

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.

Description

Herbaceous dominated. In the presettlement condition, NAVI4 (in MZ20) and HECO26 in MZ29 would have been a major upper position component. Primarily grasses with forbs. Exact species will vary depending on location. Western wheatgrass, Sandberg bluegrass, plains reedgrass, needle-and-thread, bluebunch wheatgrass, threadleaf sedge, plains junegrass and blue grama would be dominant grasses. Forbs may include Astragalus, Crepis, Castelleja, Delphinium, Agoseris, Phlox and others. There may also be significant component of small green rabbitbrush.

Succession to class B, a mid-development open stage, occurs after 40yrs. This succession was originally modeled at 20yrs; however, it was later decided that that was a minimum age for succession, and it would take more like 40yrs to achieve 5-15% canopy cover of ARTTSW. There is one paper that shows no ARTTSW 15yrs post-fire and another paper for MZ19 that indicates no recovery after as much as 18yrs (Cooper, personal correspondence). In MZ29, recovery occurred after 60yrs.

Insect/disease (0.001 probability or 0.1% of the landscape each year), native grazing (0.1 probability or 10% of the landscape each year), and wind/weather stress (every 100yrs, 0.01 probability or 1% of the landscape each year) occur, but do not cause a transition.

Replacement fire was originally modeled at every 30yrs, based on expert estimate and local observations - in BLM Fire Management Plans (Downey, personal correspondence). However, this was later changed to 90yrs based on recovery times of this type. This, and the other changes in age range, changed the class percentage from 20% to 35%.

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

Class B **40 %**

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8 Upper
PASM Mid-Upper
NAVI4 Mid-Upper
HECO26 Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	20 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is greater than five but less than 15%. Understory is well represented by herbaceous species as described for class A. (Montana Academy of Sciences publication - re: in breaks, After 15yrs after fire, no sage yet.)

ARFR4 also present in lower canopy.

Succession to class C, late development closed stage, occurs after 50yrs. (60yrs for MZ29)

Insect/disease (0.001 probability of .1% of the landscape each year), native grazing (0.1 probability or 10% of the landscape each year), and wind/weather stress (every 100yrs, 0.01 probability or 1% of the landscape each year) occur, but do not cause a transition to another stage.

Fire was modeled more frequently than in MZ22 based on expert estimate and data from BLM Fire Mangement Plans. Originally, mixed fire was modeled at occurring every 40yrs, maintaining the class in this stage (Downey, personal correspondence). However, this was later removed due to a new understanding of definitions of mixed versus replacement fire. This, and the other changes in age range, changed the class percentage from 55% to 35%. Replacement fire occurs every 90yrs.

Class C **25 %**

Late Development 1 Open

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

ARTRW8 Upper
PASM Mid-Upper
NAVI4 Mid-Upper
HECO26 Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	40 %
Height	Shrub 0m	Shrub 0.5m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Sagebrush canopy is >15%. Understory is well represented by herbaceous species as described for class A. This class is more common on drier sites.

Shrub cover max was 30% in MZ20. In MZ29, it was increased to 65% cover by other reviewers. However, it was decided that here could not be this amount of cover. Modal cover is 15%. The most measured was 32% cover. Some could have been higher cover but not much. Common in literature that grazing/over-grazing increases cover, not the opposite.
It is probably more common in 20% range. 40% is high, but could be a max (Cooper, diBenedetto, personal comm). Regional lead changed to 40% per comments.

ARFR4 is also present in lower canopy.

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

Insect/disease (0.001 probability of 0.1% of the landscape each year), native grazing (0.002 probability or 0.2% of the landscape each year) cause a transition to the mid-open stage.

Native grazing (0.1 probability or 10% of the landscape each year) occurs, but does not cause a transition to another stage.

Drought was modeled at an overall interval of 100yrs split between maintaining this stage or taking it to the mid-development stage.

Originally, mixed fire was modeled at occurring every 40yrs, maintaining the class in this stage (Downey, personal correspondence). However, this was later removed due to a new understanding of definitions of mixed versus replacement fire. Replacement fire occurs every 100yrs. This only changed the class percentage from 25% to 30%.

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	90			0.01111	100
Mixed					
Surface					
All Fires	90			0.01113	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of 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

- [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 seve

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

LANDFIRE Biophysical Setting Model

Biophysical Setting 3011320 Central Mixedgrass Prairie

☑ *This BPS is lumped with: 1150*

☐ *This BPS is split into multiple models: Lumping 1150 Tallgrass Prairie into the Mixedgrass Prairies 1132 and 1141, as we don't want to map this 1150 BpS for these mapzones. We would have to have a "fine-tooth comb" to do as such. There are individual associations of tallgrass in extreme northeast MT, but not tallgrass communities. We might have 1/4 acre of the plant associations - andropogon, halii, but not a whole system. The tiny inclusions of tallgrass would just be a portion of a mixedgrass community. If 1150 does occur in MZs 29 or 30, it might be in small, small areas, and it might not be able to be mapped. Tallgrass communities are in MZs 39 and 40. In MZs 29 and 30 only in small microsites - some species but not much. There is not tallgrass prairie west of the Missouri river historically.*

General Information

Contributors (also see the Comments field **Date** 9/30/2005

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Vegetation Type

Upland Grassland/Herbaceous

Map Zone

30

Model Zone

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

Dominant Species*

PASM KOMA
STVI ANGE
BOCU SCSC
CAFI

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

In MZ30, this would occur in sections 331Fu, 331Fv, 331Fs (eastern side), 331Fb (eastern side), 331Mc, 331Mf and 331Ea (eastern side, though questionable in this subsection). Might occur in northeastern MT, but modeling group doesn't have expertise to say one way or the other.

This might occur in the east portion of MZ30, but most of the mixedgrass prairie should be classified as 1141. Only in the far east, based on geography, classify as 1132 (Martin, pers comm).

For the lump of 1150 Tallgrass Prairie. We would have to have a "finetooth comb" to map tallgrass prairie in these mapzones. There are individual associations in extreme northeastern MT, but not tallgrass communities. There might be 1/4 acre of plant associations but not a whole system. It is thought that Tallgrass Prairie 1150 system occurs mostly in eastern Dakotas and NE, and maybe just small areas north of the Black Hills. This will not be found in the western part of MZ30, rather only the eastern part of MZ30 in small patches.

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Biophysical Site Description

In the 16-18in precipitation zone, there is more true mixedgrass.

Elevations range from 1500-3000ft. Temperatures range between extremes of hot summers and cold winters that are typical of a continental climate. Precipitation increases from west (15in) to east (20in). Most of the precipitation occurs during the growing season. Soils vary, but are generally mollisols. Soils in this BpS are formed from a diverse mixture of various sedimentary deposits. These soils range from clayey to laomy with sandy loams present in the western edge. Terrain consists of gentle rolling hills to large expanses of flat open ground.

In terms of the tallgrass prairie 1150: This BpS occurs in little depressional areas with greater than 16in precipitation in the area, in riparian stringers. It is too dry in MZs 29 and 30 for this type to occur but rarely.

Vegetation Description

This vegetation type is characterized by the dominance of grasses such as western wheatgrass (most prominent grass in 1141 too) and little bluestem (also in 1141). Typically contains grass species such as side oats grama (less important in 1141 but still present) and green needle grass (as does 1141). Includes elements from W. Great Plains short grass (BOGR - but in 1141 too) and western Great Plains Tall Grass systems (Andropogon spp - but in 1141 too), but these are probably just microsites. Trees are limited to riparian areas and drainages which may be listed under a different BpS. Silver sagebrush may be found in some floodplains. Other woody species inlcude skunkbrush sumac and snowberry, but these species are limited in abundance. Cool season grasses begin to cure in mid July, making fire more likely than earlier in the growing season.

In terms of the 1150 Tallgrass Prairie: The dominant grass is switchgrass. Big bluestem only occurs in Sidney, Mt. Might have one acre of the plant associations Andropogon, Halii, but not whole system.

Disturbance Description

This area is strongly influenced by wet-dry cycles.

Fire, grazing by large ungulates and small mammals such as prairie dogs and soil disturbances (ie, buffalo wallows and prairie dog towns) are the major disturbances in this vegetation type.

From instrumental weather records, droughts average about one in every 10yrs, but droughts are often semi-periodic lasting 3-4yrs in 30-40yr cycles.

Historically, there were likely close interactions between fire and grazing since large ungulates tend to be attracted to post-fire communities. Average fire intervals are estimated at 5-15yrs, with the average probably 10yrs. Fires were most common in July and August, but probably occurred from about April to September. Seasonality of fires influences vegetation composition. Recurring early season fires (April - May) tend to favor warm-season species, while late season fires (August - September) may affect grass species relatively equally. Replacement fire in our model does remove 75% of the above ground cover as assumed in the literature. However, MZ30 modelers did not think that loss of the above ground cover by the replacement fire will necessarily induce a retrogression back to an earlier seral stage because the main component of dominant grasses remains unharmed to insure the continuity of the seral stage.

MZ30 modelers used two levels of native grazing intensities: heavy with at least 70% biomass removal, typical of prairie dog towns and near fresh water for bison, and "regular" native grazing to be less than

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that. It was assumed that regular grazing would not alter the Early2 community enough to change classes, but it would drive Late class to Early2. It was assumed that regular grazing intensity would not be enough to change Early2 to Early1. Heavy grazing would move the community back to earlier stages. It was also assumed that grazing with drought could move a community to earlier stages. It was also assumed that nothing was enough to drive Late to Early1 in one year, hence no transition probabilities for that. It was assumed that regular levels of grazing had a 5-year return interval.

Data from prairie dog towns (early seral, aka class A) suggest cover ranges from 0-80%. Height is most valuable measure of difference between early and other seral stages, but height in mixed grass prairie often is not much greater than 50cm -- resolution of mapping may not be great enough to distinguish among classes. Cover values shown in vegetation classes therefore are not comfortably reflecting reality.

Height and cover values described in vegetation classes below are at this point expert opinion -- further refinement from literature would be better.

Adjacency or Identification Concerns

This would be difficult to distinguish from BpS 1141. 1132 has more tallgrass species that wouldn't grow in MT, however. Dominant species in 1132, however, as listed by NatureServe, are dominants in many other systems (Martin, pers comm).
There are slight nuances of the models of 1141 and 1132 that distinguish them, but they are inconsequential in terms of the MFRI and percentages within classes and general functioning of the model. Nuances are due to differing modelers and perspective of disturbances.

The central mixedgrass prairie is not well defined but in general is a transition area between the tallgrass praire and mixedgrass praire. There is higher precipitation and taller grasses thanin 1141. There are more shrubby species. 1141 is further west and has ARTR2, whereas 1132 has more chokecherry/sumac.

There is more woody species invasion further east. At 20in precipitation, deciduous trees invade from the draws. If an area is not burned, will lose the prairie. In eastern ND and SD, there are trees there, that if they don't burn, they will cover up the prairie systems (but that's the tallgrass prairie, which is almost all ag now. Much of the mixedgrass prairie is converted to ag today). That wouldn't occur in the west as much. Trees would be restricted to the microclimate situation or in draws (Martin, pers comm).

This BpS is easiy confused with NW Great Plains mixed grass praire (BpS 1141). Main difference is this BpS has higher moisture regime, more tall grass plants and lack of fire results in more shrubs and trees.

This wouldn't function differently than 1141. And it wouldn't key out differently than 1141 (Cooper, pers comm). The only way you might be able to tell this apart is by geography. 1141 is further west. Also - chokecherry and sumac in 1132 vs ARTR2 in 1141.

FROM R4PRMGn: This BpS transitions to tallgrass prairie to the east, sagebrush steppe to the west, and sandhills prairie, shortgrass prairie and southern mixed-grass prairie to the south. In the western part of this BpS, big sagebrush can invade with heavy grazing or absence of fire. Cheatgrass currently is increasing in portions of this BpS. This Bps is similar to the BpS R0PGRn from the Northern and Central Rockies model zone.

This BpS is bordered by BpS 1150 on the east; bordered by 1141 to the west; bordered by 1149 to the south.

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Many areas invaded by exotics such as smooth brome, Kentucky bluegrass, Canada thistle and Japanese brome. Sweet clover can increase during wet springs or following wildlfire.

Some of this BpS has been farmed. In places native range has also been type converted to tame grasses. Farming has helped spread exotic species. Type converted areas can have taller, denser growth of herbaceous plants if not grazed.

There might be more of the early successional, short grass class (A) on the landscape today, due to exotics and grazing.

When thinking about similarity or departure from historic or uncharacteristic communities at landscape levels, the following situations might be useful to check mapping results against classification and model logic. The major influences on current vegetation composition and structure in the great plains are (diBenedetto, pers comm):
1) Conversion of grassland/shrublands to cropland (uncharacteristic types)

2) Introduction of introduced species, primarilly crested wheatgrass, annual bromes, smooth brome etc. and yellow sweetclover (uncharacteristic type)

3) Shift from mid-grass dominanted grassland communities to shortgrass dominated communities through season long heavy grazing (departure from historic, if percentage is outside range of variability. Prairie dog towns would fit into this category. This dynamic can be a response to longterm periodic drought as well (departure from historic range). The mid-grass to short grass change is a shift that has occurred historically in response to fluctuating climate (drought, above normal precip cycles), grazing intensity/recovery. More may be in short grass, under current intensive pastoral grazing systems vs. migratory grazing patterns that occurred historically. Grazing would shift midgrass communities to short grass dominated communities (Bison may or may not have influenced this, but season long heavy livestock grazing seems to cause this shift). So a high percentage of the landscape in short grass, vs mid grass would indicate a departure.

4) Shift from grassland communities to forest, wooded or shrub dominated communities in absence of fire (departure or uncharacteristic for grass BpS). This may be a key shift that has occurred or is occurring on the Great Plains along with conversion of rangeland to cropland and planting of exotic grass species (CRP lands). Probably more meaningful in terms of fire disturbance relationships than the short grass-mid grass shift.

With the exception of areas occupied by prarire dog towns, the characteristic late successional communities should be dominated by mid-grass dominated plant communities. Tall grass dominated communities would only occur as unmapped inclusions associated with topo-edaphic positions. Tall grass dominated communities include those dominated by prairie sandreed, big bluestem, prairie cordgrass.

Please see BpS 1141 Adjacency/Identification Concerns box for additional info concerning Mixedgrass Prairie identification.

Native Uncharacteristic Conditions

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See Adjacency/Identification Concerns

Scale Description

Historically and now, fires probably ranged in size from 1000s to 10,000s of acres. The variation depends on build-up of fuel which were influenced by precipitation and grazing. Extent of weather influences (wet-dry cycles) would have been very widespread.

Issues/Problems

This system does not have well defined boundaries and tends to transition gradually into other systems.

Due to issues with mapping grass systems and separating out successional classes by height and cover of grasses, this model has been reduced to a two-box model.

Comments

This model for MZ29 and 30 was adapted from the RA model R4PRMGn Northern Mixed Grass Prairie, created by Cody Wienk and Lakhdar Benkobi and reviewed by David Engle and John Ortmann. Other modeler for MZ30 was Terry Chaplin. Other reviewer was Jim Von Loh. Regional lead for MZ30 also provided input and changes to the model to a great extent. Approval from original modelers/reviewers sought.

Ortmann in his RA review, suggested that in addition to fire, drought and grazing, insect outbreaks (Rocky Mountain locust) would have impacted all classes.

Vegetation Classes

Class A **15 %**

Early Development 1 Open

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

ARFR	Upper
BOGR2	Upper
SPCO	Upper
ARPU9	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Herb 0m	Herb 0.5m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class is similar to class A in 1141. It was originally created as just a prairie dog stage. However, after review for 1141 in MZ20, 29 and 30, regional lead suggested changing 1132 class A to a prairie dog and an early stage, and therefore change age range to approx 0-3yrs instead of five years. Cover was changed to 0-40% instead of 0-60%.

This is the immediate-post-disturbance-post-fire stage or the very short-stature vegetation resulting from prairie dog disturbance or heavy ungulate grazing. The fuel in this class are generally too sparse and/or too short to carry fire if it is a prairie dog stage. Otherwise can carry fire somewhat.

A variety of forb species such as fetid marigold, scarlet globemallow and curlycup gumweed cab dominate this class, especially in prairie dog towns, but grasses can also be common.

Common grass species include blue grama, purple three-awn, buffalo grass and prairie junegrass. MFRInged sagebrush can also be a component of this class. Prickly pear, man sage (ARLU), MFRInged sage, and broom

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snakeweed occur in this class. Abundance of prickly pear is much higher than in other seral stages.

Data from prairie dog town plots at Wind Cave National Park and Devils Tower National Monument (which are west of this mapping zone, but still relevant -- A. Symstad and C. Wienk, pers. comm.) show covers ranging from 0-80%, which cannot be accurately captured with the limitations on cover/height classes used for mapping purposes. The most distinguishing characteristic of this seral stage is its height, which is 0-30cm, and the species composition described above.

This class succeeds to B after three years.

High, prolonged heavy grazing was modeled as Optional 1. This would include prairie dog grazing. This occurs on 20% of this class each year, keeping it in this class.

Drought combined with grazing was modeled as Optional 2. This occurs on 1.2% (0.012 probability - every 80yrs) of this class each year.

Replacement fire occurs every 25yrs.

Class B **85 %**

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	Mid-Upper
PASM	Upper
CAFI	Middle
SCSC	Middle

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	41 %	100 %
Height	Herb 0m	Herb 1.0m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class is similar to 1141 class B. Blue grama, western wheatgrass, needlegrasses, prairie junegrass, upland sedges and little bluestem are common grasses. In some areas species such as big bluestem and prairie sandreed are locally common. Western wheatgrass and little bluestem are the most common species as this class ages. In some areas, western wheatgrass forms dense stands.

Common forbs include scurfpea, prairie coneflower, Rocky Mountain beeplant, scarlet globemallow and dotted gayfeather. Prickly pear, man sage (Artemisia ludoviciana), MFRInged sage, snowberry and broom snakeweed occur in this class.

This model was originally created as a three-box model; however, post-sclass-review for an adjacent MZfor model 1141, resulted in a decision to change the model to a more simpler version for LF mapping constraints.

This is a mid-late stage. Cover was changed from 61-100% to 41-100% by regional lead based on suggestions to revise model based on review in MZ20, 29 and 30 for mixedgrass prairie types and mapping constraints.

Cover in this class would actually range from 60-100%, with the average somewhere around 65-80% (wild guess on average), depending on soils and weather for the year. Height would actually range from 10-130cm, (higher range only in areas with tallgrass species such as big bluestem), averaging around 45-75cm.

Replacement fire occurs but grasses quickly recover. This occurs every 10yrs. Replacement fire was originally

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modeled as infrequently causing a transition back to the A stage (0.0001 probability). However, replacement fire was changed by regional lead to be more in line with 1141 and also due to the model changes to the entire model - ie: class A representing a suite of earlier, post-disturbance situations and changed from a three to a two-box model. Replacement fire was therefore modeled as occurring every 10yrs, half the time causing a transition back to A, half the time not causing a transition.

Heavy prolonged grazing such as prairie dogs occurs but infrequently causing a transition back to A (0.003 probability).

The effect of drought and grazing also occurs causing a transition back to A, but infrequently (0.006 probability).

Native grazing occurs on 20% of the class each year, maintaining this stage.

Drought can also occur, but infrequently causing a transition back to A (0.003 probability). Regular drought could occur, however, every 50yrs and not cause a transition (this was taken from previous model iteration, class C).

With lack of fire, encroachment might occur after this class. Trees (juniper and chokecherry) and shrubs might appear with higher cover. It would be uncharacteristic to have higher than 10% cover of shrubs/trees.

Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

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Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** II

Historical Fire Size (acres)

Avg 10000
Min 1000
Max 100000

Sources of Fire Regime Data

☑ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	11	8	25	0.09091	100
Mixed					
Surface					
All Fires	11			0.09093	

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

Additional Disturbances Modeled

☐ Insects/Disease
☑ Native Grazing
☑ Other (optional 1) heavy prolonged native grazing
☑ Wind/Weather/Stress
☐ Competition
☑ Other (optional 2) drought + grazing

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3011410** **Northwestern Great Plains Mixedgrass Prairie**

☑ *This BPS is lumped with: 1150*

☐ *This BPS is split into multiple models:* *Lumping 1150 Tallgrass Prairie into the Mixedgrass Prairies 1132 and 1141, as we don't want to map this 1150 BpS for these mapzones. We would have to have a "fine-tooth comb" to do as such. There are individual associations of tallgrass in extreme northeast MT, but not tallgrass communities. We might have 1/4 acre of the plant associations - andropogon, halii, but not a whole system. The tiny inclusions of tallgrass would just be a portion of a mixedgrass community. If 1150 does occur in MZs 29 or 30, it might be in small, small areas, and it might not be able to be mapped. Tallgrass communities are in MZs 39 and 40. In MZs 29 or 30 only in small microsites - some species but not much. There is not tallgrass prairie west of the Missouri River historically.*

General Information

Contributors (also see the Comments field **Date** 4/6/2006

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Vegetation Type

Upland Grassland/Herbaceous

Map Zone

30

Model Zone

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

Dominant Species*

PSSP6 SCSC
NAVI4 KOMA
PASM POSE
HECOC8 BOGR2

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This vegetation group covers the northern prairies east of the Rocky Mountains from north central MT to southeastern MT and northeastern WY.

This BpS occurs in every section throughout the MZ20. It occurs predominantly in subsections 331Dh (central and eastern portion) and 331La.

Subsection 331La coincides quite closely to the Brown Central Glaciated Plains MLRA52, as defined by the NRCS. The central and eastern part of 331Dh coincides with Northern Glaciated Plains MLRA. Also - MLRA 58a includes southeastern MT. This BpS also resides in MLRA53A Northern Dark Brown Glaciated Plains, Northern Rolling High Plains, MLRAs 58A, B, C, D, and Pierre Shale Plains, MLRAs 60A and 60B.

This system's extent also coincides with EPA Ecoregions Level III and IV, 42-Northern Glaciated Plains,

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43n-Montana Central Grasslands, 43m-Judith Basin Grasslands, 43o-Montana Unglaciated high Plains and 43a-Missouri High Plateau (Woods et al 2002).

Historically, this BpS could also have extended throughout the subsections for 331Kb,most of d, f and e; presently, it might be more of a shrub community.

This BpS occurs in every subsection throughout the MZs 29 and 30. It occurs predominantly depending on soil types and precipitation zones. It typically does not occur within mountain subsections. Mixedgrass prairie is the dominant vegetation type in the Northern Great Plains Steppe Ecoregion.

For the lump of 1150 Tallgrass Prairie: we would "have to have a fine-tooth comb" to map tallgrass prairie in these mapzones. There are individual associations in extreme northeast MT, but not tallgrass communities. There might be 1/4 acre of plant associations, but not a whole system. It is thought that Tallgrass Prairie 1150 system occurs mostly in Eastern Dakotas and NE, and maybe just small areas north of the Black Hills. This will not be found in the western part of MZ30, rather only the eastern part of MZ30 in small patches.

Biophysical Site Description

Elevations range from 1900-4000ft, or up to 6500ft in MZ29. The continental climate entails long cold winters, hot summers with low humidity and strong winds between November through April.

The northwestern part of this BpS is characterized by Chinook winds in winter commonly resulting in "red belt mortality" in adjacent coniferous forests (Van Fossen, pers comm).

Mean annual precipitation is generally 10-15in with most falling as rain or snow from April through June. The western part of this BpS is characterized by C3-cool-season plants and the eastern part of the BpS has an increase in abundance of C4-warm season plants, almost to the point of dominance in the plant community.

Occurs ubiquitously across soil types, except alkaline flats. Kinds, amounts, and proportions of plants vary widely relative to soil texture, soil depth, percent slope and aspect. Bunchgrass communities dominate on shallow soils. Mid, short and bunchgrass communities comprise the remainder.

Topography is level to sloping.

Reviewers of this model (B.J. Rhodes, Bill Volk and John Carlson) for MZ20 stated that this system resides in the soil survey studies done by NRCS, and that their original modeling for this effort relied heavily on the Ecological Site Descriptions for MLRA 52 (NRCS 2004), 58A and 60B (NRCS 2003). However, MLRA 52 is dominantly deep, well drained clay loam, clay, and loam textures, whereas MLRA 58A and 60B have a significant component of moderately deep and shallow silt loam, silty clay loam, and loam soils (Van Fossen, pers comm). It has been suggested by one reviewer that Glaciated Plains be separated from Northern Rolling High Plains. However, this model was not split as such.

In terms of the tallgrass prairie 1150: From B. Martin: This BpS occurs in little depressional areas with greater than 16in precipitation in the area; in riparian stringers. It is too dry in MZs 29 and 30 for this type to occur but rarely.

Vegetation Description

The vegetation is dominated by cool and warm season perennial grasses (50-85% canopy cover). Gramma

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grasses, rhizomatous grasses (western and thickspike wheatgrass, etc.) dominate the visual aspect of the community, though bunch grasses (bluebunch wheatgrass, needle grasses, etc.) often comprised more than 50% of the community composition.

The timing of precipitation/precipitation flushes that occur in mid-June through mid-July, going from west to east geographically, result in warm season grasses that are more prominent versus cool season grasses as transitioning to east, through the precipitation gradient. As go further east and north, in MT and ND, there is more typic ustic moisture regime, MFRIgid temperature regimes. As go further west, more aridic ustic MFRIgid. SD more typic ustic; mesic as go further south (WY, south SD). Due to latitudinal gradients and elevational changes. Western (MLRA52) versus Eastern (MLRA53) Glaciated Plains -typic ustic - capture timing of precipitation changes. Eastern captures more warm season grasses. So - warm season grasses, dominated by species such as - side oats grama, little bluestem, sand bluestem in sandy areas, big bluestem, prairie sandreed.

Thickspike wheatgrass (Elymus macrourus) (on lighter soils) is also present and western wheatgrass (on heavier soils). CALO can also be a dominant species. Idaho fescue is a community dominant in MZ29 where precipitation is greater than 17in (Ashland Ranger District). Prairie sandreed and upland sedges occupy sandy textured soils throughout MZs 29 and 30. Bluebunch wheatgrass is more prevalent within WY and eastern MT in MZ29. Bluebunch only occurs on shallow sites, and occurs more on the west. Bluebunch more in MZ20 vs MZ29.

Carex filifolia also present, but not that prominent.

A diverse array of perennial summer forbs (black samson, scurfpea, prairieclovers, flax, dotted gayfeather and scarlet globemallow, etc.) occupies 10% of the community.

Shrubs and halfshrubs (Wyoming big sagebrush, silver sagebrush, rabbitbrush, MFRInged sagewort, western snowberry, etc.) obtain less than five percent cover. Most of the ground surface is covered and bare ground is <10% on more mesic sites and 20% on more xeric sites (eg, glacial till and claypand soils).

The most common shrub is silver sagebrush and resprouts after fire.

In pre-European conditions, there was a component of this BpS that had significant prairie dog impact and was characterized by broom snakeweed, prairie sagewort, sixweeks fescue and plains pricklypear.

Current conditions are different - please see Identification Concerns or Issues/Problems boxes.

In terms of the 1150 Tallgrass Prairie: The dominant grass is switchgrass. Big bluestem only occurs in Sidney, Mt. We might have 1/4 acre of the plant associations - andropogon, halii, but not a whole system.

Disturbance Description

Grazing by large, concentrated herds of ungulates (bison, elk, pronghorn and deer) along with aboriginal and natural fire maintained healthy, productive and diverse grasslands. (This grazing regime is referred to as "Native Grazing" in the VDDT model.) Such grazing may have resulted in heavy defoliation and/or some soil churning, but was transitory. Temporary impact followed by rest-recovery time is characteristic. A reviewer stated that ungulate grazing might have limited the potential for replacement fires at times, as there might have been significant areas that couldn't carry a fire for very long periods of time. However, this comment was not input into the model.

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A small portion of the landscape was subjected to repeated or prolonged heavy animal impact, including heavy defoliation and repeated soil churning and/or compaction. Such areas included watering points for herds, bison or elk wallows, and prairie dog towns. This heavy animal impact disturbance was modeled as "Optional2" in the VDDT model and includes its impacts in its own class. Repetitive heavy animal impact sends the community to an alternative open successional pathway. This small prairie-dog impacted portion of the landscape was also characterized by different grasses (see Veg Description).

Periodic grazing and replacement fire, when it occurred in an intact community, resulted in removal of most of the above-ground biomass, but resulted in little mortality and relatively rapid recovery times.

Because MLRA 52 versus MLRA 58A and 60B are physiographically different enough due to soils, etc., response to fire might change in different areas of the MZ(VanFossen, pers comm).

Historically, the fire return interval averaged 8-12yrs for the region, but naturally occurring fuel breaks on slopes and badlands probably lengthened the mean interval. Fire-scarred tree-rings from areas within and adjacent to the northern Great Plains provide intervals within the 0-35yr range over the past 500yrs (Henderson 2005).

Fuel load recovery times are an alternative means by which to estimate the minimum average return interval for grassland fires, though this approach has not been formally attempted. A general decrease in productivity of ungrazed northern mixed-grass prairie is reported for 1-3yrs post-burn, and litter loads may take 11-16yrs to completely recover (as per various studies) (Henderson 2005). The total standing crop of fuel, combining both current year production and litter, is capable of recovering to pre-burn conditions in 4-8yrs (Shay et al. 2001). Theoretically, for repeated fires to occur without altering long-term grassland productivity and species composition, the mean return interval should be eight years or greater (Henderson 2005).

Given a minimum return interval of 0.5yrs, mode of eight years, and 95% probability of a fire occurring within 35yrs, the resulting right-skewed distribution makes possible return intervals >35yrs but probably never longer than 100yrs (Henderson 2005).

A negative exponential distribution probably best describes the historic fire size distribution, with a large number <1ha, median 10-100ha, mean 1000-10,000ha and a low frequency of 50,000-1,000,000ha (Henderson 2005).

Grazing and prairie dog towns also reduced fuel loads, fire frequency, size and intensity; with the most substantial impacts in valley bottom shrublands and grasslands, and upland grasslands near water. Historically, the majority of human caused ignitions were concentrated in spring and fall seasons, while lightning-caused fires were concentrated in late summer. However, in the north central part of MT, in MZ20, lightning ignitions outside of the mountains are not primarily a late summer phenomenon, but rather, late spring and early to mid-summer phenomenon (not much happening after the end of July). Ignitions occur prior to green-up. If fall storms occur with lightning, those will also cause fires - and are often associated with heavy winds.

The prairie dogs towns would have shifted slightly over long periods of time – becoming more flammable when the dogs move away (or periodically decrease). At their largest expansion periods, prairie dogs would have occupied up to 80% of their potential habitat. So, this would have had, periodically, a huge

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effect on ungulate grazing, fire and, probably, soil hydrology changes as they change with litter and dominant species (Lata, pers comm).

The absence of grazing and replacement fire for many years (eg, 50yrs) would lead to an increased shrub component (snowberry and green ash) in precipitation zones greater than 14in, and a buildup of dead grass. (Buildups of litter generally result in decreased diversity and lower basal area of remaining grass plants.) Within 10-14in precipitation zones, Wyoming big sagebrush and silver sagebrush may also increase. Productivity of the grasses is decreased, resulting in greater mortality from smoldering fire.

Mormon crickets, grasshoppers and great plains locust might have had more of an impact in this system than currently defined, but unsure of historic impact and frequency (Siddoway).

Drought also occurs somewhat frequently. Some modelers felt it occurred every 30yrs, and some believed it occurred every five years. Short term precipitation variability may also influence species productivity. Drought periodicities centering around 58yrs were characteristic of southeast MT and eastern WY for the last ~300yrs. A 22-year rhythm was characteristic of 1892 to 1977, but less clear for 1801–1889 and did not occur in 1714–1801. Ten or more years without drought in any of the four areas occurred once or twice per century (Stockton and Meko 1983). A Northern Great Plains HRV draft study by Judy von Ahlefeldt states that the frequency of droughts was less than five years in length for 2-300yrs (Weakley 1943).

Adjacency or Identification Concerns

Areas with similar soils but steeper topography (>15%) are less productive and have a higher dominance of shrubs.

The natural grazing regime has been replaced with domestick livestock grazing that is targeted toward "moderate" grazing intensity. This is often characterized by grazing each year with removal of herbage over an extended period of the growing season without adequate rest and recovery from grazing. This is contrasted with the expected historic shorter, episodic grazing patterns. One result is more structural homogeneity. Under this grazing regime, taller, palatable grasses such as green needlegrass, bluebunch wheatgrass decrease and short grasses (western wheatgrass, needle and thread grass, blue gramma and sandberg bluegrass) increase. Also under this grazing regime, litter may increase (depending on precipitation and instensity of grazing) with the expected results of decreased diversity and decreased vigor of remaining grasses. Only under season long grazing will warm-season grasses like little bluestem decrease. Season of use and/or twice-over grazing will impact the prevalence of little bluestem and other C4 plants.

Shrubs (Wyoming sagebrush, silver sagebrush, western snowberry, rabbitbrush and MFRInged sagewort) increase greatly over the historic plant community. Compare the ecological site description to avoid using a shrub model for historic plant community when considering a grass site that has changed as a result of uncharacteristic grazing or unnaturally long fire return intervals. Unnaturally long intervals without fire may contribute to an increased shrub component (shurbs might include Opuntia spp and Yucca spp in NE). Xeric sites will experience an increase in sagebrush, whereas western snowberry will increase in mesic areas.

In modern times, invasive grasses such as smooth brome (only in small areas), poa pratensis, crested wheatgrass, Kentucky bluegrass (Kentucky bluegrass and Poa pratensis only in small areas) have become widely established in some areas and are locally abundant and expanding. Other invasive species of

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concern include spotted, diffuse and Russian knapweeds, often along roads and stream corridors; leafy spurge and Canadian thistle, along stream corridors; yellow sweetclover; dalmation toadflax; and annual bromes, including Japanese brome. Dense clubmoss stands are also a problem in this class, as is blue grama - limiting productivity and diversity in this system.

Long-term high intensity grazing by domestic livestock without periods of rest and recovery can result in a conversion in the vegetation states from a mid-grass dominated community to shortgrass dominated communities (blue grama, sedges, and sandberg bluegrass, buffalograss in southern portions and junegrass). This should be distinguished from the succession class (class B) that's influenced more by presence of prairie dog towns - which have a higher forb component with less of a midgrass component than the other classes. In species composition, the prairie dog versus domestic grazed communities, are very different.

In current conditions, there has also been an increase in the amount of woody vegetation on the plains, particularly increases in snowberry on mesic sites and expansion of ponderosa pine into grasslands and shrublands which were probably maintained in a grassland state under historic fire frequencies. The lack of fire has shifted grassland systems to shrublands or woodlands.

The expansion of ponderosa pine and shrubs, including snowberry, yucca and prickly pear is noticeable, but more so (at least for these species) in the eastern portion of MZs 29 and 30.

This BpS may be similar to the PNVG R4PRMGn from the Northern Plains model zone. Reviewers (Rhodes, Volk, Adams) of this model felt that the Northern Great Plains shrubland might have been a subcomponent of this BpS that was historically limited to less productive soil types, and with a much longer fire cycle. However, other reviewers (VanFossen, pers comm) disagreed with that statement and stated that silver sagebrush, in particular, is and has been a natural component of deep, well-drained, productive soils.

In MZ20, historically, this BpS could also have extended throughout the subsections for 331K; in present, 331Kb,most of d, f and e might be more of a shrub community. Big sagebrush more susceptible to fire and so probably less prevalent historically.

There could well have been areas that were surrounded by prairie dog towns and protected from fire in that way historically. As per Clarke McClung, it occurs as such in NE (Lata, pers comm).

There might be places, as there are further south and east of MZs 29 and 30, that now have crested wheatgrass as a major component, as it was heavily seeded in the 1930s (Lata, pers comm).

There is more woody species invasion further east. At 20in precipitation, deciduous trees will invade from the draws; if the area is not burned, the prairie will be lost. In eastern ND and SD, there are trees that will cover up the prairie systems if they are not burned periodically. (but that's the tallgrass prairie, which is almost all agriculture now. Much of the mixedgrass prairie is converted to agriculture today). That wouldn't occur in the west as much. Trees would be restricted to the microclimate situation or in draws (Martin, pers comm).

When thinking about similarity or departure from historic or uncharacteristic communities at landscape levels, the following situations might be useful to check mapping results against classification and model logic. The major influences on current vegetation composition and structure in the great plains are

(diBenedetto, pers comm):
1) Conversion of grassland/shrublands to cropland (uncharacteristic types).

2) Introduction of introduced species, primarilly crested wheatgrass, annual bromes, smooth brome etc. and yellow sweetclover (uncharacteristic type).

3) Shift from mid-grass dominanted grassland communities to shortgrass dominated communities through season long heavy grazing (departure from historic, if percentage is outside range of variability). Prairie dog towns would fit into this category. This dynamic can be a response to longterm periodic drought as well (departure from historic range). The mid-grass to short grass change is a shift that has occurred historically in response to fluctuating climate (drought, above normal precip cycles), grazing intensity/recovery. More may be in short grass, under current intensive pastoral grazing systems versus migratory grazing patterns that occurred historically. Grazing would shift midgrass communities to short grass dominated communities (Bison may or may not have influenced this, but season long heavy livestock grazing seems to cause this shift). So a high percentage of the landscape in short grass, versus mid grass would indicate a departure.

4) Shift from grassland communities to forest, wooded or shrub dominated communities in absence of fire (departure or uncharacteristic for grass BpS). This may be a key shift that has occurred or is occurring on the Great Plains along with conversion of rangeland to cropland and planting of exotic grass species (CRP lands). Probably more meaningful in terms of fire disturbance relationships than the short grass-mid grass shift.

With the exception of areas occupied by prarire dog towns, the characteristic late successional communities should be dominated by mid-grass dominated plant communities. Tall grass dominated communities would only occur as unmapped inclusions associated with topo-edaphic positions. Tall grass dominated communities include those dominated by prairie sandreed, big bluestem and prairie cordgrass.

DISTINGUISHING BTWN 1132 AND 1141:
This would be difficult to distinguish from BpS 1132. 1132 has more tallgrass species that wouldn't grow in MT, however. Dominant species in 1132, however, as listed by NatureServe, are dominants in many other systems (Martin, pers comm).

There are slight nuances of the models of 1141 and 1132 that distinguish them, but they are inconsequential in terms of the MFRI and percentages within classes and general functioning of the model. Nuances are due to differing modelers and perspective of disturbances.

The central mixedgrass prairie is not well defined but in general is a transition area between the tallgrass praire and mixedgrass praire. There is higher precip and taller grasses than in 1141. There are more shrubby species. 1141 is further west. And has ARTR2, whereas 1132 has more chokecherry/sumac.

This BpS is easiy confused with central mixedgrass praire (BpS 1132). Main difference is 1132 has higher moisture regime, more tall grass plants, and lack of fire results in more shrubs and trees.

This wouldn't function differently than 1132. And it wouldn't key out differently (Cooper, pers comm). The only way you might be able to tell this apart is by geography. 1141 is further west. Also - chokecherry and sumac in 1132 vs ARTR2 in 1141.

Productivity might be lower in 1141 - soils generally not quite as deep, less rain and probably less litter build up as well, although the higher moisture in 1132 would allow litter to decompose at a faster rate (Lata, pers comm).

Native Uncharacteristic Conditions

With lack of fire, increased shrub or tree cover would be uncharacteristic.

Scale Description

Historically, natural grazing and fire generally encompassed hundreds to hundreds of thousands of acres. Repeated heavy animal impact such as prairie dog towns occurred at the scale of 10s-1000s of acres, as well as ungulate impacts - bison.

A negative exponential distribution probably best describes the historic fire size distribution, with a large number <1ha, median 10-100ha, mean 1000-10,000 ha, a low frequency of 50,000-1,000,000ha and rare outliers >1,000,000ha (Henderson 2005).

Issues/Problems

This BpS covers a large diverse area with relatively little extensive data or published studies for vegetation classification. Fire frequency is based primarily on inference based on understanding of the plant community dynamics and anecdotes or historical research (mostly oral histories) regarding Indian burning.

Due to issues with mapping grass systems and separating out successional classes by height and cover of grasses, this model has been reduced to a two-box model.

Comments

Model for MZs 29, 20 and 30 was originally adapted from RA model R0PGRn created by Shannon Downey. Model for MZ20 was originally modeled with five boxes - by Shannon Downey and Steve Cooper. However, during a review session, reviewers (BJ Rhodes, John Carlson, Rich Adams and Bill Volk) suggested changes and changed this model to a three-box model. Agreement and input was received from the original modelers. Subsequent review of this model for an adjacent mapzones by modelers (Jeff DiBenedetto, Brian Martin, Cody Wienk, George Soehn and Bobby Baker) led to adoption of a different three-box model. After agreement from original modelers and reviewers, this last three-box model is the one that was used for MZ20. Because the original five-box and other three-box models originally developed, were abandoned, the details and the changes are not detailed here. Subsequent to sclass review for MZ20, model for MZs 29 and 30 was changed based on mapping constraints. Therefore, model for MZs 29 and 30, is different than that for MZ20 in succession class proportions, age ranges and cover/height and boxes. Other reviewers for MZs 29 and 30 were Shannon Downey, Jeff Jones, Steve Cooper and Mary Lata.

Other reviewers for this model for MZ20 were Steve Barrett, Mary Manning (USFS), Steve VanFossen (NRCS) and Jon Siddoway (NRCS).

Vegetation Classes

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
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Class A 25 %

Early Development 1 All Structure

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PASM	Upper
HECO26	Upper
BOGR2	Upper
ARFR	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Herb 0m	Herb 0.5m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Class A is the post-fire early-seral stage, combined with the very short-stature vegetation resulting from prairie dog disturbance or repeated high intensity herbivory or trampling (eg, watering points, buffalo wallows).

This class may also be a short term response to severe drought, combined with other impacts (Optional 1 - modeled as occurring very infrequently - 0.001 probability, but causing a transition all the way back to the beginning). (NOTE: Previously, in MZ20, this class was defined as just a prairie dog stage with the herbivory/trampling and severe drought components -and defined as a class B instead of A. But due to mapping constraints and inability of mapping to distinguish grass species and grass heights at a fine level, and therefore a prairie dog stage versus an early successional or mid successional stage, all early post-replacement and very short stage grasses were placed into this class A.)

A variety of forb species such as fetid marigold, scarlet globemallow and curlycup gumweed tend to dominate this class. Common grass species include purple three-awn, buffalo grass, Sandberg bluegrass, blue grama and western wheatgras. MFRInged sagebrush can also be a component of this class.

Also - this represents the immediate post-disturbance intact historic plant community functioning under grazing and/or fire, dominated by cool and warm season rhihzomatous perennial grasses, as well as bunchgrasses. Little bluestem, prairie sandreed and bluebunch wheatgrass occur as dominant species in small patches. Other species in this class are Artemisia, grama grasses, western yarrow and prairie junegrass. Other species might include blue grama and western yarrow. STIPA, PSSP6 and SCSC might also be indicators.

Due to the combination of the prairie dog stage (indicator species: BOGR2, POSE, ARFR and DYPA) and the early successional stage (indicator species: PASM, NAVI4, HECO26 and BOGR2), the indicator species were combined for this class.

Because this is the post-fire early regen stage, or a prairie dog stage, this is generally a shortgrass functional group which are communities dominated by species such as: poas, dryland sedges, blue grama, buffalograss, clubmoss, junegrass and forbs either singly or in combination; may also be characterized by higher bare soil. This might be a shortgrass EVT. A higher proportion of this class on the landscape today would indicate departure.

This class lasts approximately three years. If in a prairie dog state, then the class would last longer in order to transition out of it; however, this is accounted for, by having a prairie dog disturbance in the model, resetting succession and keeping it in this class. The three-year interval attempts to capture what would happen post-fire or post-drought. (Also - post heavy grazing in current conditions would take longer to transition out of this class.)

Native grazing (bison, prognhorn and prairie dog) can be locally heavy due to increased succulence of young

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grasses. This occurs on 20% of this class each year, keeping it in this stage. This was split 50/50 between native grazing and Optional 2, prairie dog grazing. Prairie dog grazing takes this stage back to the beginning, whereas grazing just occurs without causing a transition.

Drought can occur every 30yrs, not causing a transition.

Replacement fire occurs but not as frequently, due to lack of fuel, every 20yrs.

(Note about identifying in current conditions: Long-term high intensity grazing by domestic livestock without periods of rest and recovery can result in a conversion in the vegetation states from a mid-grass dominated community to shortgrass dominated communities (blue grama, sedges and sandberg bluegrass, buffalograss in southern portions and junegrass). This is different in species composition than a prairie dog community. However, for LANDFIRE (LF) mapping purposes, it is not possible to distinguish between the different types of short grasses occurring.)

Prairie dog disease is also a potential impact, but because prairie dog stage was combined with early succession, this disturbance was not modeled for MZs 29 and 30.

It is thought that a prairie dog class should comprise approximately 5-8% of the landscape, and no more than 10% (Dan Uresk, pers comm). Research for historical Northern Great Plains vegetation would have prairie dog communities within an early successional stage of max 10-15% across an entire landscape. So only a portion of the early successional stage would be a prairie-dog-type community - ie: maybe 5-8%.

Class B **75 %**

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PASM	Upper
NAVI4	Upper
HECO26	Upper
BOGR2	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	90 %
Height	Herb 0m	Herb 1.0m
Tree Size Class		

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

Shrub species could be present with approximately 0-10% cover. Common shrubs - silver sagebrush, winterfat, MFRInge sagewort and rubber rabbitbrush. Less common would be skunkbush sumac, mostly on slopes and shallow soils.

Description

Class B represents the intact historic plant community functioning under grazing and/or fire, dominated by taller, cool and warm season rhihzomatous perennial grasses, as well as bunchgrasses. This is the all-encompassing mid-late-development, functioning fine stage.

This model was originally created as a three-box model; however, post-sclass-review for an adjacent mapzone, resulted in a decision to change the model to a more simpler version for LF mapping constraints.

Little bluestem, prairie sandreed and bluebunch wheatgrass occur as dominant species in small patches. Other species in this class are Artemisia, grama grasses, western yarrow and prairie junegrass. Other species might include blue grama and western yarrow. STIPA, PSSP6 and SCSC might also be indicators.

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

Little below-ground mortality occurs after replacement fire, and resprouting of perennial grasses and forbs often occurs within days or weeks, depending on season. Grasses show greater vigor; some forb establishment may occur as a result of exposure of mineral soil. Canopy cover recovers quickly after resprouting.

Shrub species could be present at 0-10% cover. Silver sagebrush and winterfat (on deeper soils) are the most common shrub, and would start resprouting. Wyoming big sagebrush can also be a component (on shallower soils) of this BpS, although a small component.

Club moss might be present in Glaciated Plains at 0-5% cover, but not on shallow clay sites or dense clay sites, sands, saline upland, saline lowland, sub-irrigated or wet meadow.

Replacement fire occurs every 5-15yrs.

Drought occurs every 30yrs and maintains this stage. A reviewer felt that drought occurred more often, every five years, but because most wanted to model it at 30yrs, it was left as such.

Native grazing by large ungulates could have occurred, inlcuding bison grazing. It is likely heavy locally due to increased succulence of young grasses. It might occur with a probability of 0.2 (every five years, or 20% of this class each year).

Native grazing by prairie dogs could also occur on a small portion of the landscape (0.001 probability of 0.1% of this class), bringing this state to A.

Optional 1 was also modeled, which includes a combination of disturbances of drought, native bison grazing and a small amount of fire (not enough to be its own category). When all of these disturbances occur in concurrence, you might get a transition to the short-stature A-class type community. This occurs on a small portion of the landscape (0.001 probability of 0.1% of this class).

Insect/disease occurs very infrequently with a probability of 0.0001. It has been suggested that grasshoppers and Mormon crickets might have a larger impact historically than the probability assigned here. However, unsure of impact and frequency.

With a lack of fire, this class might shift to having more shrubs and tree invasion.

Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☑ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

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Class D 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** II

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	13	2	40	0.07692	100
Mixed					
Surface					
All Fires	13			0.07694	

Fire Intervals (FI):

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

Additional Disturbances Modeled

☑ Insects/Disease ☑ Native Grazing ☑ Other (optional 1) drought + native bison grazing + small fire portion

☑ Wind/Weather/Stress ☐ Competition ☑ Other (optional 2) prairie dog grazing

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

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

LANDFIRE Biophysical Setting Model

***Biophysical Setting* 3011470** **Western Great Plains Foothill and Piedmont Grassland**

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

General Information

Contributors (also see the Comments field **Date** 11/1/2006

Modeler 1	Elena Contreras	econtreras@tnc.org	**Reviewer**	Eldon Rash	erash@fs.fed.us
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Modeler 3			**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

30

Model Zone

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

Dominant Species*

BOGR2	MUMO
SCHIZ4	PASM
BUDA	HECO26
NAVI4	SPCR

General Model Sources

☑ Literature
☐ Local Data
☐ Expert Estimate

Geographic Range

Occurs in the southern Great Plains, in southern CO and eastern NM.
It is questionable whether this occurs in MZs 29 and 30. It could be on the front range with cool season species, but it's aggregated with other grass types. It could occur in the Wolf Mtns - 331Gf, 331Kf - in between these. This is more of a CO-front range type with sandy soils. If it occurs anywhere, it might be in MZ30, 331Fb.

This primarily occurs in MZ33 in SE WY, along the bluffs. It also occurs in the southern portions of MZ29, but isn't going to be common. It could also occur along the western boundary of MZ29 in the Laramie Peak Range.

Biophysical Site Description

This type typically occurs on plains and draws, or on gently rolling uplands of the southern Great Plains. In NM and CO, elevations range from 1600-2200m (5250-7200ft). Precipitation ranges from 12-14in, and occurs predominantly during the summer.

Vegetation Description

Wolf Mtns has Idaho fescue and bluebunch.

This type typically occurs on the rolling uplands of the Great Plains. Vegetation is mid and short grass dominated little bluestem, blue grama, buffalo grass and needle-and-thread, with intermingled forbs and scattered half-shrubs. This type correlates with Kuchler's (1964) types 65, 66, 67 and 68.

VEG FOR MZ29 AND 30??

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Disturbance Description

Return interval for fire could be extended by ungulate grazing. Episodic disturbance caused by insect infestation (grasshoppers, range caterpillars, and Mormon crickets) occured. Insects could also extend the fire return interval.

This system was historically grazed by bison, now grazed by cows for the most part.

Periodic drought can also change fire return intervals. First fire return interval decreases as drought occurs then lengthens as drought continues and less biomass is produced.

This type was modeled with an overall MMFRI of 10yrs. There is a question as to whether this interval is too short. Also, there should not be any mixed fire in this type, as it is a grassland model. It should all be replacement fire (Regional lead removed mixed fire).

Question as to whether there are any other disturbances occurring here.

Adjacency or Identification Concerns

Higher elevation sites of this type borders the juniper steppe type. This also borders cottonwood riparian in places and mountain shrublands - mostly sagebrush in others.

If this is adjacent to juniper, then juniper invasion of the grasslands would be an uncharacteristic condition.

Also - cheatgrass occurs.

There would probably be lower canopy cover today from season long, year after year grazing of cows combined with high stocking of deer and elk. Bison grazing was probably more intermittent and likely to vary from year to year.

Native Uncharacteristic Conditions

There would probably be lower canopy cover today from season long, year after year grazing of cows combined with high stocking of deer and elk. Bison grazing was probably more intermittent and likely to vary from year to year.

Scale Description

This would occur in small patches in MZs 29 and 30, if at all.

Along the western border of MZ29, this occurs in patches of 10s-1000s of acres.

Issues/Problems

Comments

This model for MZs 29 and 30 was adopted from the same BpS from MZ28 created by Gale Green and Wayne Robbie and reviewed by Vic Ecklund and Chuck Kostecka. Regional lead, however, made model fixes to abide by mapping rules and new understanding of severity types.

This model is based on the Rapid Assessment (RA) model R3PGRs, which was reviewed by B. Baker (bakerwl@wyo.edu). FRCC model PGRA4 was the original model. Review suggests one model for all plains grasslands. Because of species composition differences, and class differences, 1147 and 1149 were

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not combined.

Final qa/qc of the RA model resulted in the elimination of a VDDT rule violation, and changed the resulting amount in classes B and C by five percent (Pohl, 8/17/2005).

Vegetation Classes

Class A **5 %**

Early Development 1 All Structure

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	All
BUDA	All

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Dominated by resprouts and seedlings of grasses and post-fire associated forbs. Low to medium height with variable canopy cover. This type typically occurs where fires burn relatively hot in classes B and C.

This class was originally modeled in MZ28 with cover of 0-10%. However, due to mapping rules, it was changed to 0-20% for MZs 29 and 30.

This class succeeds to C after four years. It can also succeed to B as an alternative successional pathway (0.01 probability).

Replacement fire occurs every 15yrs. Mixed fire was originally modeled for MZ28; however, it was removed for MZs 29 and 30, due to a new understanding of lack of mixed fire in grassland systems.

Class B **25 %**

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	Upper
BUDA	Upper
SCHIZ4	Upper

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	31 %	70 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Greater than 35% herb cover. Generally associated with more productive soils, but can be caused by cumulative high moisture seasons increasing the cover and productivity of class C. Low to medium height.

This class can persist.

Mixed fire was originally modeled for MZ28; however, it was removed for MZs 29 and 30, due to a new understanding of lack of mixed fire in grassland systems. Replacement fire occurs every 15yrs keeping in this class. Replacement fire also occurs every 100yrs bringing this class back to A, and replacement fire every 100yrs bringing to C.

Wind/weather stress (drought) occurs every 13yrs, or affects 7.5% of this class each year.

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Class C **70 %**

Mid Development 1 Open

Indicator Species* and Canopy Position

BOGR2 Upper
BUDA Upper

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☑ Herbaceous
☐ Shrub
☐ Tree

Fuel Model 1

Description

Less than 35% herb cover. Generally associated with less productive cobbly and gravelly soils, but can also be caused by cumulative drought shifting class B to this class. Low to medium height.

This class was originally modeled in MZ28 with cover of 11-30%. However, due to mapping rules, it was changed to 21-30% for MZs 29 and 30.

Alternate successional pathway without fire for 20yrs, brings this class to B.

Mixed fire was originally modeled for MZ28; however, it was removed for MZs 29 and 30, due to a new understanding of lack of mixed fire in grassland systems. Replacement fire every 100yrs bringing to A. Replacement fire every 12yrs not causing a transition.

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Disturbances

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

Fire Regime Group:** II

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

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

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	12	2	35	0.08333	100
Mixed					
Surface					
All Fires	12			0.08335	

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

Additional Disturbances Modeled

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

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3011480** **Western Great Plains Sand Prairie**

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

General Information

Contributors (also see the Comments field **Date** 4/6/2006

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Vegetation Type

Upland Grassland/Herbaceous

Map Zone

30

Model Zone

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

Dominant Species*

CALO SPCR
SCSC
BOGR2
HECO26

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

Predominantly the eastern portion of MZ20. Also found in scattered pockets elswhere throught the zone. It probably occurs on the Charles Russel National Wildlife Refuge. In 331Kf, this might occur.

In MZs 29 and 30, more of this type than in MZ20 because more sandstone and sandy soils. Mostly only in MZ30. 30K acres (guesstimate); maybe southern portion MZ29. Occurs around Broadus and Ekalaka. Medicine Rocks State Park almost all sand prairie. 331Kf, in 331Gf, d. Occurs in Little Missouri Grasslands in Dakotas.

There are good classification data and local descriptions of this type for Theodore Roosevelt National Park near Medora, ND as part of the USGS-NPS Vegetation Mapping Program (Jim Von Loh, pers comm).

Biophysical Site Description

This BpS would be found in NRCS's sand type or the Sandy Ecological site description. Occurs around sandstone outcrops.

Lower productivity on these sandy sites versus the mixedgrass prairie sites.

Vegetation Description

Dominant vegetation includes prairie sandreed (Calamovilfa longifolia), little bluestem (Schizachyrium scoparium), blue grama (Bouteloua gracilis), needle-and-thread (Stipa comata), sand dropseed (Sporobolus cryptandrus). Shrubs seen may include horizontal juniper (Juniperus horizontalis), silver sagebrush (Artemisia cana), and skunkbrush (Rhus trilobata). Further east (not in MZ20), BOHI2 and

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ANHA might occur.

It's uncommon to find Wyoming big sagebrush, and when you do - it's usually Wyoming big sagebrush with bluebunch wheatgrass or needle-and-thread, that you'd find on a sandy soil. The sagebrush in this type is usually silver sagebrush. It would be unusual to have more than 10-15% shrub cover except in the case of Juniperus horizontalis, where cover can go up to 80% or more.

Disturbance Description

Fire, grazing and drought were the primary disturbances. Disturbances were cyclic with the earliest and latest seral stages fluctuating widely in accordance with changes in climate.

The principal large grazer of the system was most likely bison which, when occurring in large numbers, would have locally disturbed large areas due both to grazing impact and physical disturbances such as trampling and wallowing. Grazing impacts are more pronounced near water and removed from steep, rough terrain. Overall the whole system would have been frequently impacted by large ungulate grazers.

Prairie dogs might have been a very minor component of the system. Where they occurred, prairie dogs grazed vegetation close to the ground which provided a local firebreak. It is questionable, however, as to whether prairie dogs prefer sandy soil and actually occurred here. It is thought that prairie dogs would not occur on these sandy sites and rather they usually occur on fine textured soils.

Fire was a frequent and widespread occurence. The most extensive fires are likely to have occurred in years with wet springs followed by hot, dry summers when grazing pressure was low. Wet springs would have resulted in more productive and more continuous plant cover (ie, fuel) that would have supported and expanded fires ignited under dry conditions occurring later in the season. In addition, litter accumulation over several fire-free years would also have supported widespread fire, in any conditions. The litter component, a determining factor in fire size and frequency, is correlated with seral stage. Three to five fire-free years produce enough litter to carry another fire. Post-fire shifts in species composition depend on the timing and condition of fire. It is also speculated that native burning might have been an influence in this BpS.

Fire regime similar to adjacent grassland.

Extended periods of severe drought is likely to have affected both species composition and the stability of the sandy soil, particularly when compounded by wind and heavy grazing. Droughts could affect the entire region.

Adjacency or Identification Concerns

Northwestern Plains Mixed Grass Prairie systems are often found nearby, especially in the western portion of the zone. The sand prairie, however, occurs on the sandy sites. Identify this system by sandy/soil types.

Pine savanna is sometimes at top of these sandy sites. Trees on northerly or easterly slopes, might be looking at sandy outcrop. Portion of upper slope might be associated with sand prairie. Top will be mapped to pine savanna or woodland.

The disturbance regime has been drastically changed since European settlement. Agriculture replaced bison and fires have been effectively suppressed.

Bromus much less prevalent on sandy soils than on mixedgrass prairie, but does occur. There aren't any invasives for this system that are particularly an issue.

It's uncommon to find Wyoming big sagebrush, and when you do - it's usually Wyoming big sagebrush with bluebunch wheatgrass or needle-and-thread, that you'd find on a sandy soil. The sagebrush in this type is usually silver sagebrush. It would be unusual to have more than 10-15% shrub cover except in the case of Juniperus horizontalis, where cover can go up to 80% or more.

This system is much less departed than 1141. This system is probably not very far departed from the HRV if at all.

Native Uncharacteristic Conditions

Over 60% cover herbaceous would be uncharacteristic… probably wouldn't be a sandy site anymore. Herb height also wouldn't be over one meter.

Scale Description

This is generally a patch that occurs within the larger northwestern Great Plains mixedgrass. Size probably varies widely, but is generally going to be 10s of thousands of acres in MZ29 at the large side versus hundreds of acres or less in MZ20.

In terms of disturbance impact, in MZ20, entire patches are going to be impacted, whereas it will vary to an unknown level in MZ29.

Issues/Problems

Very little data are available from presettlement times.

Comments

This model for MZs 29 and 30 was adapted from the same BpS from MZ20 created by Peter Lesica, Vinita Shea and Ben Pratt and reviewed by Steve Barrett and Brian Martin.

This model for MZ20 was adapted from the Rapid Assessment model R4NESP Nebraska Sandhills Prairie created by Tom Bragg (tbragg@mail.unomaha.edu), Mary Lata (mlata@fs.fed.us) and Dave Shadis (dshadis@fs.fed.us) and reviewed by John Ortmann (jortmann@tnc.org). Major descriptive and quantitative changes were made so that the model more appropriately represented MT, instead of NE.

Vegetation Classes

Class A **20 %**

Early Development 1 Open

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

SPCR	Upper
HECO26	Lower
SCSC	Upper
CALO	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	40 %
Height	Herb 0m	Herb 0.5m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Class A represents immediate to three year post disturbance conditions. Vegetation consists of resprouting and seedling grass and forbs. Total bare soil is greater than before the disturbance particularly on less productive sites. The vigor of new growth and the specific species affected depend on the season of the

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disturbance and on pre- and post-disturbance environmental conditions (eg, available soil moisture). Litter is low initially but increases until, by year three, there is enough to support fire under average burning conditions. Fire was therefore modeled as occuring somewhat less frequently than in class B. In uplands, where soil-type is dominated by coarse-grained sands with low water-holding capacity, post-disturbance primary production initially decreases thus fire may only carry under ideal conditions. Under these conditions, grazing is likely to be light. In lowlands, with finer-textured soils, primary production is determined largely by moisture availability.

HECO26 was used as an indicator species for MZs 29 and 30 instead of BOGR2.

ARCA13 can resprout immediately after fire, so it could be present in this stage as well. It could, however, be killed following intensive fires. But since not much litter in these sites, possibility of intense fire reduced.

It was originally suggested that there be a prairie-dog influenced stage at approximately two percent of the landscape. However, there was some disagreement as to whether this class should exist or not for this system, as it is thought that these sandy sites might have been unlikely to have prairie dog towns. It was only distinguished from A by different species (Buchloe dactyloides - only in the extreme southeast portion of the stage and Bouteloua gracilis, and Agropyron dasystachyum). Canopy cover was 0-20%. This (very unlikely) prairie dog influenced class was therefore merged into the early successional stage, class A. It is doubtful that prariie dogs would colonize very sandy sites; most prairie dog sites have fairly fine-textured soils.

Repeated grazing of these areas will prevent succession to class B. Grazing occurs with a probability of 0.05. Prairie dog grazing was modeled as optional 1, with a very unlikely probability of 0.0007. Both of these will set succession back to the beginning.

Replacement fires occur every 40yrs (due to less litter until the last years of this class, they were modeled as occurring less frequently than in class B. (20yr vs 40yr MFRI does not change percentages in each class.)

Class B **80 %**

Late Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

CALO	Upper
SCSC	Upper
BOGR2	Lower
ARCA13	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	60 %
Height	Herb 0m	Herb 1.0m
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This system was originally modeled as a four-box model with a mid and late stage; however, it was changed to a three-box model, combining the mid and late stages, since species and structural info was very similar, as were disturbances. It was then combined into a two-box model because of the lack of a prairie dog stage.

This mid-to-late seral stage would persist three years after a fire. The maximum cover height for grasses would be approximately 60%, even though in other mapzones, cover might be much higher.

Other species indicators could be JUHO2 and SPCR - in the later part of this stage. Various sprouting shrubs may be established. The shrubs are as tall or taller than the grasses, but they would not be dominant; shrubs might occupy approximately 10% of the area. Some of the shrubs include Juniper horizontalis and skunkbush sumac (Rhus trilobata). Other woody species such as chokecherry (Prunus virginiana) and snowberry

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(Symphoricarpos occidentalis) may also be established.

This stage includes moderate grazing by native ungulates and insects.

Litter accumulates providing continuous fuel for fires thereby increasing the probability of larger fires. However, for the model, fires were attributed similarly between classes A and B.

Prairie dogs might impact this class with a very unlikely probability of 0.0007, bringing this class back to class A.

Other native grazing occurs with a probability of 0.01, bringing the class back to an early seral state, or with a probability of 0.15, maintaining this stage.

Replacement fires occur every 20yrs.

Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☑ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Description

Disturbances

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Fire Regime Group:** II

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

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

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	20	2	100	0.05	100
Mixed					
Surface					
All Fires	20			0.05002	

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

Additional Disturbances Modeled

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

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

LANDFIRE Biophysical Setting Model

Biophysical Setting **3011490** **Western Great Plains Shortgrass Prairie**

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

General Information

Contributors (also see the Comments field **Date** 10/18/2006

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Modeler 3	Harvey Sprock and many more	many	**Reviewer**		

Vegetation Type

Upland Grassland/Herbaceous

Map Zone

30

Model Zone

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

Dominant Species*

BOGR2 ATCA2
BUDA KRLA2
PASM HECO26
NAVI4

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

In MZ29, occurs in 331Fn and 331Fr in the south end in a transition zone between MZs 29 and 31. Maybe in 331Fb, but very unlikely, also maybe 331Ff. It would occur in SD but below MZ30. Truly, MZ33 is where shortgrass is starting to occur. It might finger up north of the MZ33 line, but a very small area. This would only occur in the south portions of MZ29. This doesn't occur in MZ30. Perhaps this occurs in eastern WY?

The range of this system is essentially limited to the Central Shortgrass Prairie and Southern Shortgrass Prairie ecogregions, although it may be peripheral in a few other ecoregions such as the Central Mixedgrass Prairie, Northern Great Plains Dry Steppe and Osage Plains/Flint Hills Prairie (Comer et al. 2003).

This occurs in the southern Great Plains from northeastern to southeastern CO and south through western OK, eastern and northeastern NM, and west Texas Panhandle. Historically, some stages of this type might have been less extensive than currently. This system probably didn't occur much throughout KS historically. But southeastern CO and the eastern 1/3 of CO, southwestern KS, and in southeastern WY, it did occur. It does not/did not occur in the center of NM, as that would be a desert grassland type. (However, it does occur on the western facing piedmonts of the central mountain chains of NM in the northern Rio Grande corridor.) Precipitation, grazing and decadal fluctuations could have changed the historic distribution, and this is most likely to have occurred along the ecotone with the mixed grass prairie (Lauenroth et al. 1994).

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Some feel that this type does not occur/extend into the westernmost areas of NM and the south/southwest corner of MZ27 such as portions of of ECOMAP subsections 315Ad western half, 315Ab, M313Bd, M313Bb, M331Fh, 321Ad, M313Bf and M313Bg (Laurenroth and Milchunas 1991), which would be drier and desert grassland types. However, modelers from NM state that this type does occur and is dominant historically and currently throughout most of MZ27, except for the southern portions of subsections 315Ad and Ab.

Shortgrass occurs mostly west of KS border (although it also occurs in western KS)- see precipitation gradients. However, west of KS there is a mix of more productive shortgrass prairie and mixedgrass. West of I-25 border, is drier shortgrass. Some shortgrass however, is in southwest corner of KS. (Mixedgrass is in the northern portion of KS and NE.) There are north-south bands (isoclines) of productivity of shortgrass vegetation, corresponding to increased precipitation going east due to the rainshadow of the Rocky Mountains. See Lauenroth and Milchunas (1991).

The northern boundary is near the CO-WY border at the 41°N latitude, and extends south to latitude 32°N in western TX (Laurenroth and Milchunas 1991).

Biophysical Site Description

This system occurs primarily on flat to rolling uplands with loamy, ustic soils ranging from sandy to clayey. In NM, it is more aridic than ustic. This type typically occurs on loamy to clayey uplands (moderate to fine textures).

In NM and CO, elevations range from 1500-2000m. In KS, elevations can be 1000m.

Shortgrass prairie occurs dependent on precipitation gradients - long-term precipitation patterns and north-south bands or isoclines of productivity of shortgrass vegetation, corresponding to increased precipitation going east due to the rainshadow of the Rocky Mountains.

Mean annual precipitation is approximately 300-500mm (Lauenroth and Milchunas 1991) (ranges from 8-14in and might go up to 16-18in in MZ27 NM in the northeast), but there is a gradient into the mixedgrass prairie at the higher end, and there is a band against the Rocky Mountains that occurs in the approximate 350-375mm split, between drier versus wetter area; as you go east, it becomes wetter with higher precipitation and you move out of the shortgrass system. In rainshadow, probably lower end of 10in in MZ33.

Most precipitation occurs in the summer months.

The windiest areas of the US occur in the shortgrass steppe (Lauenroth and Milchunas 1991).

Vegetation Description

For MZ29, very infrequent. South of the 37 degree parallel, dominance of warm season grasses - shortgrass, blue grama, buffalograss (27/33) and galleta grass. Above 37 parallel, C3 cool season grasses=mixedgrass, and C4 warm/short and warm/tall in NE sandhills.

Historically, vegetation was dominated by short grass, and the subdominants were midgrasses and a small amount of shrubs on the MFRInges. Dominant species include blue grama, western wheatgrass, needlegrasses (needle-and-thread more associated with sandier sites), buffalo grass (historically, buffalograss present, but not much; currently it's prevalent though in CO and northern NM), with

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intermingled forbs. Shrubs included four-wing saltbush, winterfat, with lesser amounts of rabbitbrush, broom snakeweed, MFRInged sage and also plains prickly pear, in NM - walking stick cholla, yucca glauca, ring muhly, mat muhly, and sandsage which would occur on soils with coarser texture control section in NM. (Today, however, very low diversity - mostly buffalograss in CO, blue grama in NM, cactus and snakeweed - which has increased its range since historic.) Also - Spherelcia coccinea is a common forb in NM. Currently, there is mesquite widespread and low-statured, although historically was present but not as prominent.

For the dominant species list, it covers mostly MZ33-CO. For MZ27-NM, order should be:
BOGR2
PASM
SPCR
ATCA2
KRLA2
HECO26
BUDA
ARFI2

Disturbance Description

This type likely occurred in MZ29 before Euro-American settlement because of heavy grazing in places by bison.

Large-scale processes such as climate, fire and grazing influence this system. The often dry, semi-arid climate conditions can decrease the fuel load and thus the relative fire frequency within the system. However, historically, fires that did occur were often very expansive.

There is debate as to the MFRI for this shortgrass system. Because of the lack of long-lived trees, and trees that do exist are in relatively productive sites, there is absolutely no way to reconstruct a reliable historic fire return interval. All estimates of historic fire return intervals must be based on those for surrounding vegetation types that do have means for reconstruction, and then extrapolating based on differences in primary production and herbivore removal of fuel loads. Therefore, there is no means to directly obtain the estimate, and the range is varied. It depends on many factors - portions will be drier, and portions will vary in frequency over time and there will be decadal variation. There is a wide variability of MFRI across this system, based on precipitation and fuel.

One camp feels that the MFRI was historically approximately 25-35yrs (Harvey Sprock, Terri Schulz, Rich Sterry, Este Muldavin, et al. pers comm). Bison grazing created patchy fuel, and therefore small fires at times. So return interval to one spot was longer than expected - ie: a fire can burn somewhere on the landscape often, but it may not necessarily return to the same spot for 25-50yrs or more (Chris Pague, Terri Schulz, Harvey Sprock, pers comm).

However, another camp feels it was shorter. It is thought that some of the differences and suggestions for a longer MFRI could come from present range management applications. It is thought that the range of MFRI in shortgrass for MZs 27 and 33 is between 5-20yrs, dependent on the precipitation gradient east to west (David Augustine, USFS, pers comm). Some feel, however, that five years is too short, as that is more similar to a tallgrass system (multiple MZs 27 and 33 reviewers).

An arbitrary precipitation gradient between drier versus wetter somewhere around approximately 350-375

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mm annual precipitation delineates a change in fuel and fire behavior across the west to east gradient in precipitation/aboveground primary productivity. While there is no precise line, we may make a general rule-of-thumb that prescribed burns below 375mm are generally more difficult to burn. Farther east, with higher precipitation, it is easier to burn. At generally around 470mm, fire easily burns through the landscape (David Augustine, USFS, pers comm), especially where some growing season deferment occurs.

Some feel that in the western portion of MZs 27 and 33, the MFRI would be a little longer, in the 15-20yr range, whereas in the eastern portion, it would be shorter, in the 5-10yr range. It is a gradient. It is thought that the areas intergrading with mixedgrass would be even shorter as one goes further east into western KS - approximately five years (David Augustine, USFS, pers comm).

Also - both lightning-induced fire and spring fires set by Native Americans are recognized as important pre-European components of the fire regime (Williams 2003). The rates of lightning ignitions are high in both the wet and drier areas of the shortgrass. The shortgrass prairie also probably burned more frequently with Native Americans (Williams 2003).

Some studies from other systems have inferred a short historical fire return interval for the shortgrass (David Augustine, USFS, pers comm). The MFRI should be somewhere between the frequency from mixedgrass prairie to desert grassland. A review of the role of fire in desert grasslands indicated that the natural frequency of fire was probably on the order of every 7-10yrs (McPherson 1995). Even though this is a shortgrass system we're describing, production in the shortgrass is higher, and so MFRI should be similar, even though historical grazing would have affected the MFRI in portions of the shortgrass more than others (David Augustine, USFS, pers comm). Studies on mixed-grass prairies indicate variable fire return intervals that typically range from 3-5yrs (Bragg and Hulbert 1976, Bragg 1986, Umbanhowar et al. 1996). Given rainfall on the shortgrass prairie that is intermediate between desert grasslands and mixed-grass prairie, historic fire frequency may have been between these estimates, ie, on the order of 5-10yrs (David Augustine, USFS, pers comm). There are also good arguments for shortgrass having a higher MFRI either than desert or mixed grass, primarily because the shortgrass region gets more dry lightning storms (higher ignition probability) than mixed grass and has more times of the year when fuel are dry and “ignitable” than mixed grass. The eastern 2/3 of MZs 27 and 33, shortgrass also has much more continuous fuel than the desert grasslands, hence greater probability of large fires than the desert grasslands (David Augustine, USFS, pers comm.). This is contested by others.

A counter-argument thinks that shortgrass should not be in between the desert grassland and mixedgrass intervals, rather, it should be longer. Both of those systems are more productive and less variable in terms of precipitation and therefore production compared to shortgrasss. This argument states that sandhills and bluestem (the references listed above re: short MFRIs in mixedgrass) are very productive special areas within the mixedgrass, not really mixedgrass and not the drier mixedgrass. Also note that in Zak et al. (1994), the productivity for desert grasslands is actually greater than that for shortgrass. This could be due to a variety of factors, some of which being timing, event size and longer growing season, or even methodology. Also, evidence from the Sevilleta suggests the desert grasslands may burn more readily than shortgrass, but they may not be as resilient (Este Muldavin, pers comm).

Augustine (pers comm.) cites evidence of large fires historically as evidence of the shorter interval. Older examples include from Wright and Bailey (1982): “In the semiarid areas, big prairie fires in the past usually occurred during drought years that followed one to three years of above average precipitation, because of the abundant and continuous fuel. Consequently, wildfires traveled for many kms when the winds and air temperatures were high and relative humidity was low. An example is an account of a fire

(Haley 1929) that started in the fall of 1885 in the Arkansas River country of western Kansas. It jumped the Cimarron River, burned across the North Plains of Texas, and did not stop until it reached the rugged Canadian River Breaks, a distance of 282 km (175 miles). About 0.4 million ha (1.0 million acres) of the XIT Ranch alone burned in Texas."

However, some feel that there is little reason to believe that fires swept the shortgrass so often (5-10yrs) due to high variability. There may be a discrepency about MFRI and the occurence or records of some large fires. Some large fires occurred and that probably is not rare. However, there is scant to no evidence in much of the shortgrass prairie that large fires are frequent in the same locations. Even the evidence stated above only reports on some fires -- all in different locations. Really small fires might also have been common, but rarely occurred in the spot that another fire struck. Patchiness, lack of probability, and lack of opportunity were all players. We do not know how often fires occurred in the same location. We do not even know exactly how bison grazed the landscape nor how indigenous people used fire in the shortgrass. Most of the myths of these practices are myths indeed. In 15yrs in CO there have been few repeat fires in shortgrass, i.e., at the same place. This may indicate that the return interval is long while fire itself is not particularly rare. This would match the rainfall pattern as well, i.e., rainfall is not easily predictable (Chris Pague, TNC, pers comm.).

Some feel that the ecological reasons for a shorter interval might not be evident until near the mixed grass.

Overlap in agreement between the long-vs-short-interval perspectives probably occurs in the eastern edge of the shortgrass zone (i.e., Baca County and east as well as northeast CO). There are likely to be more consistent fuel -- and probably a shorter MFRI. There are also probably more dry strikes in shortgrass (but not consistently more fuel). The Palmer Divide might also have more fuel in most years.

However, there is also other evidence for a shorter interval in northeast NM. Ford and Johnson (2006) found that a six-year dormant-season fire (ie, burned once in six years) as a fire treatment shows the potential for increased site production relative to 'reference condition' unburned grassland, which might imply that shortgrass might have had a similarly short return interval. However, there is a question as to whether or not this would be similar to historic conditions, considering the prevalence of heavy grazers pre-settlement.

It was also thought that the MFRI in MZs 27 and 33 should be similar to that for shortgrass in MZ34, which is approximately 10-15yrs. The MFRI for shortgrass in Rapid Assessment model R3PGRs, which covered this same area, was a 10yr MFRI. The MFRI for southern plains grassland in the FRCC model PGRA4 was approximately 10yrs varying due to effects stated in this MZs 27 and 33 description. The MFRI for the original model from the MZ27 NM modelers was a 15yr MFRI. In terms of having consistency across mapzones and between mapzones, and between all sources of information, and weighing all factors and resources, the regional lead (RL) chose a similar interval of approximately 20-25yrs to account for the west to east gradient for these mapzones and the confounding evidence and opinions. All modelers/reviewers informed.

Note that changing the MFRI from 22yrs to 15yrs or 10yrs only slightly altered percentages in each of the successional stages to where approximately five percent more was in A and percent less in C. Also, FRG 2 is consistent.

Note that large fires might be currently rare in some areas due to several factors, including aggressive suppression action, fuel reduction due to continuous grazing being more uniform across the landscape, heavy stocking, presence of roads and discontinuous land ownership (checkerboard effect). In recent years, the combined extent of prescribed and wildland fires on the Grasslands has varied annually but has been approximately 0.5 - two percent of the total area, or a fire return interval of >50yrs (Coarse filter analysis of habitat conditions on the grasslands).

Return interval for fire could be extended (longer return interval) by continuous ungulate grazing. Fire return intervals are now occurring more infrequently - over 50yrs (Harvey Sprock, Terri Schulz, Rich Sterry, pers comm).

The short grasses that dominate this system are extremely drought- and grazing-tolerant. These species evolved with drought and large herbivores and, because of their stature, are relatively resistant to overgrazing. The shortgrass system adapted evolutionarily with historical heavy grazing (Milchunas et al. 1988). The return intervals for grazing varied. There were probably areas distant from water sources that were not grazed as heavily as those near water. However, the shortgrass steppe is probably the system with the highest intensity of grazing than other systems historically (Milchunas 2006, Lauenroth et al. 1994).

Black-tailed prairie dogs (BTPD) are an ecologically important component of the grazing regime in shortgrass prairie and would have occurred extensively. (Prairie dogs were less important both historically and currently in sandsage prairie, canyonlands, and riparian habitats due to edaphic and topographic limitations on burrow construction). There were some very large towns, but there were also areas without any towns. Quantitative historical estimates of BTPD abundance are difficult to obtain, but the U.S Fish and Wildlife Service estimated that about 160 million hectares (395 million acres) of potential habitat historically existed in the US, and about 20% was occupied at any one time (Gober 2000). (Coarse filter analysis of habitat conditions on the grasslands). Shortgrass has most of the suitable soil types for prairie dogs. In general, they need loamy or clay soil.

In historic times, there was frequent and broad-scale grazing by bison, elk, deer and pronghorn. Through growing season, bison might have been there for relatively short periods in some years; however they might have been there longer on other years. There were also resident herds of bison in areas of CO. Historically, such areas would also have been populated by bison in sufficient numbers to support populations of wolves. Bamforth (1987) suggested that bison herds under relatively undisturbed conditions (<1846) most often ranged in size from several hundred to several thousand.

Shaw and Lee (1997) reviewed diaries of European travels in the southern Great Plains from 1806 to 1857. Organized by historical period and biome type, the authors suggest populations of three major large herbivores—bison, elk and pronghorn—changed in the first half of the nineteenth century; bison were most numerous on the shortgrass prairie prior to 1821, pronghorn were most abundant on the shortgrass prairie between 1806 and 1820, again in the 1850s.

In drier areas in the western portion of MZs 27 and 33, distance from water was probably a factor in grazing gradients. Individual herds were probably tied to river drainages and migrations from those drainages.

The dry half of the Great Plains has high interannual rainfall variability, so historically, the population declined faster in dry years. This resulted in a time lag or temporal variability, in which density could be reduced greatly. Bison historically moved nomadically in response to vegetation changes associated with rainfall, fire and prairie dog colonies. The time lag for return movements provided deferment during the regrowth period for which according to both historic and archeological records may have ranged from 1-

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8yrs (Malainey and Sherriff 1996 and others).

If there was a series of droughts followed by a wetter year, there would have been little grazing pressure, which would then result in a higher severity or frequency of fire. Drought and grazing were probably most important disturbances historically and greatly influenced fire frequency and extent. This is a drought tolerant system. However, extended drought (over 3-4yrs) will reduce cover.

Historic variability in bison grazing appears to have been on the temporal and spatial scales of years and tens to hundreds of square miles, while current variability in livestock grazing is at scales of weeks to months and acres to several square miles (David Augustine, USFS, comm).

Insects were also a natural disturbance agent on the landscape - grasshoppers, range caterpillars and Mormon crickets.

Note that we are also not modeling the white grub disturbance interaction, which could be an important disturbance. It can cause a shift in stages and could cause a large impact. It combined with drought could be highly impacting and could cause a similar impact as prairie dogs. However, it was not modeled.

A healthy shortgrass prairie system should support prairie dog complexes, viable populations of pronghorn, endemic grassland birds, and other Great Plains mammals.

However, currently in areas, there is overgrazing and continuous grazing, creating more areas heavily dominated by shortgrass (in areas where there might have been more mixedgrass) and increasing fire intervals (less fire).

Adjacency or Identification Concerns

In MZ29, this type might only occur due to overgrazing. Maybe it becaime more widespread for a while after Euro-amer settlement resulted in more concentrated grazing.

The distinction between this system and the Northwestern Great Plains Mixedgrass Prairie is unclear and the two should be better described, but here’s how this system is thought of in WY... This Shortgrass Prairie system is strongly dominated by the sod-forming grasses, Bouteloua gracilis and Buchloe dactyloides; other species are minor players. Those two species are major species in the geographic region described in the NatureServe document because that is where summer thunderstorms provide a large proportion of the annual precipitation. It was created by heavy grazing. Frederic Clements and John Weaver recognized it as an example of their concept of the grazing disclimax. The prevalence of Buchloe dactyloides distinguishes it from heavily grazed examples of the NW Great Plains Mixedgrass Prairie, which are dominated by Bouteloua gracilis but lack Buchloe (and which occurs outside of the area where summer thunderstorms are so important). And Buchloe is a major species only in very southeastern WY. That’s why the Shortgrass Prairie system is present only in the southern end of MZ29. Maybe this system is restricted to MZ33 farther south, but its presence in MZ29 seems likely (George Jones, pers comm).

This system is similar to Kuchler's (1964) "Bouteloua-Buchloe" vegetation type except at the northern border (Lauenroth and Milchunas 1991).

This system occurs in the area corresponding to Kuchler's Plains Grassland PNVG and the RA's R3PGRs Shortgrass Prairie and FRCC PGRA4 Southern Plains Grassland.

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This system could be confused with mixedgrass prairie. Production is less in shortgrass versus mixedgrass prairie. They can be distinguished - higher occurrence of blue grama - thus shortgrass. If have more mixedgrasses, should be considered mixedgrass prairie. If have 50% or more midgrasses, would probably be mixedgrass.

Shortgrass occurs mostly west of the KS border; however, west of Kansas there is a mix of more productive shortgrass prairie and mixedgrass. Some shortgrass however, is in the southeast corner of Kansas. Mixedgrass is in the northern portion of KS and NE. There is a gradient into mixedgrass. West of approximately the I-25 border in Colorado, there is drier shortgrass. These boundaries are relevant to fuel loading. On the eastern border of 27, it also grades into mixedgrass prairie of small remaining quantities near Texas (those areas of Texas not in agriculture).

This system should not be confused with the desert grassland and plains mesa types occuring in the southern skewing west/southwest corners of MZ27. See RA's depiction of the plains mesa and desert grassland types versus this shortgrass type. See RA PNVGs and Kuchler types and Laurenroth and Milchunas (1991) for historic potential. The desert grassland types have more tobosa, galleta grasses. Consider BpS 1122 Gyp, 1504 Bottomland Swale/Tobosa Flats, 1503 Loamy Plains, 1147 Foothill/Piedmont.

Some (John Tunberg, NRCS et al, Este Muldavin, pers comm), however, state that shortgrass occurs in all sections/subsections of MZ27 in NM.

In MZ27 in NM, in the west end near Las Vegas, it grades into pinyon-juniper (PJ) and ponderosa pine, as it does in Colorado near Trinidad.

This system could be adjacent to Foothill/Piedmont Grassland. It is also adjacent to desert grasslands in the south - sand dune / mesquite dunelands in the south and east. It is also adjacent to tobosa plains in the south and gyp hills in the east end of MZ27 NM east of Estancia. On the eastern edge of MZ27 in NM, it is adjacent to playas scattered throughout (closed depressional wetland systems).

Some (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm) feel that there is more shortgrass now than historically in areas at the ecotone with mixedgrass prairie - due to management practices today. Shortgrass prairie has expanded currently due to continuous grazing. Central Mixedgrass Prairie has been greatly reduced currently due to agricultural conversion. In Colorado, some believe that historically had lower producing mixedgrass, but now it is shortgrass (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm) and that even some of the shortgrass prairie today that would have existed historically, is departed. Much is continuously grazed.

In contrast, Milchunas et al. (1998) considers the shortgrass to be climatically determined, with large herbivores and aridity being convergent selection pressures. Grazing and climatic cycles do, however, result in shifts in the location of the mixedgrass-shortgrass ecotone (Lauenroth et al. 1994). Research on short duration grazing shows no difference with continuous grazing on plant community composition (Derner and Hart submitted). Long rest periods would be necessary to increase heterogeneity (Fuhlendorf and Engle 2001).

Currently, fire suppression and certain grazing patterns in the region have likely decreased the fire frequency from historical regimes, and it is unlikely that these processes could occur at a natural scale today.

A large part of the range for this system (especially in the east and near rivers) has been converted to agriculture. Areas of the central and western range have been impacted by the unsuccessful attempts to develop dryland cultivation during the Dust Bowl of the 1930s.

There is also much residential development in this system.

Currently, there are some non-natives - cheatgrass, kochia, but not a big invasive problem.

Some mesquite hummocksmight also occur currently in MZ27 NM more than historically. Currently, there might be more mesquite widespread and low-statured, although historically, it might have been present but not as prominent. If mesquite is over 3 feet high, it's a different BpS. There might be more mesquite, cholla, prickly pear currently - which is uncharacteristic. There is little data on this, however.

There is also some encroachment of juniper into these grasslands currently in MZ27 NM. If there is over 10% juniper canopy cover in grasslands, that would be uncharacteristic.

In MZ27 in SE CO, this system might have been former prairie chicken habitat.

There are conflicting views about what this landscape looked like historically versus currently.

One viewpoint states that currently, today, most of the landscape is in Class B. The departure in this system would be in the lack of the Classes A and C on the landscape today (Daniel Milchunas, CSU and David Augustine, USFS, pers comm). This is because cattle have been evenly distributed throughout the landscape. Historically, there were a mix of heavily grazed, heavily disturbed areas, moderately grazed areas more distant from water, and lightly grazed areas even more distant from water, during low population cycles of bison, or where bison had not returned recently. Management today, together with water improvements on the range, results in a relatively greater amount of the middle class. Management today is also removing prairie dogs and fire. Therefore, historically, there were more disturbed areas (Class A) and undisturbed areas (Class C).

Another view, however (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm), states that currently, continuous, heavy grazing practices have turned Class B stage more into Class A, the sod portion - which didn't happen often historically. This opposing view also states that there is not much of the Class B, historic climax plant community, today. This opposing view also states that the sod class Class A, that would have been a very small, localized condition historically. However, today, it would be very prevalent. Historically, the landscape would have just had small areas of continuous grazing or migration corridors.

Another similar viewpoint states that the go-back-cropland would be in class A, and today there are extensive areas of abandoned dust bowl cropland that now have blue grama sod with low cover and productivity. The surface soil horizon is eroded by wind and is no longer apparent. Bedrock is exposed in some areas (John Tunberg, Rex Pieper, Clarence Chavez, pers comm). This viewpoint also states that most would be in the sod class today.

Grazers, combined with prairie dogs and fire, would allow the native bison grazers to beat up an area. That stage no longer exists today, which is in part why some of those shortgrass prairie grassland birds are in such significant decline today (Herkert 1994, Knopf 1994, Peterjohn and Sauer 1999).

Note that there is a difference in cover amounts between southern NM MZ27 and northern NM MZ27; however, the model and probabilities are the same. Also note some species order differences between southern and central shortgrass.

Native Uncharacteristic Conditions

If grass is over 0.5m, it would be uncharacteristic because it would be in a different BpS.

Scale Description

This is a matrix community - small to large patches. Disturbances can also occur within a matrix - small to large, huge patches. Driving variable is climate (drought, low rainfall, etc), grazing and to a lesser extent fire.

This type probably occurs in very small patches, smaller than a few acres in MZs 29 and 30.

Issues/Problems

This system was originally modeled with two models - one for CO MZs 27 and 33 and one for New Mexico southern version of MZ27. Even though there are monsoonal and climatic differences/factors - differences in geography, moisture and function between the two areas, those factors were easily textually represented. Therefore, the southern and central versions were combined into a more all-encompassing model for all of MZs 27 and 33 which includes southern and central shortgrass. Cover will be different between the two (state line - NM vs CO Raton Pass, Mesa de Maya) and this is described textually in the successional class descriptions. Note that there is a difference in cover amounts between southern NM MZ27 and northern NM MZ27; however, the model and probabilities are the same. Also note some species order differences between southern and central shortgrass.

There is some disagreement about historical versus current manifestation of this system.

Also - Instead of calling the classes early, mid and late, which do not actually apply in shortgrass prairie and the different stages that we are describing, we are calling all of the stages “mid-development.” Succession in a grassland system does not abide by typical definitions as in a forested community. The stages of the grassland are created and/or maintained by disturbances or lack thereof.

Also - Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover. These covers do not reflect reality on-the-ground.

Comments

This model for MZ30 was adopted from a draft model from MZs 27 and 33 created by Daniel Milchunas, David Augustine, Harvey Sprock, Terri Schulz, Rich Sterry, Dan Nosal, Keith Schulz, Rex Pieper, John Tunberg, Clarence Chavez and Lee Elliott and reviewed by Steve Kettler, Este Muldavin, Keith Schulz and Paulette Ford. See MZs 27 and 33 for further evolution comments. MZs 27 and 33 model changed after MZs 29 and 30 model was delivered. Therefore, RL made those changes MZ27/33 changes to the MZs 29 and 30 model. Reviewer for MZs 29 and 30 notified.

The model for MZ33 in Colorado based on MZ28 created by Galen Green, Wayne Robbie and Anne Bradley and reviewed by Vic Ecklund and Chuck Kostecka.

This model for MZ28 was based on the Rapid Assessment model R3PGRS,which was reviewed by an

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anonymous reviewer. Minor edits made on 5/6/2005 by Mike Babler.

The Rapid Assessment model was originally based on the FRCC model PGRA6. Review suggest combining all plains grasslands. Because of sepcies composition differences, and class differences, 1147 and 1149 were not combined.

Vegetation Classes

Class A 20 %

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	Upper
BUDA	Upper
ARIST	Upper
VUOC	Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover, since the cover in class A actually ranges from a low, mosaic-bare-ground cover to a high sod-cover, which includes litter too. Due to mapping constraints and past issues with mapping herbaceous cover and resultant errors, this class A is being set at 0-20% even though it was originally suggested to be 0-70%. Either way, these covers do not reflect reality on-the-ground. Remote sensing will show part of this stage as litter plus veg.

Also - the NM draft older version had a cover of 0-20% for the prairie-dog-type-stage and the sod class with a cover of 41-50%.

Description

Instead of calling the classes early, mid and late, which do not actually apply in shortgrass prairie and the different stages that we are describing, we are calling all of the stages “mid-development.” Succession in a grassland system does not abide by typical definitions as in a forested community. The stages of the grassland are created and/or maintained by disturbances or lack thereof.

Class A is the low biomass (0-1in based on the Robel pole density/visual obstruction method), heavy disturbance dependent community. It combines two types of communities. One consists of the high cover blue grama buffalo grass sod that looks like a golf course (high cover in patches). The other is the low cover bare soil, Aristida, and forb stage, which could have taller grasses than the sod, but they are spaced apart due to bare soil between. See biomass in Milchunas et al. (1994) and Milchunas and Lauenroth (1989) and basal cover for sod class by point frame in Milchunas et al. (1989).

Please note that this system should be distinguished on-the-ground by biomass and not cover, since the cover

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in class A actually ranges from a low, mosaic-bare-ground cover to a high sod-cover, which includes litter too. Due to mapping constraints, we are defining dropdown boxes on cover; however this stage could go up to 70% cover, including litter, with very low biomass. Basal cover for high cover sod is approximately 45% or higher if including litter. Basal cover for low cover prairie dog area is approximately 20-25% cover. On-the-ground, this class should be distinguished by biomass.

There are relatively few cool season grasses in this stage. There is always blue grama in this stage, as in the others. Cactus is present (and could even be a dominant in the class A sod depending on soil type). Aristida is present, which increases with prairie dog colonies. Annual grasses - sixweeks fescue, red three-awn, ragweed and annual forbs. [Currently, you would see non-native annuals in this class such as cheatgrass and kochia - only in the high biomass type. annuals and exotics are actually less abundant in the sod type than any other class (Milchunas et al. 1989; Milchunas and Lauenroth 1989; Milchunas et al. 1988); the landscape might also have non-natives of bindweed on prairie dog towns today, but not historically.] On loamier or sandier sites, there is sand dropseed. For the southern NM version, other indicator species are lemonweed, showy goldeneye and verbena.

Original draft model indicator species for the prairie dog stage also included ARPUL, AMPS and SPCR. Original indicator species for the sod stage also included OPPO.

There are low intensity fires in the low biomass high cover sod and relatively rare fire in the low biomass low cover bare soil. Fires are spotty through here and not as frequent as in other stages. They do not cause a change in stages.

This stage is produced by heavy grazing, and long-term prairie dog colonies which will maintain this stage long-term. This stage can also be maintained by heavy continuous grazing if the area is near water. Also – if an area is burned and grazed, the high cover version of this stage will be reached if not continuously grazed.

Grazing that gives adequate plant recovery periods occurs in this stage.

If there is no fire and no prairie dog or heavy grazing maintaining this stage, then in approximately 5-10yrs, this stage will transition to the class B stage. This was modeled as "alternate succession" occurring as a probability of 0.1, for modeling purposes.

Drought occurs.

It is thought that there should be approximately 20-30% of this stage historically, based on historical prairie dog communities combined with bison grazing (Gober 2000; David Augustine, USFS, pers comm). However, the viewpoint which created this model feels that there is very little of this stage on the landscape today. Prairie dog plague today would also not allow this class to be maintained for long today.

Another opposing viewpoint feels that the sod portion of this class would have been a very small, localized condition historically and that today it would be very prevalent. This view states that historically, there would just have been small areas of continuous grazing or migration corridors.

This stage would also include buffalo wallows (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm). (Today, it might be go-back-cropland.) It is also thought, however, that today there are extensive areas of abandoned dust bowl cropland that now have blue grama sod with low cover and productivity. The surface soil horizon is eroded by wind and is no longer apparent. Bedrock or subsoil/parent material is exposed in

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some areas (Harvey Sprock, Terri Schulz, Rich Sterry et al., pers comm). This view is questioned, however, by others.

Class A was originally modeled in the draft model as the prairie dog stage lasting 20yrs, as it would take a long time to move out of this stage due to the prairie dog communities. Class C was originally modeled as the sod class.

Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover, since the cover in class A actually ranges from a low, mosaic-bare-ground cover to a high sod-cover, which includes litter too. Due to mapping constraints and past issues with mapping herbaceous cover and resultant errors, this Class A is being set at 0-20% even though it was originally suggested to be 0-60%. Either way, these covers do not reflect reality on-the-ground. Remote sensing will show part of this stage as litter plus vegetation.

Note that the NM southern version had a canopy closure of 0-20% for the prairie-dog-type stage class A and 41-50% for the sod class.

Class B **60 %**

Mid Development 2 Closed

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

BOGR2	Upper
PASM	Upper
BUDA	Upper
STIPA	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	80 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

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

Scattered shrubs may be present (up to 15%, maybe up to one meter) - four wing and winterfat. There might be scattered cholla in MZ27, east of Colorado Springs. Once cholla gets thick, shifts to another BpS.
Note that the draft NM southern version of the Historic Climax Plant Community (HCPC) class had a cover of 21-40%.

Description

Instead of calling the classes early, mid and late, which do not actually apply in shortgrass prairie and the different stages that we are describing, we are calling all of the stages “mid-development.” Succession in a grassland system does not abide by typical definitions as in a forested community. The stages of the grassland are created and/or maintained by disturbances or lack thereof.

Class B is the mid biomass (2-4in based on the Robel pole density/visual obstruction method), mid cover stage. See biomass in Milchunas et al. (1994) and Milchunas and Lauenroth (1989).

This stage again consists of blue grama. Cactus is often present and could even be the second dominant depending on soil type. There are less needle-and-thread and western wheatgrass than in class C. This also includes the “historic climax plant community” with blue grama, buffalograss, and western wheatgrass, galleta grass, green needle grass (not in NM much), MFRInged sage, New Mexico feather grass in the south. Historically, there would have been more midgrasses (Harvey Sprock, et al., pers comm). In NM, there would be scatterings of black grama, vine mesquite on heavier soils.

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement seve

Fire does occur in this stage. If there is 1-2yrs of no grazing or 4-10yrs of no fire, then 4-10yrs post-fire, this class would transition to the high biomass class C stage. This was modeled as "alternate succession" occurring as a probability of 0.05, for modeling purposes.

Prairie dogs could occur in this stage. If they do, the long-term prairie dog grazing causes a transition to class A.

Proper grazing that allows adequate plant recovery periods occurs but does not cause a transition. With heavy grazing, this class could transition to class A.

Drought was modeled with a probability of every 40yrs and causes no transition.

The current modelers (Augustine, et al) feel that currently, today, most of the landscape is in class B. However, another viewpoint feels that there probably is not much of class B on the landscape today.

Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover. Due to mapping constraints and past issues with mapping herbaceous cover and resultant errors, this class B is being set at 21-80% even though it was originally suggested to be 61-80%. Either way, these covers do not reflect reality on-the-ground.

Class C **20 %**

Mid Development 3 Closed

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

BOGR2	Upper
HECOC8	Upper
PASM	Upper
STIPA	Upper

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	81 %	100 %
Height	Herb 0m	Herb 0.5m
Tree Size Class	None	

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

Scattered shrubs may be present - snakeweed and prickly pear cactus

Description

Instead of calling the classes early, mid and late, which do not actually apply in shortgrass prairie and the different stages that we are describing, we are calling all of the stages “mid-development.” Succession in a grassland system does not abide by typical definitions as in a forested community. The stages of the grassland are created and/or maintained by disturbances or lack thereof.

Class C is the high biomass (4in+ based on the Robel pole density/visual obstruction method), high cover stage. See biomass in Milchunas et al. (1994) and Milchunas and Lauenroth (1989) and basal cover in Milchunas et al. (1989).

The same grasses are present as the previous. However, there are also more C3 perennial cool season grasses. (However, some have questioned the increase in cool-season grasses with succession as being speculative. There are definite edaphic differences. Gravelly sites in NM often support H neomexicana even under intense grazing regimes.) Blue grama is still present and dominant. Needle-and-thread, galleta grass and also western wheatgrass are more prominent. Note also that more annuals and exotics occur in the ungrazed than

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

in the heavily grazed sod class (Milchunas et al. 1989; Milchunas et al. 1992).

This stage is arrived at through lack of fire and grazing, although while already in this stage, fire would be more likely to occur due to the increased biomass.

Fire does occur in this stage. If there is fire and then grazing, this will over time transition to Class B, and with long-term heavy grazing to Class A. Fire alone may not cause a transition, but can especially on coarser textured soils and also when fire occurs with heavy grazing. Regular grazing can just move the class to class B.

Prairie dogs are unlikely to occur in this class, but when they do, they will occur as a patch within the matrix and will cause a transition.

Drought occurs.

As per the current modelers (Augstine, et al), it is thought that there should be approximately 10-20% of this stage historically. However, there might be very little of this stage on the landscape today, although some feel that there might be a large amount of it on the landscape today in NM.

Please note that the covers in the dropdown boxes in this system are arbitrary and are only being used for LANDFIRE mapping purposes. Please note that this system should be distinguished on-the-ground by biomass and not cover. These covers do not reflect reality on-the-ground.

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement seve

Fire Regime Group:** II

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	22			0.04545	100
Mixed					
Surface					
All Fires	22			0.04547	

Fire Intervals (FI):

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

Additional Disturbances Modeled

- ☐ Insects/Disease
- ☑ Wind/Weather/Stress
- ☑ Native Grazing
- ☐ Competition
- ☑ Other (optional 1) prairie dogs
- ☑ Other (optional 2) heavy grazing and fire

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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* 3011530 Inter-Mountain Basins Greasewood Flat**

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

General Information

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

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Modeler 3	Dennis Knight	dhknight@uwyo.edu	**Reviewer**

Vegetation Type
Wetlands/Riparian

Map Zone
30

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

Dominant Species*
SARCO PUCCI
DISTI
SPAI
PASM

General Model Sources
☐ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

Occurs throughout much of the western US in intermountain basins and extends onto the western Great Plains. Occurs throughout zone in all subsections at lower elevations. In MZ20, this BpS is thought to be limited to very limited in extent.

In MZs 29 and 30, might occur - but in little areas - in playas. This type goes into western ND in MZs 30 and 29. In central area of MZ29. In streams and closed depressional areas.

Biophysical Site Description

Typically occurs near drainages, on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites typically have saline soils, shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations.

Vegetation Description

This system sometimes occurs as a mosaic of multiple communities, with open to moderately-dense shrublands dominated or co-dominated by Sarcobatus vermiculatus (greasewood). Atriplex confertifolia (shadscale) or Krascheninnikovia lanata (winterfat) may be present or co-dominant. Occurrences are often surrounded by mixed salt desert scrub. Herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of Sporobolus airoides (alkali sacaton), Distichilis spicata (saltgrass) or Eleocharis palustrus (spikerush). In MZ22 very little Atriplex confertifolia (shadscale) but rather Atiplex gardneri. Artemesia tridentata ssp. tridentata is common in southwest part of MZ22, usually in riparian systems, Artemesia wyomingensis occurs more in the playa types.

Disturbance Description

Historically, fire was extremely infrequent. There is conflicting evidence about mean MFRI in this system.

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

Anderson (2004) claims a MFRI <100yrs, whereas expert opinion considers fire rare to absent in greasewood. As a compromise, a mean MFRI of 200yrs was chosen here.

Greasewood is a vigorous resprouter following low to moderate severity fires, although severe fires may result in some mortality. Some re-seeding may occur from nearby remnant plants.

Greasewood may be killed by standing water that lasts greater than 40 days.

Adjacency or Identification Concerns

Greasewood communities are susceptible to invasion by non-native annual grasses (cheatgrass).

Native Uncharacteristic Conditions

Scale Description

One to hundreds of acres.

Issues/Problems

Comments

This model for MZs 29 and 30 was adopted as-is from the same model from MZs 20 and 22, created by George Soehn, George Jones and Dennis Knight and reviewed by Steve Cooper.

This model for MZ20 was adopted as-is from the draft model from the same BpS from MZ22. No changes were made yet.

This model for MZ22 was adapted from the model from the same BpS from MZ23 created by Jolie Pollet, Annie Brown and Stan Kitchen. Quantitative and descriptive changes were made, and it was changed to a two-box model.

The model for MZ23 is identical to the model for the same BpS in MZ16 (Utah High Plateaus) and did not receive any peer review.

Vegetation Classes

Class A **5 %**

Early Development 1 All Structure

Indicator Species* and Canopy Position

DISTI	Lower
SPAI	Lower
	Upper
	Upper

Upper Layer Lifeform

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

Fuel Model 2

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Some grasses, with greasewood sprouts present. Some representation of other sprouting species may be present such as rabbitbrush (Ericameria nauseosus). Grass species vary geographically, but include the following: inland saltgrass, bottlebrush squirreltail and alkali sacaton. Succession to class B after two years.

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

Class B **95 %**

Late Development 1 Open

Upper Layer Lifeform

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

Fuel Model 2

Indicator Species* and Canopy Position

SARCO	Upper
DISTI	Lower
SPAI	Lower
	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	50 %
Height	Shrub 0m	Shrub 3.0m
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Greasewood shrubs maturing or have reached maturity, and will increase canopy closure. Perennial grasses will still be in the understory. Vegetation will revert to class A with replacement fire (mean MFRI of 200yrs). Flooding (mean return interval of 75yrs) causes a transition to class A.

Shrubs probably only reach heights of 1.5m.

Class C **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

- [ ] Herbaceous
- [x] 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.
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Fire Regime Group:** V

Historical Fire Size (acres)

Avg 50
Min 10
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	210	100	800	0.00476	100
Mixed					
Surface					
All Fires	210			0.00478	

Fire Intervals (FI):

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

Additional Disturbances Modeled

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

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

LANDFIRE Biophysical Setting Model

Biophysical Setting **3011620** **Western Great Plains Floodplain Systems**

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

General Information

Contributors (also see the Comments field **Date** 4/6/2006

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Modeler 3			**Reviewer**	Peter Lesica (rvw'd again)	peter.lesica@mso.umt.edu

Vegetation Type

Wetlands/Riparian

Dominant Species*

PODE3	CORNU
SALU2	ROSA5
SAEX	FRPE
SAAM2	ARCA13

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Map Zone

30

Model Zone

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

Geographic Range

Great Plains river systems from eastern MT west to the Rocky Mountain front. Such river systems include the Missouri, Mussell, Yellowstone,Teton, Marias and Sun rivers. The major tributaries to these river systems would be in this BpS. Cheyenne River in MZ31 into MZ29. Belle Fourche in WY into SD. Little Missouri - ND/SD. Yellowstone River. In MZ30, it would be in section 331Md along the floodplain of the Little Missouri River. This would occur throughout MZ29 in MT, including Yellowstone and its major tributaries in Big Horn, Tongue, Powder and the Little Missouri. In MZ30 it would include the Yellowstone and Missouri rivers (331E, 331M).

See Adjacency/Identification Concerns box regarding smaller second and third order prairie streams and where they occur or what they're classified as. Also see Adj/ID box to describe how to distinguish this from Rocky Mountain riparian systems.

Biophysical Site Description

Alluvial surfaces, usually bare, within broad floodplains are present as low elevation shorelines and barforms. The slightly higher fluvial landform adjacent to the channel forms the first terrace for fluvial dependent species. Over time, laterally migrating point bars form bench platforms that may become late seral stage floodplain forests.

Great Plains riparian and floodplain will be lower elevations/in the plains matrix.

Vegetation Description

Dominant types are cottonwood and willow. Broadleaf deciduous forest dominated by cottonwood

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(primarily Populus deltoides), yellow willow, or peach leaf willow and sandbar willow. In the Milk River drainages, narrowleaf cottonwood (Populus angustifolia) is common (but rare or absent in MZs 29 and 30). Narrowleaf cottonwood occurs in upper (intermountain valley) reaches of the Marias and Yellowstone rivers. Black cottonwood (Populus trichocarpa) is found along the Milk and Yellowstone, but only occasionally along the Marias (and not in MZs 29 and 30). Early seral stage phreatophytic vegetation becomes established on low elevation flood deposits, however, long-term survival is possible only on bare, moist sites on slightly higher elevation (1-3m above lower limit of perennial vegetation) Other species found in the floodplain riparian zone include sandbar willow, box-elder, green ash typically associated with late seral stages. Box-elder is more common along the Milk than along some of the other drainages. Box-elder, however, is also seen today in the Musselshell/ Little Missouri River, but it is questionable as to whether that would have occurred historically. Girard et al. (1989) do not report box-elder for cottonwood forests, and Hansen et al. do not report box-elder for plains cottonwood forests in MT.

Populus deltoides and Fraxinus pennsylvanica are characteristic of Great Plains riparian forests. Fraxinus becomes a dominant in MZ30 riparian areas where it comes in after P. deltoides, grows much more slowly, but persists after P. deltoides because it can recruit into shaded, relatively undisturbed sites. FRPE was therefore added as a dominant for MZ29 and 30, and PASM was removed.

Green ash commonly forms a subcanopy in older stands and can eventually dominate if stands persist for more than 150-200yrs without major flood disturbance.

PODE is a pioneer species along Missouri River, in central ND, in southeast SD and near Omaha, NE, and is replaced successionally by various combinations of Fraxinus, Ulmus, Acer and Celtis (Hansen et al. 1984). Undergrowth dominated by SYOC, RHAR and other shrubs. Among the grasses, Calamovilfa longifolia, Elymus canddensis and Muhlenbergia racemosa are important (Hansen et al. 1984).

In Theodore Roosevelt National Park in ND, Poa pratensis is the most important grass, and Melilotus officinalis is the most important forb (Hansen et al. 1984).

Silver sagebrush is present in this system in the late successional stage.

Understory species in these later seral stages may include dogwood, currents, snow berry, wild rose and chokecherry.

Disturbance Description

The development and maintenance of this system is dependent on fluvial geomorphic processes such as channel meandering/erosional processes of river flooding, sedimentation, erosion, channel avulsion and barform accretion driven by hydrologic variability. This variability incorporates the features of timing, duration, frequency, magnitude and intensity. Regeneration of the dominant species (cottonwood and willow) is dependent on flooding and movement of river channels, which creates bare, moist soil needed for seedling establishment. Oxbow and slough development also influence the floodplain system and create variability in plant community composition. Upper terraces have infrequent flooding and scouring events, while the lower terraces nearest the river flood frequently.

Early seral stage development stands are produced on point bars via channel meandering, which occurs most often during moderately frequent high flows. Also produced in other ways - ie: two kinds of rivers - meandering and as well as occurring on areas of sediment deposition - if river has large flood and bare

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area created, then system established; or via silt deposit that assists establishment (Scott et al 1996).

Scouring caused by ice jams during the winter, channel meandering, oxbows and slough development greatly influence this system. Ice jams and ice scouring were not modeled.

Changes in hydrology due to the activities of beaver are also an important ecological process in the Great Plains Floodplain, particularly on the tributaries (Little Missouri) to the Missouri River, as well as tributaries of the Yellowstone (Powder, Tongue and Big Horn). Beavers are present on the main stem Yellowstone River, but are not critically important because bank dens are frequently flooded and destroyed. Beaver impoundments kill trees (sometimes over large areas) and may create open water habitat, willow stands or contribute to channel meandering. The effects of beaver ponds on forest dynamics in this system are also poorly understood at the landscape level, especially in the presettlement context. Note that beaver populations might have been maintained at artificially low levels on the Great Plains due to constant harvesting by humans. Beaver activity could have been a large influence in this sytem historically. It could have contributed to the system going from the mid seral stage to the silver sagebrush stage. However, this would happen if they were old stands on higher terraces close to the channel, but not if they were younger stands on lower, moister terraces. Cottonwoods on lower moister terraces would resprout and there would be a willow-cottonwood, beaver-induced disclimax. Beaver damage could be highly extensive in areas in this system (Lesica and Miles 2004; 1999). The effects of beaver activity on forest dynamics in this system are also not well understood at the landscape level, especially in the presettlement context.

Traveling ungulate herds and Native American activities locally impacted seral stage development. However, not enough is known about about such disturbance to attempt modeling. Native Americans likely camped along rivers and used fire to attract game - low severity fires in early spring probably more frequent than 50-75yrs (Butler, pers comm).

This seral community is most affected by fluvial geomorphic processes such as flooding, avulsion and deposition and channel movement. The floodplain valley was modeled up to the last high terrace that rarely floods to reset to an early successional seral stage. The model does include shallow wetlands, sloughs or oxbows. Deep water habitat and the wetted width of the active river were not included in the model. Different flooding regimes were used in the model. The rivers flood to some extent almost every year. This annual, spring, snowmelt flooding is the primary driver of point bar formation. 50-yr or 100-yr floods can wipe out point bars, but they form lots of habitat for cottonwood and willow establishment through scouring and deposition. Minor, point-bar forming floods occur almost every year, while serious, scouring, high-terrace depositing events may be 20-50yrs. Flood frequency is also based on location on the floodplain, with higher terraces being subject to longer flood cycles.

Fire was a disturbance mechanism within portions of floodplain, however, the frequency and intensity is unknown. We can, however infer mixed severity fires in general, given the highly variable species and varying fuel amounts and spatial arrangements. The role of fire was less important, with relatively infrequent and patchy, low-to-mixed severity fires. A reviewer (Barrett, personal correspondence) commented that the overall MFRI was probably approximately 50-75yrs given the presumably abundant ignition opportunities in the neighborhood (ie: occassional fires spreading into this BpS from adjacent frequently burned grasslands). The overall MFRI was thus modeled as such. However, Butler commented that Native Americans likely camped along rivers and used fire to attract game - low severity fires in early spring probably more frequent than 50-75yrs (Butler, pers comm).

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Adjacency or Identification Concerns

This system is easily identified by using flood plain which is covered by a 10-yr event. Surrounding vegetation could vary from forested to grass prairie transition. In the western part of MZ20, could have narrowleaf cottonwood and could have hybrids between this system and narrowleaf.

Russian olive and tamarisk may be invaders. Tamarisk comes in with cottonwood and willow in earliest post-disturbance stage. Russian olive might affect later successional stages - after 10yrs, usually at approximately the time that green ash and Rocky Mountain juniper come in. Rocky Mountain juniper also invades along the Little Missouri River in MZ29.

Leafy spruce, smooth brome, Canada thistle and Russian knapweed might invade also.

The natural flooding frequencies have been changed by the modern water control structures (dam and irrigation projects). Flooding intensity has been altered by construction of small impoundments on tributaries as well as larger impoundments on the main-stem rivers. Decreased flood frequency along the Little Missouri River decreased cottonwood abundance and increased distribution of silver sage in MZ29 currently. However, this trend has just started - ie: increase of silver stage today versus historically.

Agriculturial activities have change seral development and introduced invasive plant species to the BpS.

Woodcutters along the system operated from the earliest days (1860s) to supply wood to the paddlewheelers plying the river. They cut many of the early stands along the river and perhaps threw the balance to POPDEL regeneration as opposed to ACENEG. It is very difficult to model the presettlement conditions of these river systems, not knowing their original composition.

Currently, there would be higher cover and taller shrubs on the landscape today, versus historically - in MZs 29 and 30.

Johnson (1992), in a study of Missouri River floodplain forests in central ND, determined that the presettlement forest was, in fact, dominated by early successional stages. He reports that young pioneer stands (<40yrs) comprised 47% of the forest, while older pioneer stands (40-80yrs) comprised 25% of the forest; that transitional forest (80-150yrs) comprised 21% of the forested acreage and that equilibrium stands (dominated by green ash, elm, oak, etc.) (>150 yrs) comprised only seven percent of the forested acreage. Johnson (1992) also demonstrated that with construction of Garrison Dam and subsequent cessation of flooding, there is a continuing shift to older forest stages and very little recruitment of new, early successional forest; the very types that once dominated the Missouri River floodplain and provided habitat for its varied native wildlife.(from Ode 2004).

Over the past 37yrs much has changed in the cottonwood forest of LaFramboise Island in South Dakota. As the density of cottonwoods has declined (at a rate of about two per acre per year), the number of junipers and, to some extent, green ash have dramatically increased. In cottonwood forests throughout much of the upper Missouri River Valley, green ash is one of the most important tree species to colonize cottonwood forests and, over time, becomes the dominant forest tree (Ode 2004). Whatever thevdominance of green ash in the future forest, it will likely be over-whelmed if not over-shadowedvby the massive number of junipers which are now developing in the LaFramboise Island forest understory (Ode 2004). Cottonwood is declining.

Junipers are notoriously vulnerable to fire. On the presettlement landscape of the northern plains, where

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prairie fires were frequent events, juniper woodlands were restricted to fire-protected environments like river breaks, badland escarpments, buttes and islands (Ode 2004).

This system to be distinguished from 1159 by geographic range/ecoregions. The Great Plains Floodplain systems are in the Northwestern Glaciated Plains and the Northern Great Plains; the Rocky Mountain Montane Riparian systems are in the lower elevations (ie, not alpine) of the Northern and Middle Rockies, some of which occur as isolated mountain ranges in the Great Plains. Broadly generalized, the Great Plains Floodplain systems typically have broader floodplains and more terrace development.

Also - montane riparian systems of central MT and probably the Black Hills too will have steeper gradients, narrower floodplains, and be dominated by Populus angustifolia or P. balsamifera as opposed to P deltoides for Great Plains floodplains. Rivers like the Powder, Tongue and probably Little Missouri start as montane rivers and become Great Plains rivers.

There might be some difficulty distinguishing the Floodplain Systems from the Riparian from the Wooded Draw/Ravines - and where to assign smaller, second and third order prairie streams. The second and third order prairie streams can sometimes have cottonwood and be like small rivers (Riparian, Floodplain); sometimes they are dominated by other woodies such as water birch, box-elder, green ash (Wooded Draw/Ravine) and willows, depending on how far east you go; sometimes they have very few woody plants other than silver sagebrush (Floodplain box E). Streams in the eastern half of MT (east of the Big Snowies) could probably be modeled as either a cottonwood successional sequence or a woody draw successional sequence, depending on the size of the drainage basin. If the basin is big enough there will eventually be a flood big enough to result in cottonwood regeneration. This may not happen very often naturally, so these types of drainages would be in class E Floodplains (silver sagebrush) a lot of the time. This is especially true now that we have all the impoundments in the headwaters of these prairie streams. Drainages that just don't have the area to get a serious flood would probably have been some sort of woody draw, dominated by green ash in the eastern third of the state or other woodies like hawthorn or chokecherry in the more western part of the Great Plains. In terms of assigning the drainage to one or the other type of system would depend on basin size.

The Rocky Mountain riparian systems will occur in the mountains, while great plains riparian and floodplain 1162 will be lower elevations/in the plains matrix of eastern WY and east MT plains grasslands and better described by 1162. The exception to this is the strings of narrow-leaf cottonwood (p. angustifolia) found along the laramie river and other rivers in the Wyoming portions of zone 29, which are Rocky Mountain in character despite being surrounded by grasslands and sage-steppe. These riparian zones in the middle of sage-steppe are really Rocky Mountain systems, not Great Plains.

Rivers and streams that have had impoundments (current conditions) for 50yrs or more probably have more class D and E than presettlement but less class A and B. Class A and B currently has tamarisk. Class C and D have Russian olive currently. Several exotics, such as Canada thistle, Kentucky bluegrass and quackgrass are ubiquitous in classes B through E currently.

Native Uncharacteristic Conditions

Native uncharacteristic conditions- Rivers such as the Missouri below Fort Peck Dam and the Big Horn and Tongue below their dams probably have more late-seral and less early-seral vegetation because of the reduced flooding frequency and severity.

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Scale Description

Landscape adequate in size to contain natural variation in vegetation and disturbance regime. This BpS occurred in a linear dimension along the Missouri River floodplain and Little Missouri River (MZ30), with smaller areas covered in tributary rivers and streams. Wetland complexes include oxbow lakes, slough and marshes.

Issues/Problems

Assumptions: Rapid Assessment model developed with the recognition that the Great Plains Floodplain forest (cottonwood-willow community) is a seral community. This seral community is most affected by fluvial geomorphic processes such as flooding, avulsion and deposition, and channel movement. The floodplain valley was modeled up to the last high terrace that rarely floods to reset to an early successional seral stage. The model does include shallow wetlands, sloughs or oxbows. Deep water habitat and the wetted width of the active river were not included in the model. Flood frequency for a class is based on location on the floodplain, with higher terraces being subject to longer flood cycles.

Woodcutters along the system operated from the earliest days (1860s) to supply wood to the paddlewheelers plying the river. They cut many of the early stands along the river and perhaps threw the balance to POPDEL regeneration as opposed to ACENEG. It is very difficult to model the presettlement conditions of these river systems, not knowing their original composition.

Comments

This model for MZs 29 and 30 was adopted from the same BpS from MZ20 created by Peter Lesica and Vinita Shea and reviewed by Brian Martin, Steve Cooper and Linda Vance. Slight model changes made.

This model for MZ20 was adapted from the Rapid Assessment model R4NOFP Great Plains Floodplain created by George Cunningham (gcunningham@mail.unomaha.edu) and reviewed by John Ortmann (jortmann@tnc.org). The model for MZ20 was modified greatly descriptively and quantitatively by Vinita Shea (vshea@blm.gov) and Ben Pratt (ben_pratt@fws.gov). The model is also reflective of the upper Missouri River region. Upon review for MZ20 by Peter Lesica, Brian Martin and Steve Cooper, other major quantitative changes were made and successional classes were changed to encompass the silver sage component of class E instead of a green ash community, which was thought to not exist in MZ20. Other reviewers for MZ20 were Steve Barrett.

Vegetation Classes

Class A **15 %**

Early Development 1 All Structure

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model

Description

Indicator Species* and Canopy Position

PODE3	Upper
SAEX	Upper
SALU2	Upper
SCHOE6	Low-Mid

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	0 %	50 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

The upper layer lifeform is comprised of a seedling and sapling shrub (willows) and tree component. Trees might be more abundant/frequent. Shrubs of any cover and 0-1m are in this class.

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Created by deposition, stream meander changes, point bar formation and scouring.

This model was originally made with two early classes, A and B. One reviewer for MZs 29 and 30 suggested combining classes A and B. They were combined for MZs 29 and 30 in order to accommodate another late successional stage with green ash and box-elder. This class is now ages from 0-15yrs.

The upper layer lifeform is comprised of a seedling and sapling shrub (willows) and tree component and dominated by a young canopy of tree saplings and shrubs after a few years. Trees might be more abundant/frequent.

Sandbar willow, Salix interior is invariably the first which makes its appearance on the newly made lands on the borders of the Mississippi and Missouri, and seems to contribute much towards facilitating the operation of raising this ground still higher; they grow remarkably close and in some instances so much so that they form a thicket almost impenetrable (from Meriwether Lewis during the Lewis & Clark expedition in 1804 to 1806, from Ode 2004).

Pioneer tree and shrub species of cottonwoods and willows. The understory is highly variable and consists of bare sand, annuals or perennial hydrophytes. Species would include various grass, sedges and rushes. Annuals become less and less common after 10yrs as the rhizomatous perennials take hold. Herbaceous understory of sedges (bulrushes) and native annuals in wet areas. In the early few years of this stage, most of the area is bare sand. Age 0-4yrs for the first part of this class, then 5-14yrs for the second part of this class.

Most of area is seasonally flooded. Much bare, wet-alluvium habitat for cottonwood establishment is created each year during spring floods. However, most all of these will be swept away by the next year's flood in the early part of this class. It is probably only every 10-20yrs that flooding occurs up high enough on point bars and low terraces to establish cottonwoods and then allow them to escape flooding until they are large enough to persist - in the early part of this class.

During the 2nd part of this class, at age 5-14yrs, minor flooding occurs every 20yrs, advancing this stage to the next; deposition causes the terrace to build and become higher and drier. This was modeled as alternate succession. Lack of flooding actually maintains the stage.

Major flooding occurs every 50yrs, bringing it back to the beginning of this stage. This was modeled as wind/weather stress.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. It was modeled as "optional 1". Beavers, however, do not have as much of an impact in stands less than 10yrs old unless there is nothing else in the area. Beaver activity is quite variable. It was modeled as occurring on one percent of this class on the landscape each year, maintaining this class.

After 15yrs, this class succeeds to the mid-development closed stage.

Johnson (1992) states that young pioneer stands (<40yrs) comprised 47% of the forest historically.

Class B **30 %**

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PODE3	Upper
SAAM2	Mid-Upper
SALU2	Middle
FRPE	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	70 %
Height	Tree 5.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This stage develops as the stand starts to mature. This community tends to be partially opened, with scattered cottonwoods and willows. Stands of cottonwoods 20-50yrs old can be fairly dense, although there are usually some openings. The shrub layer is highly variable and may include species such as rose, snowberry, chokecherry and dogwood. Glycyrrhiza lepidota might also occur. Elymus canadensis might also occur.

Green ash begins to establish in cottonwood stands when they are approximately 20yrs old (Lesica and Miles 1999).

The understory vegetation is highly variable. Age is 15-50yrs, succeeding to class C, a late closed stage.

Flooding occurs every 50yrs, and advances it to the next stage; it promotes it to the next stage by raising the level of the terrace. Minor flooding leads to deposition. This was therefore modeled as alternate succession. Major flooding occurs every 50yrs, bringing this class back to the early class A stage. This was modeled as wind/weather stress.

Replacement fires were modeled at occurring every 150yrs. However, it has been suggested that stand replacing fires might not occur in this class because it might be too wet for fire. However, due to lack of data, replacement fires were kept in the model. It is questionable as to whether replacement fire would set this stage back to the beginning of class A, as the terrace would be too high and dry to provide conditions for successful establishment of cottonwood and willow from seed. If the cottonwoods resprouted, it would be more like the middle of class A because the understory would be more mature than the beginning of class A; if the cottonwoods didn't resprout, it would probably just be a willow stand. Replacement fire was however modeled as taking this class to class A.

Low severity and mixed fire also occur every 100yrs, combined, and does not transition to another stage.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. It was modeled as "optional 1". Beaver activity is quite variable. It was modeled as occuring on one percent of this class on the landscape each year, maintaining this class.

One reviewer suggested combining classes B and C; however, they were left intact due to their species and ecological differences.

It has been suggested that Native Americans likely burned (low severity fires) these areas more often than every 100yrs. Also, some sites were likely heavily grazed by bison (low severity fire sites) and horses near camps. However, the model was retained as-is, as no further feedback was received.

Johnson (1992) states that young pioneer stands (<40yrs) comprised 47% of the forest historically.

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Class C **25 %**

Late Development 1 Closed

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PODE3	Upper
PASM	Low-Mid
SYOC	Middle
FRPE	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	61 %	80 %
Height	Tree 25.1m	Tree 50m
Tree Size Class	Very Large >33"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class is a mature, late seral closed canopy cottonwood floodplain forest. Overstory is dominated by cottonwood, green ash. (Original MZ20 modelers included box-elder ACENEG in this class; however, all other reviewers disagreed and said that ACENEG was a minor component historically. It might be present, but in small amounts; chokecherry is more common; box-elder, however, is seen today in the Musselshell/Missouri River, but it is questionable as to whether that would have occurred historically.) System becoming drier, so western wheatgrass coming in.

At least four studies along the Missouri River in southeastern SD have described aspects of a successional sequence that begins with colonization by cattails or sandbar willow, develops through transitional phases to a plains cottonwood dominated forest, and finally, in the absence of stand replacing floods, develops into a mixed deciduous forest that may contain the following tree species (in addition to aging cottonwoods): green ash, American elm, box-elder, bur oak, slippery elm, hackberry, American basswood, black walnut and eastern red-cedar (Johnson 1950, Heckel 1963, Wilson 1965 & 1970, Lawry 1973). Ecological studies along the Missouri River in central ND have documented a similar successional pattern ultimately resulting in a forest dominated by green ash, box-elder, bur oak and American elm (Johnson, et al. 1976). (from Ode 2004). This was therefore modeled as an alternate successional pathway to class D. Some cottonwood stands follow the successional pathway and proceed to E. Others have enough green ash that the next class, in this case class D, is dominated by green ash and Symphoricarpos occidentalis. Of course some stands would be a mosaic of these two late-seral types.

Age 51-200yrs and can then succeed to E.

Minor flooding occurs every 10-20yrs. Minor flooding raises the level of the terrace. Because this is the last stage in this cottonwood portion of the system, this minor flooding was modeled as wind/weather stress, causing no transition. Major flooding occurs every 50-100yrs, bringing this class back to class A. This was modeled as wind/weather stress.

Replacement fire occurs every 150yrs (this interval is speculative, as not much data is available.) and takes this class to E, the silver sagebrush class. It is thought, however, that before it gets to silver sagebrush, there might be an intermediate stage dominated by western wheatgrass and snowberry before silver sagebrush establishes in significant amounts. However, due to the limitations of the five-box model, this intermediate stage was not modeled.

Low severity fire was also modeled as it was in class B, causing no transition. Mixed severity fire was also included with the same probability as low severity, every 100yrs. It is thought that mixed severity fire would cause a more open, drier stand that would allow invasion of silver sagebrush earlier, bringing it to E earlier; however, because that type of transition was captured in replacement fire, mixed severity fire was modeled as removing some of the overstory and thus causing a transition to B.

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Optional 2 in this class represents erosional processes of river meandering that would bring this class eventually back to class A. The class/system will first be part of the river, but then will succeed to class A or a point bar state. This occurs with a frequency of several hundred years and was modeled at a frequency of 400yrs.

River meanders back and begins to cut away at the banks whereon a mature or old-growth stand of POPDEL exists and the living trees slowly are undercut and ultimately fall into the stream.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. It was modeled as "optional 1". Beaver activity is quite variable. It was modeled as occuring on one percent of this class on the landscape each year, maintaining this class.

One reviewer suggested combining classes B and C; however, they were left intact due to their species and ecological differences.

Johnson (1992) states that older pioneer stands (40-80yrs) comprised 25% of the forest; that transitional forest (80-150 yrs old) comprised 21% of the forested acreage and that equilibrium stands (dominated by green ash,elm, oak, etc.) (>150yrs) comprised only seven percent of the forested acreage historically.

Class D **5 %**

Late Development 2 Closed

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

FRPE	Middle
ACNE2	Middle
PODE3	Middle
SYOC	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	71 %	100 %
Height	Tree 5.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class was based on R4NOFP class E. Found along the upper terrace that has been protected from most flood events, except for rare high intensity flooding. Species composition increases towards south and east within the region. Overstory species include hackberry, green ash, sycamore, black walnut and elm. Understory species include vines and poison ivy.

In the absence of stand replacing floods, this class is what has developed - a mixed deciduous forest that may contain the following tree species (in addition to aging cottonwoods): green ash, American elm, box-elder, bur oak, slippery elm, hackberry, American basswood, black walnut and eastern red-cedar (Johnson 1950, Heckel 1963, Wilson 1965 & 1970, Lawry 1973). Ecological studies along the Missouri River in central ND have documented a similar successional pattern ultimately resulting in a forest dominated by green ash, box-elder, bur oak and American elm (Johnson, et al. 1976). (from Ode 2004).

Class D hackberry sycamore slippery elm, basswood, burr oak and black walnut would be rare or absent in eastern MT and (presumably) western ND. These species occur in central to eastern ND. I think the only trees you can count on in class D in eastern MT and western ND (and probably much of western SD too) are green ash, American elm, box-elder and eastern red-cedar (Juniperus scopulorum).

Hansen et al. (1984) state that other dominants are Toxicodendron rydbergii and Elymus canadensis.

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

The FRPE/SYOC association is an edaphic climax on the floodplain adjacent to the Little Missouri River and its major tributaries. PODE currently dominates many stands but is no longer reproducing. It will be replaced by FRPE. The larger trees, some 6-7dm DBH are PODE, but the young trees establishing in the stands are FRPE. JUSC is tallied with the tree species, although it's an understory species in the closed forest. Its current abundance is attributed to adequate light penetrating to the shrub and herb layers of the community as a result of wide spacing of the old Populus. Along the Missouri River, in central ND, southeast SD and near Omaha, NE, PODE is a pioneer species and is replaced successionally by various combos of Fraxinus, Ulmus, Acer and Celtis. Among the grasses, CALO, ELCA and MURA are important (Hansen et al 1984).

The disturbances are those from R4NOFP: Major flooding events can bring this class back to A (0.004 probability - every 250yrs), modeled as wind/weather stress. Flooding events can also cause a transition back to C (0.005 probability - every 200yrs), modeled as wind/weather stress.

Mixed fire occurs every 50yrs but causes no transition.

Dominants of the green ash/western snowberry stands can resprout after fire. However, a very hot fire can kill the green ash (Lesica 2003), in which case it would probably become a stand of western snowberry-silver sagebrush-western wheatgrass (not modeled here).

Class E **25 %**

Late Development 3 Closed

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

ARCA13	Upper
SYOC	Upper
PASM	Middle

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	40 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class	None	

☐ Upper layer lifeform differs from dominant lifeform.

Description

This is a silver sagebrush climax community on river terraces and larger streams. It has been noted (Cooper, personal correspondence) that the usual case in this system is for plains cottonwood to die out and for the stand to go to silver sagebrush domination with western wheatgrass in the undergrowth or western snowberry and rose (Rosa spp) with grasses (mostly PASSMI). That is what is therefore modeled here. It is thought that before this stage gets to silver sagebrush, there might be an intermediate stage dominated by western wheatgrass and snowberry before silver sagebrush establishes in significant amounts. However, due to the limitations of the five-box model, this intermediate stage was not modeled.

This class also represents the post-replacement fire community from C. If a replacement fire were to occur in C, it would come to this stage - which is why this stage therefore starts at age 50yrs. This is a stable community. It persists. Silver sagebrush resprouts after fire.

This class is less likely to have depositional flooding than other stages. It was therefore not modeled here.

Major flooding events were modeled as wind/weather stress occurring every 250yrs, bringing this class back to A.

Optional 2 in this class represents erosional processes of river meandering that would bring this class eventually back to class A. The class/system will first be part of the river, but then will succeed to class A or a

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point bar state. This occurs with a frequency of several hundred years and was modeled at a frequency of 400yrs.

Replacement fire was modeled at every 50yrs, similar to other silver sagebrush communities, but maintaining this stage, as this class is stable, as stated above - and the silver sagebrush resprouts and thus maintains this stage.

Note for mappers: although height and cover overlap with class A, species are completely different. This is no longer a PODE3 community.

It is thought that this stage might be more prevalent currently vs historically due to impoundments increasing the silver sage distribution.

It has been suggested that this class did not occupy 25% of the landscape but rather a lesser portion historically. However, upon further consideration from modelers and experts, 25% seeemd reasonable for big rivers, but may be a little low for smaller streams that don't flood with the same frequency; in other words, there might be more than 25% historically for smaller streams.

Johnson (1992) states that older pioneer stands (40-80yrs) comprised 25% of the forest; that transitional forest (80-150yrs) comprised 21% of the forested acreage and that equilibrium stands (dominated by green ash,elm, oak, etc.) (>150yrs) comprised only seven percent of the forested acreage historically.

Disturbances

Fire Regime Group:** III

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

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

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	115			0.0087	45
Mixed	150			0.00667	35
Surface	260			0.00385	20
All Fires	52			0.01921	

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

Additional Disturbances Modeled

- [ ] Insects/Disease
- [x] Wind/Weather/Stress
- [ ] Native Grazing
- [ ] Competition
- [x] Other (optional 1) beaver
- [x] Other (optional 2) erosional processes of river meandering

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3011791** **Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna - Low Elevation Woodland**

☑ *This BPS is lumped with: 1013*

☑ *This BPS is split into multiple models:* *Bur Oak is being lumped into several systems as an inclusion within the system, because it occurs in a variety of settings/communities - 1054, 1117, 1385, riparian, and transitioning from aspen in north in ND. It's in transition zones in MZs 29 and 30. Therefore, we can tell you where to map it (Dakotas), but it won't have its own model, because each model would encompass pieces of the aforementioned models.*

Querceus macrocarpal/Prunus virginiana habitat type forms relatively extensive communities on backslopes of intermittent streams and drainageways. This habitat type was limited to glaciated areas. The Populus tremuloides/QUMA2 community type occupied erosive slopes. Once these areas become stabiliized, the QUMA2/PRVI habitat type will probably result because QUMA2 reproduces in the understory. The QUMA2/Corylus species habitat type is found in the Killdeer Mountains and adjacent areas. This habitat type is on gentle slopes and the soils are more leached than many of the ohter types. The Betula papyrifera Corylus Cornuta community type occupies similar sites and is seral to QUMA2/Corylus species habitat type (Girard et al. 1989).

This system is split into Low Elevation PIPO, and PIPO Savanna.

General Information

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

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Vegetation Type

Forest and Woodland

Map Zone

30

Model Zone

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

Dominant Species*

PIPO	JUCO6
PRVI	MARE11
QUMA2	TORY
ORAS	ARUV

General Model Sources

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

Geographic Range

Black Hills region, eastern MT, northeastern WY and western SD. Includes Bull mountains and Missouri Breaks, north of Billings - northeastern quadrant of MZ29. This type would be in MZs 29, 30 and 20. in MZ29 subsections 331Mi, 331Md; 334Ab.

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This type occurs in central and eastern MT, ND and SD, Black Hills, and a portion of eastern WY, including the Rochelle Hills of the Thunder Basin National Grassland. It also occurs along the Missouri River Breaks, and in 331G, 331K, and east of Bighorns.

This is the PIPO Woodland, Low Elevation, that isn't in the mountains of the Rockies.

Biophysical Site Description

North and northeast aspect slopes outside of the Black Hills and Laramie Peak (section M331I). Soils range from sandy loams to loams (Hansen and Hoffman 1988). The underlying substrate would be predominantly sedimentary. Elevation would be at approximately 3000-4000ft.

This BpS is found on all aspects of the Black Hills, below Ponderosa Pine Black Hills high elevation (BpS 1048) and above Ponderosa Pine savanna (BpS 11792) (generally 4000-6000ft), predominately on the lower limestone plateau and material weathered from metamorphic rocks. This type is generally on sites with sandy loam to clayey loam soils.

Vegetation Description

Ponderosa pine, bur oak (in northern Hills and Bear Lodge Mts.), chokecherry, Saskatoon serviceberry, aspen, Ribes species, rose species, ironwood (Black Hills), hawthorn, Oregon grape, raspberry, roughleaf ricegrass (Black Hills), littleseed ricegrass, Canada wildrye, needlegrasses, sideoats grama, sedges, common juniper and poison ivy.

BpS Code 1013 Bur Oak included in this model; 1013 occurs primarily in the North Western Black Hills and Bearlodge although can occur in scattered areas throught the BpS. For more information on this site can see Marriott et al 2000.

Disturbance Description

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

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

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

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

Fire intervals found at Wind Cave National Park are among the shortest documented for northern ponderosa pine forests. Fire frequencies at Wind Cave sites are comparable to those found in southwestern

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US ponderosa pine forests and some lower elevation ponderosa pine sites in the northern Rocky Mountains (Brown and Sieg 1999).

In the Rochelle Hills, the mean fire-free interval (WMPI) of the non-suppression period is not statistically different from the mean fire-free interval of the suppression period. Although suppression period sample size is limited, our estimates of minimum frequencies should limit the power (lowering the chance of not detecting a difference when there is a difference) that greater sample numbers (fire years) would generate (Perryman and Laycock 2000).

Most of southern and southwestern forested areas of the Rochelle Hills have somewhat closed canopies, substantial amounts of litter accumulations, and relatively high tree densities. This set of circumstances will most likely lead to a future catastrophic fire, but it is unclear if fire suppression activities have given rise to this condition or if this condition is a part of the natural cycle in the ecology of this system (Perryman and Laycock 2000).

Bragg (1985) calculated a MMFRI of 3.5 before 1900 increasing to 8.5 between 1900 and 1958 in PIPO areas of the Nebraska Sandhills.

The Little Missouri Grasslands are thought to also have a very short fire return interval.

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

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

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

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

In ponderosa pine, bur oak occurs with fire adapted species. When a stand replacing fire occurs, system will get big patches of bur oak that will persist until the pine comes in. It's shade intolerant. (The Laramie Peak area does not have bur oak.)

In the northern Black Hills, there is a separate bur oak type with a long MFRI. However, because bur oak is an inclusion within many systems in this mapzone, it was not modeled separately and is rather included in many of the systems.

Adjacency or Identification Concerns

This type occurs at elevations above Ponderosa Pine Savanna and at elevations below Ponderosa Pine Black Hills High Elevation. This type differs from Northwestern Great Plains Highland Spruce Woodland

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and Ponderosa Pine-Black Hills (BpS 2910480) because it has been documented to have more frequent surface fires, less frequent replacement fires and less closed canopy forest. (Brown 2003)

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

As this system model and description is a copy of 1054, this system will be difficult to distinguish from that one, and is only distinguished by geography.

Currently, there have probably been at least five fire cycles that have been missed due to suppression, grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 70-90% canopy closure. RC: Increased ladder fuel as a result of missed fire cycles increases the probability of a stand replacement fire.

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

The absence of dwarf mistletoe distinguishes this PIPO system from most others in the country.

This model for 11791 for MZ29 seems to differ slightly from 1054 in MZ20 (adjacent mapzone), due to distinctness of Black Hills ponderosa pine. However, in general, overall MFRI similar with mostly low severity fires. And general amounts in the successional classes are similar, with similar cover/height distinctions. Some of the other disturbance probabilities differ, due to more information provided in literature for MZ29.

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

Native Uncharacteristic Conditions

Currently, there have probably been at least five fire cycles that have been missed due to suppression, grazing, etc. in the Black Hills. Therefore, the system today would look much more like the late closed stage with approximately 70-90% canopy closure, at least in the Black Hills area.

Scale Description

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

In the Black Hills and Missouri Breaks, system would have been 100s-10,000s of acres. Outside of the Black Hills and Missouri Breaks, this BpS would have been 10s-1000 acres.

Issues/Problems

Comments

This BpS was originally modeled as MZ29 and MZ30 BpS 1054 which included the Black Hills. However,

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post-model-review-and-delivery, the new Northwestern Great Plains Black Hills Ponderosa Pine BpS was created by NatureServe. Therefore, this model is a copy of MZs 29 and 30 1054, only different from the current 1054 by defined geography.

The 1054 model for MZ29 and 30 was adapted from the model from the Rapid Assessment (RA) R0PIPObl Ponderosa Pine woodlands and BH low elevation developed by Kelly Pohl, Cody Wienk and Carolyn Sieg. Other modelers for MZs 29 and 30 were Paul Mock, Dave Overcast and Kim Reid. Other reviewers for MZs 29 and 30 were Carolyn Sieg, Gwen Sanchez-Lipp, Kathy Roche and Mary Lata.

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

Vegetation Classes

Class A **5 %**

Early Development 1 All Structure

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

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

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Description

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

In Bear Lodge this stage dominated by bur oak. In the Black Hills proper, lower limestone, it is dominated by grass/forb, with chokecherry, serviceberry, leadplant (not present on Laramie Peak), raspberry, rose and currant can be present. Bur oak is an indicator for the Black Hills, not other areas.

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

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

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

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

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Class B **15 %**

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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

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

Class C **15 %**

Mid Development 1 Open

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PRVI	Middle
AMAL	Middle
QUMA	Mid-Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class persists 15-50yrs. Surrounding this class are other trees/stands that are over 100yrs old. In Bear Lodge Mountains, bur oak persists, particularly in open canopy stands.

Understory species would be similar to those in class A. Snowberry will also become more prevalent. Grasses could include roughleaf ricegrass in Black Hills.

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

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

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

Class D **55 %**

Late Development 1 Open

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
PRVI	Middle
AMAL	Middle
QUMA	Mid-Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Open canopy stand; persists 50yrs+. Patches of dense doghair and 200yrs+ trees persist. Bur oak mostly restricted to northern Black Hills and Bear Lodge. Common juniper and rough leaf ricegrass common in Black Hills.

Other understory species same as in class C and A.

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

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

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

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

Class E **10 %**

Late Development 1 Closed

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
JUCO	Low-Mid

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

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

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(modeled as every 333yrs).

Ironwood and bur oak in northern Black Hills and Bear Lodge Mountains.

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

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

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

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

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg
Min 1
Max 100000

Sources of Fire Regime Data

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

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

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

Additional Disturbances Modeled

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3011792** **Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna - Savanna**

☑ *This BPS is lumped with: 1013*

☑ *This BPS is split into multiple models:* *Bur Oak is being lumped into several systems as an inclusion within the system, because it occurs in a variety of settings/communities - 1054, 1117, 1385, riparian, and transitioning from aspen in north in ND. It's in transition zones in MZs 29 and 30. Therefore, we can tell you where to map it (Dakotas), but it won't have its own model, because each model would encompass pieces of the aforementioned models.*

Querceus macrocarpal/Prunus virginiana habitat type forms relatively extensive communities on backslopes of intermittent streams and drainageways. This habitat type was limited to glaciated areas. The Populus tremuloides/QUMA2 community type occupied erosive slopes. Once these areas become stabiliized, the QUMA2/PRVI habitat type will probably result because QUMA2 reproduces in the understory. The QUMA2/Corylus species habitat type is found in the Killdeer Mountains and adjacent areas. This habitat type is on gentle slopes and the soils are more leached than many of the ohter types. The Betula papyrifera-Corylus Cornuta community type occupies similar sites and is seral to QUMA2/Corylus species habitat type (Girard et al. 1989).

This system is split into Low Elevation PIPO, and PIPO Savanna.

General Information

Contributors (also see the Comments field **Date** 6/12/2006

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Vegetation Type

Forest and Woodland

Dominant Species*

PIPO	PASM
JUSC2	CAREX
RHAR4	SCSC
PSSP6	QUMA2

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

Map Zone

30

Model Zone

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

Geographic Range

This BpS is located in the lower elevations of the Black Hills, western ND and SD, eastern MT, the Missouri River Breaks of northern MT, and from the High Plains of eastern WY (including the Rochelle Hills of the Thunder Basin National Grassland) eastward to western NE (in NE, the Pine Ridge escarpment would be included in this, but not the Sand Hills. The Pine Ridge escarpment reaches to the

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edge of the Sand Hills, but not really into them). This might describe areas in MZs 29, 30, 20 and 31. In MZ29, it could occur generally east of the Bighorn and Laramie Ranges (including sections 331G, 331K; subsections M334Aa, 331Mi, 331Md).

This is the PIPO Savanna that isn't in the mountains of the Rockies.

Biophysical Site Description

The geology is typically sedimentary in origin. Often found on buttes, hogbacks, rocky outcrops and steep, rocky slopes. Elevations range from 3200-4400ft, but in the southern Black Hills may be found up to 5700ft on southern aspects. In eastern MT and northeast WY, it is also found on southern aspects.

Vegetation Description

This type is dominated by interior ponderosa pine and it is often the only tree present. Understory composition varies but Rocky Mountain juniper, skunkbush sumac, mountain mahogany (in southern Black Hills and the eastern Pine Ridge), snowberry, and yucca are common woody species (one reviewer noted that under the historic fire regime, the occurrence of yucca would have been a bit lower than at present). Bur oak might occur in this system as well. Currant and chokecherry are found in the MT portion of the BpS's range. These also occur on the Pine Ridge, but neither is significant except in draws. Poison ivy is also common in the Pine Ridge.

Regional lead asked about JUSC2 as an indicator... for the Black Hills, JUSC2 really is a component and indicator of many of the ponderosa pine savanna areas. The species generally becomes more prominent in the pine savanna as the soils become more skeletal, or the soil profile and surface contain more rock fragments. There may be some sites where it is a very limited component. JUSC2 can also be considered an indicator for Thunder Basin. In the Pine Ridge in Nebraska, JUSC2 is never hard to find in the ponderosa pine areas, but you sometimes have to actively look for it - so it might not be an indicator on the Pine Ridge; this may be one of the differences between this side of the range and the northwest side of the range. Rocky Mountain juniper is listed as present in late successional communities for ponderosa pine/Idaho fescue, ponderosa pine/sun sedge and ponderosa pine/bluebunch wheatgrass habitat types by Hanson and Hoffman (1988) for southeastern MT. But it's not mentioned as present in the other ponderosa pine habitat types (ponderosa pine/common juniper and ponderosa pine/chokecherry). Rocky Mountain juniper is not an indicator for ponderosa pine habitat types in southeastern MT or western ND.)

Herbaceous species include needlegrasses, gramma grasses, little bluestem, western wheatgrass, sedges and bluebunch wheatgrass. There is Idaho fescue as far east as Ashland, MT.

Disturbance Description

Generally frequent fires of low severity (Fire Regime Group I). Mixed severity fire occurs in the closed canopy conditions, and stand replacement fire is very infrequent (300yrs+). Low-severity fires are frequent and range from <10yrs to more than 20yrs (Brown and Sieg 1999, Fisher et al. 1987), but probably not more than 40yrs at the high end (3-70yrs range). The MFRI is approximately 12-15yrs for low severity fires.

There is considerable debate over the role of mixed severity and surface fires in the historical range of variability in this and other ponderosa pine forests in the northern and central Rockies (Baker and Ehle 2001, 2003; Barrett 2004; Veblen et al. 2000). However, Brown (2006) argues that surface fire was the dominant mode of fire disturbance and that the role of mixed-severity fires is overstated.

The surgeon’s log at Fort Robinson in 1893 states that the White River face has steep asclivities are black

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with the pines that have given their name to the ridge. The forest growth is limited by the creek and beyond are grass-grown prairies whose annual fires have destroyed the seedling pines. A drive of twelve miles would take us to the summit and bring to view a rolling fertile land that sinks by gentle slopes to the level of the Niobrara on Running Waters. Things would have changed some by 1893, but this area didn't settle heavily until at least two decades after that. Additionally, a form he had to fill out stated that the trees were mostly up on the ridges. So – this documents a very high frequency fire regime, at least at that time (the last armed conflict with Native Americans was in 1890, so Native American influences on the fire regime were already tremendously affected – probably shorter. Higgens suggested that with the coming of the railroads, fire frequencies increased significantly (Lata, pers comm).

In the Rapid Assessment (RA) workshop, review indicated more mixed fire should occur in the early stage and surface fire should be modeled in all structural stages. Peer review comments during the RA disagreed on the role of mixed and surface fire in this type. The majority of review agreed with the original model's parameters for mixed fire, but thought surface fire could be slightly less frequent. One review contended that there is no evidence of mixed severity fire in this type at all, and that the overall MFRI should be around 25yrs.

For MZs 29 and 30, it was suggested that mixed fire be removed from this model; reviewers agreed, and therefore mixed fire is not in the model.

Variation in precipitation and temperature interacting with fire, tip moths and ungulate grazing affects pine regeneration. Windthrow, storm damage and mountain pine beetles were minor disturbances in this type unless stands reach high densities. The interactions among drought, insects and disease are not well understood.

Ips spp of bark beetles can cause significant mortality among pole-sized and larger diameter pines, especially those weakened by drought, fire injury and the hail-related native disease diplodia. This serves to maintain the late-development open stage (class D) and move the late-development closed stage (class E) to the late-development open stage (class D).

In ponderosa pine, bur oak occurs with fire adapted species. When a stand replacing fire occurs, system will get big patches of bur oak that will persist until the pine comes in. It's shade intolerant.

In the northern Black Hills, there is a separate bur oak type with a long MFRI.

Ponderosa pine - Juniperus scopulorum savanna in the southern Black Hills has lots of rock exposure orvsparsely grassed soils, which probably protected some of the juniper seed trees from being wiped out by fire.

Adjacency or Identification Concerns

This type is either surrounded by Northern Plains grasslands and shrublands or is a transition between Northern Plains grasslands and shrublands and higher-elevation coniferous forests. Ponderosa pine in this BpS has encroached into the Northern Plains grassland and shrubland types in many areas due to fire suppression and grazing.

As this system model and description is a copy of 1117, this system will be difficult to distinguish from that one, and is only distinguished by geography.

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Invasive species in this system include cheatgrass, Japanese brome, crested wheatgrass, Kentucky bluegrass and intermediate wheatgrass. Crested wheatgrass and cheatgrass are at lower elevations mostly. Cheatgrass has altered the fire frequency and extent (although not on the Pine Ridge).

Currently, there have probably been at least 5-10 fire cycles that have been missed due to suppression, grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 50-80% canopy closure - uncharacteristic. Also - encroachment into prairies by pine and juniper is an issue today (Juniper becomes more of an issue further east; it's primarily ponderosa pine that is encroaching in the NE area), although JUSC2 is an indicator at least in the Black Hills. Generally. the juniper that is an issue with the prairies east of the Black Hills is the eastern red-cedar. As it continues to be incorporated into windbreaks, it is continuing to increase into new areas.

Hardwoods exist in drainages, which encompasses a separate BpS. In NE, there is green ash, chokecherry, hackberry and American elm, which get crowded out by the ponderosa pine.

Currently expanding into grasslands because of fire suppression, grazing and natural expansion from Holocene rebound (Norris 2006).

Native Uncharacteristic Conditions

Currently, there have probably been at least 5-10 fire cycles that have been missed due to suppression, grazing, etc. Therefore, the system today would look much more like the late closed stage with approximately 50-80% canopy closure - uncharacteristic. Some areas have been thinned to "even spacing," rather than the "clumpier" arrangement that is shown in early photos.

Scale Description

Disturbance patch size probably ranged from 10s-10,000s of acres. On the Pine Ridge in NE, fires could have at least been 75-100,000ac, as evidenced by current fires that have burned there (approx 60K acres), that would have continued to burn if they weren't suppressed.

System would be a patchy mosaic of 10s -1000ac. It could be a range of patches, such as in Missouri Breaks where it could be up to 10,000ac patches.

Issues/Problems

Comments

This BpS was originally modeled as MZs 29 and 30 BpS 1117 which included the Black Hills. However, post-model-review-and-delivery, the new Northwestern Great Plains-Black Hills Ponderosa Pine BpS was created by NatureServe. Therefore, this model is a copy of MZs 29 and 30 1117, only different from the current 1117 by defined geography.

The 1117 model for MZs 29 and 30 was adapted from the Rapid Assessment (RA) model R0PIPOnp developed by Breck Hudson and reviewed by Bill Baker, Dennis Knight and Brad Sauer. Other modelers for MZs 29 and 30 were Paul Mock, David Overcast and Kim Reid. Other reviewers for MZs 29 and 30 were Carolyn Sieg and Mary Lata.

RA Workshop code was PPIN11.

Additional authors for the RA include Deanna Reyher, Carolyn Sieg, Breck Hudson, Cody Wienk, Peter Brown and Blaine Cook. This type was modeled based on earlier work done by an expert panel (Morgan and Parsons 2001). Collapsing of stages were necessary to fit the five-box model used for this process.

Vegetation Classes

Class A 5 %

Early Development 1 All Structure

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

NAVI4	Mid-Upper
PASM	Mid-Upper
PSSP6	Mid-Upper
CAREX	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	90 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	Seedling <4.5ft	

- [ ] Upper layer lifeform differs from dominant lifeform.

Shrubs are the upper layer, perhaps, but cover is <20%.

Description

This community is dominated by herbaceous and woody species, including the graminoids needlegrasses, western wheatgrass, bluebunch wheatgrass, sedges, Idaho fescue and little bluestem in moister areas, and various shrubs including skunkbush and snowberry. Ponderosa pine seedlings are scattered and found in small clumps.

Little bluestem will also be indicator species.

Number of years in this class is variable depending on climatic patterns and fire disturbances. This class typically ends at 30yrs in this model. Without fire for 25yrs, this class can move to a mid-closed stage.

Needlegrasses can be tall up to one meter, but other graminoids are typically less than 0.5m.

Low severity surface fires occur every 30yrs. Replacement fires (since this is mostly grassland in this class) occur every 50yrs.

Class B 2 %

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Multi-story stand of small and medium trees with saplings and seedlings coming in as clumps. Understory is sparse. Some juniper might be present - could be an outlier. Grasses and shrubs are shaded out.

This class lasts approximately 70yrs, then moves to a late closed stage.

Low severity surface fires occur every 15yrs and move this stage to a mid open stage. Replacement fires occur infrequently approximately every 300yrs.

Insect/disease was modeled at approximately occurring every 50yrs, not causing a transition.

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

Class C **8 %**

Mid Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
NAVI4	Lower
PASM	Lower
PSSP6	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Graminoids could have up to 60-80% cover (Hansen and Hoffmann 1988). Grasses co-dominate.

Description

Predominantly single story stands with a few pockets of regeneration. Low shrubs such as snowberry and skunkbush and poison ivy are dominant as well as grass and forbs. Graminoids could have up to 70-80% cover. Rocky Mountain juniper present in patches (Rocky Mountain juniper is not common on the Pine Ridge in NE).

Carex spp and little bluestem will also be indicator species.

This class lasts approximately 50yrs then goes to a late open stage. Without fire for 40yrs, this could transition back to a mid closed stage.

Low severity surface fires occur every 15yrs, maintaining this class. Replacement fires occur very infrequently (modeled at 0.0015 probability).

Class D **80 %**

Late Development 1 Open

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Indicator Species* and Canopy Position

PIPO	Upper
NAVI4	Lower
PASM	Lower
PSSP6	Lower

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Graminoids could have up to 60-80% cover. Grasses co-dominate.

Description

Predominantly single story stands of large ponderosa pine with pockets of smaller size classes (replacement). Snowberry, skunkbush and patches of Rocky Mountain juniper. Understory is dominated by shrub species and grasses and poison ivy. Graminoids could have up to 70-80% cover.

Carex spp and little bluestem will also be indicator species.

It is thought that class D, the late open stage, should occupy approximately 80% of the historical landscape.

Low severity fires occur every 15yrs and maintain this stage. Replacement fires occur very infrequently (0.0015 probability). If no fire occurs after 40yrs, this class could transition to the late closed stage.

Insect/disease occurs every 50yrs and maintains this stage.

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Class E 5 %

Late Development 1 Closed

Indicator Species* and Canopy Position

PIPO Upper

Structure Data (for upper layer lifeform)

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

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Description

This is a somewhat uniform late-development stage, multi-story stands of large, medium, small and seedling ponderosa pine. Shrubs and grasses are sparse. This type generally exceeds 70% canopy cover. DBH is less in this class than late-open.

Low severity surface fires occur every 15yrs and cause a transition back to the late open stage. Replacment fires occur every 300yrs.

Insect/disease occurs every 250yrs, causing a transition back to the late open stage. Drought can also occur - every 500yrs, causing a transition to the late open stage.

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg
Min 1
Max 50000

Sources of Fire Regime Data

☑ Literature
☑ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	380			0.00263	4
Mixed		0			
Surface	15	3	70	0.06667	96
All Fires	14			0.06931	

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

Additional Disturbances Modeled

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

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

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LANDFIRE Biophysical Setting Model

Biophysical Setting **3013850** **Western Great Plains Wooded Draw and Ravine**

☑ *This BPS is lumped with: 1013*

☐ *This BPS is split into multiple models:* *Bur Oak is being lumped into several systems as an inclusion within the system, because it occurs in a variety of settings/communities - 1054, 1117, 1385, riparian, and transitioning from aspen in north in ND. It's in transition zones in MZs 29 and 30. Therefore, we can tell you where to map it (Dakotas), but it won't have its own model, because each model would encompass pieces of the aforementioned models.*

Quercus macrocarpa/Prunus virginiana habitat type forms relatively extensive communities on backslopes of intermittent streams and drainageways. This habitat type was limited to glaciated areas. The Populus tremuloides/QUMA2 community type occupied erosive slopes. Once these areas become stabiliized, the QUMA2/PRVI habitat type will probably result because QUMA2 reproduces in the understory. The QUMA2/Corylus species habitat type is found in the Killdeer Mountains and adjacent areas. This habitat type is on gentle slopes and the soils are more leached than many of the ohter types. The Betula papyrifera-Corylus Cornuta community type occupies similar sites and is seral to QUMA2/Corylus species habitat type (Girard et al. 1989).

General Information

Contributors (also see the Comments field **Date** 9/11/2006

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Vegetation Type

Forest and Woodland

Dominant Species*

FRPE	SYOC
ULAM	CASP7
ACNE2	ELYMU
PRVI	QUMA2

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Map Zone

30

Model Zone

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

Geographic Range

Predominately west of the Missouri River in ND and SD, with minor extensions east of the Missouri River and south into NE. (also extends into WY and MT.) It occurs in upland draws and ravines scattered throughout the Northern Mixed Grass Prairie and Northern Great Plains Steppe. This BpS is probably best developed in the Little Missouri Badlands of western ND (MZ 30, Section 331Md). This BpS also extends along drainages east to the Missouri River into MZ30, Section 331Mc, and west and north into section 331Me and 331Ea (possibly all way west to MZ20, although this is speculation), and likely into MZ29, Section 331 Mi.

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The bur oak component is also by Sturgis, East of Black Hills, where grass meets the Black Hills.

See Adjacency/Identification Concerns box regarding smaller second and third order prairie streams and where they occur or what they're classified as.

Biophysical Site Description

This BpS occurs in major tributaries and upland drainages with extensions onto steep north-facing slope. The vegetation type is best developed in topographic conditions that favor snow trapment and protection from fires in the adjacent grasslands. This BpS is heavily influenced by topographic situations that produce a combination of deeper soils, supplemental moisture from run-off and snow catchment. Soils on toeslopes and north facing backslopes are deep and well developed, while slopes on south facing backslopes tend to be dry, coarse textured and not well developed.

Bur oak occurs on sideslopes.

In Theodore Roosevelt National Park, it occurs in ravines or draws or on moderately steep north-facing slopes throughout much of the Park (Hansen et al. 1984).

Note from E. Contreras: The POTR/BEOC (aspen/paper birch) habitat type in Theodore Roosevelt National Park in ND, occurs on upper slopes facing northwest to east. Stands of the Fraxinus/Prunus habitat type are lower on the same slopes (Hansen et al. 1984).

Vegetation Description

Intricate mix of western grassland and shrubland species, with elements of eastern deciduous woodlands. Northern extent occasionally supports quaking aspen, while southern extent supports Juniper species and western extent includes ponderosa pine.

Green ash, chokecherry are dominant species, as well as buffaloberry, snowberry and American elm. On north end into ND, one would start seeing aspen, bur oak and paper birch (in Theodore Roosevelt NP; also tend to be small, incidental communities in the Little Missouri NG). In southern extent, would not see those as much. Rocky Mountain juniper also occurs in places, but tends to be an understory shrub in MT. Should also have Canada wildrye and woods rose. Variable across distribution. Muhlenbergia racemosa also common.

The bur oak type (even though lumped into this BpS and others) occurs within here. Green ash on bottom, and backslopes could have oak within it - in higher elevation (in these MZs 29 and 30) areas such as Black Hills and Missouri River Badlands. On eastern edge of Black Hills, bur oak is predominant species in drainages extending into prairie. Bur oak extends west into extreme southeastern corner of MT.

Quercus macrocarpa/Prunus virginiana habitat type forms relatively extensive communities on backslopes of intermittent streams and drainageways. This habitat type was limited to glaciated areas. The Populus tremuloides/QUMA2 community type occupied erosive slopes. Once these areas become stabiliized, the QUMA2/PRVI habitat type will probably result because QUMA2 reproduces in the understory. The QUMA2/Corylus species habitat type is found in the Killdeer Mountains and adjacent areas. This habitat type is on gentle slopes and the soils are more leached than many of the ohter types. The Betula papyrifera-Corylus Cornuta community type occupies similar sites and is seral to QUMA2/Corylus species habitat type (Girard et al. 1989).

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Other dominant species: poison ivy

Disturbance Description

The Wooded Draw BpS forms an intimate association with adjacent mixed grass prairie and shrublands where non-typical replacement fires are relatively frequent because of productive grass fuel and cycles of moisture and drought. Fires could go through the tree stands without topkill. Most years, the fires occur and meander but they're not intense enough to crown.

In drought periods, especially in late fall/summer, conditions were dry enough for stand replacing fires.

In areas where Rocky Mountain juniper or ponderosa pine invade woody draws, enhance flammability of system; fire carries through system. Juniper would then be lost, and smaller pines would be lost.

In some of the woody draws, there is bur oak - since it is fire-tolerant, a strong sprouter and shade intolerant, it will be enhanced by stand replacing fire, especially in times with higher moisture.

Much of trees could be killed by drought and fire together - weak sprouters such as green ash and American elm could be killed.

Fraxinus is even more tolerant than bur oak - so it would sprout up as well after high intensity fire. Periods with more fires - bur oak dominates. Without fire - elm and ash dominate.

Less frequent stand replacement fires were generally associated with periods of exceptionally high moisture conditions immediately followed by severe dry conditions.

Native ungulates play a role in stand regeneration on sites where deer and elk (and less so - bison, which don't congregate in the woody draws) concentrate for food, cover, and shelter.

Drought and moist cycles are major factors that interact with both fire and native grazing.

Low and mixed severity fire probably occurs on average every 10yrs.

Replacement fire: green ash trees are over 50yrs old. Replacement fires occurring every 60yrs.

Deciduous trees in the Badlands of the Dakotas in woody draws are reported to be no older than 50yrs and juniper is no older than 100yrs (Warner 1983). The fire return intervals of 15-30yrs were estimated for more broken topography at Scotts Bluff National Monument, NE (Wendtland and Dodd 1992). This return interval would have interacted with long term wet and dry periods for the area. The edges of these draws would have been impacted by the return intervals and fire frequencies of the surrounding prairie. The more mesic areas of the draws would have only been likely to burn in dry periods. The community, when maintained by fire, will have a mosaic of different age classes within a watershed. Browse for ungulates will increase. Sheltering cover will remain within 25% of current levels. Canada thistle and associated non-native species related to homesteading will be reduced. The structural complexity of the community will be maintained. (from Badlands National Park Fire Management Plan).

Heart rot can occur with Fraxinus spp.

Adjacency or Identification Concerns

Occurs in upland draws and ravines scattered throughout the Northern Mixed Grass prairie. There may be

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intermediates of this type of green ash community and cottonwood stand, especially in the eastern portion of the map zone along the larger, primary drainages associated with the Missouri River, and also in southern edge of Black Hills. In some cases, the type merges with north-facing Rocky Mountain juniper stands, especially at the top of draws.

This could also grade into the Floodplains or riparian areas. There might be some difficulty distinguishing the Floodplain Systems from the Riparian from the Wooded Draw/Ravines - and where to assign smaller, second and third order prairie streams. The second and third order prairie streams can sometimes have cottonwood and be like small rivers (Riparian, Floodplain); sometimes they are dominated by other woodies such as water birch, box-elder, green ash (Wooded Draw/Ravine) and willows, depending on how far east you go; sometimes they have very few woody plants other than silver sagebrush (Floodplain box E). Streams in the eastern half of Montana (east of the Big Snowies) could probably be modeled as either a cottonwood successional sequence or a woody draw successional sequence, depending on the size of the drainage basin. If the basin is big enough there will eventually be a flood big enough to result in cottonwood regeneration. This may not happen very often naturally, so these types of drainages would be in class E Floodplains (silver sagebrush) a lot of the time. This is especially true now that we have all the impoundments in the headwaters of these prairie streams. Drainages that just don't have the area to get a serious flood would probably have been some sort of woody draw, dominated by green ash in the eastern third of the state or other woodies like hawthorn or chokecherry in the more western part of the Great Plains. In terms of assigning the drainage to one or the other type of system would depend on basin size.

The bur oak type (even though lumped into this BpS and others) occurs within here. Green ash on bottom, and backslopes could have oak within it - in higher elevation (in these MZS 29 and 30) areas such as Black Hills and Missouri River Badlands. On eastern edge of Black Hills, bur oak occurs in drainages extending into prairie.

Aspen in this system could be confused for the Northwestern Great Plains Aspen Woodland and Parklands. However aspen parklands are not extensive in this part of the US. The range of aspen parklands just gets to the ND-MB border. There could be some plots that trickle into ND but we wouldn't expect many. The aspen parkland system is really in Canada, Alberta in particular (Menard, pers comm). There is a aspen/paper birch habitat type described for Theodore Roosevelt NP.

Understory is currently often dominated by Kentucky bluegrass throughout its extent in these mapzones, and leafy spurge is dominant in the Little Missouri grasslands.

Grazing by domestic livestock has reduced regeneration (increased mortality). On heavily grazed sites, stands are much more open than historically, with an understory of Kentucky bluegrass. There's also more compaction. Mid-story and regeneration is "missing." When trees start getting decadent, can lose the whole stand. Combo of drought and grazing/trampling could cause loss of stand.

In ND, system more likely to withstand grazing effects due to higher precipitation.

There's probably less of this system currently versus historically. Due to grazing, this system probably appears departed from its reference condition.

In many of the woody draws on Buffalo Gap and Oglala NGs, cattle will hang out in the draws and prevent almost all surface vegetation from growing. This increases erosion and compacts soil, and affects flammability for those fires that do occur. This leads to an overabundance of Rocky Mountain juniper in some draws. Fires burning up these draws with good burning conditions would be high severity (take out everything aboveground).

Native Uncharacteristic Conditions

Scale Description

Landscape is adequate in size to contain natural variation in vegetation and disturbance regime. Western stands are usually relatively small (<50ac). Larger areas, 50-100ac, occur infrequently on the eastern and northern edge of distribution. Long, linear corridors could be <50m wide but snake through the landscape for many miles, although it is not necessarily a continuous system (dendritic scale similar to riparian scale).

Most fires meander from adjacent system - grasslands. If drier year, will burn through system.

Issues/Problems

Long, linear nature of distribution makes them difficult to map. Consequently, they are often listed as a complex in relatively small-scale mapping efforts.

Comments

This model for MZs 29 and 30 was adapted from the model from Rapid Assessment R4WODR created by Jack Butler and Stefanie Wacker and reviewed by John Ortmann; however, portions of the MZs 29 and 30 model were also taken from MZ20 model for this BpS created by Peter Lesica. The VDDT model and descriptions used were those from MZ20.

This model for MZ20 was adapted from the Rapid Assessment model R4WODR Northern Great Plains Wooded Draws and Ravines created by Jack Butler and Stefanie Wacker and reviewed by John Ortmann. For MZ20, major descriptive and quantitative changes were made in order to represent MT better. The MZ20 model was changed to a three-box model.

Vegetation Classes

Class A **20 %**

Early Development 1 All Structure

Upper Layer Lifeform

☐ Herbaceous
☑ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

CASP7	Lower
SYOC	Upper
PRVI	Upper
	Lower

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	21 %	80 %
Height	Shrub 0m	Shrub 1.0m
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

This class is dominated by shrubs. Cover averages approximately 50%, and the minimum cover would never be as low as zero percent. In the first year, herbaceous species might dominate. The herbaceous cover is high underneath the shrubs. The herbaceous cover would probably be 25-50% cover. This class succeeds to B after approximately 10yrs.

This class is similar to a snowberry rose coulee type. It contains chokecherry and snowberry, with a mesic understory of CASP7 and various woodland forbs and poison ivy.

The transition from A to B could be retarded by native ungulate browsing. Grazing would set this stage back

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to its beginning state. Grazing, however, is dependent on weather cycles, as well. However, deer select green ash. There is also elk browsing.

The combined effect of drought and grazing was modeled as Optional 1. It was modeled to occur on 10% of this class on the landscape each year, setting succession back to zero.

Grazing alone was modeled as occurring on 25% of the landscape each year, but maintaining the class and not causing a transition.

The MFRIs are similar to grassland systems, but we're not in a grassland system here the entire 10yrs or throughout the system - partly shrubs, so there aren't replacement fires occurring all of the time. Occassionally, there are replacement fires if going through the grass. There are also mixed severity fires - 25-75% topkill - since the shrubs aren't completely topkilled. Fires were modeled at an overall interval of 15yrs, half replacement and half mixed severity.

Class B **15 %**

Mid Development 1 All Structures

Upper Layer Lifeform

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

Fuel Model

Indicator Species* and Canopy Position

PRVI	Mid-Upper
SYOC	Low-Mid
FRPE	Lower
CASP7	Low-Mid

Structure Data (for upper layer lifeform)

	Min	Max
Cover	11 %	50 %
Height	Tree 0m	Tree 5m
Tree Size Class	Sapling >4.5ft; <5"DBH	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

This class is dominated by shrubs and trees and is a mid-development stage. Its ages are 10-29yrs. Trees are coming in and getting taller in this stage. Trees are growing approximately 2/3 of a foot each year. A 30% canopy cover of trees would be the average (Lesica 2001). This stage reaches approximately 30yrs of age. It is similar to class A, but the shrubs are taller, and the trees that are coming in, are beginning to overtop the shrubs. A true tree canopy has not yet developed.

The MFRI is similar to that in a grassland system, although this system might experience somewhat less frequent intervals, as occassionally fires might not burn through this stage. Some will be replacement fires (100yrs) and take out all of the stand, although this would be less frequent and would also depend on the year and drought. Some fires might maintain the stand. Most of the fires would be mixed (40yrs) and low severity (65yrs), although the frequency of types would be similar. There would be less mortality on larger trees. During episodes of drought and grazing, there would be no fuel present for fire. Fire was therefore modeled at an overall frequency of 20yrs, but split 30/50/20 percent between low, mixed and replacement fires. The low and mixed fires do not cause a transition to another stage.

The combined effect of drought and grazing was modeled to occur on 10% of this class on the landscape each year, but not causing a transition, and rather maintaining this class.

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Class C **65 %**

Late Development 1 All Structures

Indicator Species* and Canopy Position

FRPE	Upper
PRVI	Mid-Upper
SYOC	Middle
CASP7	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	100 %
Height	Tree 5.1m	Tree 10m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model

Description

This class begins at approximatelly 30yrs old and persists. This includes both open and closed stages of this system in this age range. An average canopy closure would be approximately 50%. Height can be between 40-70ft and DBH approximately 45in (USDA Forest Service 2002), although most old-mature ash trees in this type in MT are 20-40ft high with a basal diameter of 20-30in. Tree canopy in this stage is now formed. It takes on aspects of a woodland instead of a shrubland (the first two classes are more shrub communities).

The MFRI is similar to that in a grassland system, although this system might experience somewhat less frequent intervals, as occassionally fires might not burn through this stage. Some will be replacement fires and take out all of the stand, although this would be less frequent and would also depend on the year and drought. Some fires might maintain the stand. Most of the fires would be mixed and low severity, although the frequency of types would be the same. There would be less mortality on larger trees. Fire was therefore modeled at an overall frequency of 20yrs, but split 30/50/20 percent btwn low, mixed and replacement fires. The low and mixed fires do not cause a transition to another stage.

The combined effect of drought and grazing was modeled to occur on 10% of this class on the landscape each year, but not causing a transition, and rather maintaining this class.

Disease might occur in this stage, which opens the stand (Lesica et al. 2003). In MT, this is more prominent than in the Dakotas. In the Dakotas, canopy closure could be 90%. In MT, open canopy would be about 40-45%, and the relatively open nature of stands is probably due, in large part, to high rates of heart-rot disease. Disease is not as common further east, in the Dakotas and NE, etc, and as one gets further east into higher precipitation zones. In the east, canopy cover would be higher and more closed (therefore, canopy cover increased to 100% for MZs 29 and 30). Disease was modeled as occuring on 20% of this class each year and causing no transition - just keeping it a more open stand. It does not cause a transition to another stage (ie: B), however, because it was questionable as to whether the disease-caused, open, mature stand would be the same as the 9-30yr old 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

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement seve

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** I

Historical Fire Size (acres)

Avg 50
Min 5
Max 100

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	75	30	100	0.01333	26
Mixed	40			0.025	49
Surface	80	10	100	0.0125	25
All Fires	20			0.05083	

Fire Intervals (FI):

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

Additional Disturbances Modeled

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

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

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

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement seve

LANDFIRE Biophysical Setting Model

Biophysical Setting 3014820 **Great Plains Prairie Pothole**

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

General Information

Contributors (also see the Comments field **Date** 12/18/2006

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Modeler 3			**Reviewer**		

Vegetation Type
Wetlands/Riparian

Map Zone
30

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

Dominant Species*
CAPE42 SCMA8
CAAT2 ELEOC
SPAN PASM
SCAC3 CALA11

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This type is found primarily in the glaciated northern Great Plains of the US and Canada. This system can be found throughout the Northern Great Plains ranging from central IA northeast to southern Saskatchewan and Alberta, and extending west into north-central MT. It encompasses approximately 870,000 square km with approximately 80% of its range in southern Canada. It is also prevalent in ND, SD and northern Minnesota.

It occurs in section 331E in MZ30; also occurs in MZ20. It does not occur in MZ29.

Biophysical Site Description

BpS is dominated by depressional wetlands formed by glaciers scraping the landscape during the Pleistocene era. This system is typified by several classes of wetlands distinguished by changes in topography, soils and hydrology. Many of the basins within this system are closed basins and receive irregular inputs of water from their surroundings (groundwater and precipitation), and export water as groundwater. Hydrology of the potholes is complex. Precipitation and runoff from snowmelt are often the principal water sources, with groundwater inflow secondary. Evapotranspiration is the major water loss, with seepage loss secondary. Most of the wetlands and lakes contain water that is alkaline (pH >7.4). The concentration of dissolved solids result in water that ranges from fresh to extremely saline. The flora and vegetation of this system are a function of the topography, water regime and salinity. In addition, because of periodic droughts and wet periods, many wetlands within this system may undergo vegetation cycles. This system includes elements of emergent marshes and wet, sedge meadows that develop into a pattern of concentric rings.

This system is dominated by closed basins, potholes, that receive irregular inputs of water from the

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surroundings and export water as groundwater. The climate for the range of this system is characterized by mid-continental temperature and precipitation extremes. Snowmelt in the spring typically fills many of the potholes in examples of this system. The region in the range of this system is distinguished by a thin mantle of glacial drift with overlying stratified sedimentary rocks of the Mesozoic and Cenozoic ages; these form a glacial landscape of end moraines, stagnation moraines, outwash plains and lakeplains. The glacial drift ranges 30-120m thick and forms steep to slight local relief with fine-grained, silty to clayey soils. Limestone, sandstone and shales predominant, and highly mineralized water can discharge from these rocks. The hydrology of this system is complex with salinity ranging from fresh to saline, and chemical characteristics varying seasonally and annually. Precipitation and snowmelt are the primary water sources with evapotranspiration being the source of major water loss.

Many or most of the potholes are depressions where glaciers deposited big chunks of ice in the ground. The ice melted leaving a depression that became ponds. Hydrologic regime and water quality (pH and conductivity) determine vegetation.

Vegetation Description

Dominant species are Carex lanuginosa (woolly sedge) or Carex lasiocarpa and C. atherodes. C. lasiocarpa is found in fens while C. lanuginosa occurs in mineral soil of wetlands such as wet meadows and marshes.
Associations are:
Carex lasiocarpa or lanuginosa-Carex oligosperma/Sphagnum spp.;
Schoenoplectus acutus (=Scirpus acutus) - (Schoenoplectus fluviatilis);
Schoenoplectus maritimus (=Scirpus maritimus) - Schoenoplectus acutus (=Scirpus acutus) - (Triglochin maritima);
Carex oligosperma (in the east - not west of Minnesota) - Carex lanuginosa; Schoenoplectus acutus - (Schoenoplectus tabernaemontani) semipermanently;
and Schoenoplectus maritimus.

In the drawdown zone, species are Eleocharis acicularis, Rumex maritimus and Hordeum jubatum.
In the wet meadow zone- Hordeum jubatum, Juncus balticus and Spartina pectinata.
In the shallow marsh zone- Carex atherodes, Glyceria grandis, Eleocharis palustris Scirpus americanus and Scirpus maritimus.
In the deep marsh zone- Typha latifolia, Scirpus acutus.

Western wheatgrass and Eleocharis spp are typical of the drier zones in MT.

The context in which these potholes exist is not always grassland or xeric shrubland but can include aspen or mixed aspen/conifer communities as well.

Saline playa vegetation is the same as drawdown zone and shallow marsh zone vegetation for prairie potholes. Saline playas don’t have deep marsh (cattail-bulrush) or open water vegetation like the deeper prairie potholes do.

Disturbance Description

Flooding is the primary natural dynamic influencing this system. Snowmelt in the spring often floods this system and can cause the prominent potholes within the system to overflow. Greater than normal precipitation can flood out emergent vegetation and/or increase herbivory by animal species such as muskrats. This system can undergo periodic wet and droughty periods that can
cause shifts in the vegetation. Vegetation zones are evident around the wet potholes throughout this

system, and each zone responds to changing environmental conditions. Draining and conversion to agriculture can also significantly impact this system. Much of the original extent of this system has been converted to cropland, and many remaining examples are under pressure to be drained.

Drought-flood cycling is the main disturbance and primary driver of successional change. Drought causes deep marsh to become shallow marsh, shallow marsh to become wet meadow etc.

Fire frequency would probably be much less than that in adjacent mid-grass prairie because these systems stay pretty wet in at least 50% of years. However, it is probably less wet and in fewer years in the southern end of the MZ. Fire would have little effect on these systems because nearly all the dominant plants are rhizomatous perennials that would not be damaged.

Fire is most likely in a year with a wet spring and high grass productivity. However, a wet spring will usually mean the wetlands are wet, so fire will have minimal effect if the wetlands even burn. Brief spring rains followed by dry period will result in greatest fire potential in southern end of MZ.

Most of the wetlands in the North Dakota Arrowwood NWR Complex contain heavy fuel loadings of emergent vegetation including bulrush, cattail and other vegetation that when cured, will support a fire even over the top of the water. During dry years, many of these areas will completely dry up, burning with moderate to high fire behavior characteristics (Arrowwood NWR Complex Fire Management Plan, 2001).

There can be little doubt that the activities of the wild bison, which was extirpated from the Prairie Pothole Region of the Dakotas in the 19th century, had a major biotic influence on prairie wetlands in pristine times. Unfortunately, there is no documentation of how wetlands were impacted by the feeding, drinking, dusting or other activities of millions of these huge, shaggy beasts as they roamed the prairies. Other grassland mammals extirpated from the region are the grizzly bear (Ursus arctos), kit fox (Vulpes velox) and plains wolf (Canis lupus). These carnivores probably made only minor use of prairie wetlands (Kantrud et al. 1989).

Uncounted numbers of wapiti (Cervus elephus) and pronghorn (Antilocapra americana) and smaller numbers of mule deer (Odocoileus hemionus), the only other large herbivores of open grasslands, once inhabited the region and undoubtedly used the wetlands, at least for drinking. These three species are still found in small numbers in the region. Also nearly extirpated from the prairie region are the river otter (Lutra canadensis), mountain lion (Felis concolor), lynx (F. lynx) and bobcat (F. rufus). Although once distributed throughout the region, it is unlikely that any of these species were strongly associated with the wetlands dealt with in this report (Kantrud et al. 1989).

Potholes are a sort of subclass within depressional wetlands; therefore, the model from the Depressional Wetland system is used for this BpS.

Adjacency or Identification Concerns

Many wetlands today have been drained and cropped; federal policy has slowed this process.

In MZ30 these wetlands are surrounded by mixed-grass prairie or cropland. In MZ20, they can be surrounded by aspen or fescue (foothills) prairie.

The context in which these potholes exist is not always a grassland or xeric shrubland but can include

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aspen or mixed aspen/conifer communities as well.

This system could be confused with Western Great Plains Depressional Wetland System, and indeed, some shallow, saline prairie potholes have nearly identical vegetation. It may also even be said that potholes are a sort of subclass within depressional wetlands, they just have a unique origin, occurring within glaciated terrain where ice-blocks have melted leaving kettle holes (depressions) of various dimensions. (Saline playa vegetation is the same as drawdown zone and shallow marsh zone vegetation for prairie potholes. Saline playas don't have deep marsh (cattail-bulrush) or open water vegetation like the deeper prairie potholes do.) However, the potholes are also different from wetlands in that potholes are typically connected to each other in a broad spatial/temporal fashion. In wet years and wet seasons, and in individual basins, they often have both surface and groundwater connections.

Poa pratensis, Poa palustris and Kochia scoparia are common exotics.

In prairie wetlands, disruption of natural processes such as fire has led to domination by robust, emergent plants, particularly in the prairie pothole region. Cattail, once rare on the Great Plains, has spread across thousands of prairie wetlands, as has purple loosestrife, a species native to Europe which is now threatening waterways across the United States (US Congress, Office of Technology Assessment 1993, Malecki and Blossey 1994). In the past, climate, fire and grazing controlled the diversity and abundance of vegetation in northern prairie wetlands (http://www.npwrc.usgs.gov/resource/habitat/grlands/landmgt.htm).

More is known about the effects of grazing than fire. Nodal rooting, or underground branching, and unpalatability are evident evolutionary responses of wetland plants to grazing. Under certain conditions grazing can increase species diversity and the development of intricate patterns and sharp boundaries among prairie wetland plant communities (Bakker and Ruyter 1981).

About half of the original potholes in the Dakotas have been destroyed (60% in ND and 40% in SD; Tiner 1984). Over half were altered by agriculture, irrigation and flood control projects (http://www.fws.gov/nwi/Pubs_Reports/isolated/report_files/2_section/overview.htm).

Native Uncharacteristic Conditions

Vegetation may be more productive in wetlands polluted by agricultural fertilizers.

Scale Description

Prairie wetlands can vary in size from a couple acres to hundreds of acres.

Potholes are typically connected to each other in a broad spatial/temporal fashion.

Issues/Problems

Comments

This model for MZ30 was created using the NatureServe original description, some comments and model from BpS 1495 Western Great Plains Depressional Wetland System for the successional classes and model. No review received yet. It is highly recommended that this model/system receive review for mapzones further east of MZ30.

Vegetation Classes

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Class A 35 %

Early Development 1 All Structure

Upper Layer Lifeform

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

Fuel Model 0

Indicator Species* and Canopy Position

CALA11
CAAT2
ELEOC
PASM

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Dominated by resprouts and seedlings of grasses and post-fire associated forbs. Low to medium height with variable canopy cover. For MZ22, indicator species could also be PUCCI and SPAI.

Persists for 20yrs and then succeeds to class B, a mid-development closed stage. This long span in class A was questioned by a reviewer. It was stated that the only way this would happen is if there was some pretty heavy livestock grazing. Class B would be back in just a few years following a fire. Fire would cause little change in species composition except possible a temporary decline in Puccinellia and Hordeum (bunch grasses). However, the 20yr interval was retained for feedback from original modelers.

Also - the periodic wet and dry periods are the reason for the long time in class A and the slow recovery of cover. Perhaps as you go further south and more outside the glaciation effects, the recovery of the system is slower (Kathy Roche, USFS, pers comm). In the southern end of the mapzone, the dry periods are longer and slow the vegetation recovery.

Native grazing and herbivory could be heavy (10% of this class each year).

Replacement fire occurs every 50yrs, which is somewhat longer than the MFRI of an adjacent grassland community. Since this is a wetland community, it is thought that fire would impact the landscape much less frequently.

Class B 65 %

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 0

Indicator Species* and Canopy Position

CALA11
CAAT2
ELEOC
PASM

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	30 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	None	

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

Scattered shrubs may be present.

Description

Greater than 30% herb and shrub cover combined. For MZ22, indicator species could also be SPAI and SARU.

Native grazing and herbivory could be heavy (20% of this class each year).

Replacement fire occurs every 50yrs, which is somewhat longer than the MFRI of an adjacent grassland community. Since this is a wetland community, it is thought that fire would impact the landscape much less frequently.

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

Class 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:** 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	50	10	100	0.02	100
Mixed					
Surface					
All Fires	50			0.02002	

Fire Intervals (FI):

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

Additional Disturbances Modeled

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

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

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

LANDFIRE Biophysical Setting Model

***Biophysical Setting* 3014950** **Western Great Plains Depressional Wetland Systems**

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

General Information

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

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Vegetation Type

Upland Grassland/Herbaceous

Map Zone

30

Model Zone

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

Dominant Species*

PASM
DISP
HOJU
ELAC
ELPA3
JUBA
PUCCI

General Model Sources

☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This occurs throughout lowland low elevation areas of MZ22. These are wetlands that are saline playas. This model might also be used for MZ29. This system is very uncommon in MZ20.

Saline playas are not common in the MT part of MZ29. However, this habitat does occur both north and west of Billings probably in 331k. There may be more playas in the Bighorn basin of WY. For MZ30, there is probably not any playa-type vegetation in northeastern MT. However, there are some large areas on the Fort Peck Indian Reservation west of Froid that could be this type. These probably do also occur in the Dakotas.

Biophysical Site Description

The closed depression wetland has communities associated with the playa lakes in the southern areas of this province and the rainwater basins in NE characterize this system. They are primarily upland depressional basins. This hydric system is typified by the presence of an impermeable layer such as a dense clay, hydric soil and is usually recharged by rainwater and nearby runoff. They are rarely linked to outside groundwater sources and do not have an extensive watershed. These closed depression wetland sites on the unglaciated great plains (ie: not prairie potholes) that are not Western Great Plains Saline Depressions CES303.669 are few and far between in MZ20.

In the open freshwater depression wetland, the system is composed of lowland depressions and also occurs along lake borders that have more open basins and a permanent water source through most of the year except during exceptional drought years. These areas are distinct from Western Great Plains Closed

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Depression Wetland (CES303.666) by having a large watershed and/or significant connection to the groundwater table. The system includes submergent and emergent marshes, and associated wet meadows and wet prairies. These types can also drift into stream margins that are more permanently wet and linked directly to basin via groundwater flow from/into the pond or lake.

Vegetation Description

In MZ20, vegetation is dominated by sparse to dense cover of graminoids, up to one meter tall, although typically 0.6m or shorter. Pascopyrum smithii usually dominates, with Distichlis spicata, Hordeum jubatum, Eleocharis acicularis or Eleocharis palustris almost co-dominant. Juncus balticus will be present in areas where water stands for longer after a storm or where flooding occurs. Other graminoids include Puccinellia nuttalliana, Bouteloua gracilis, Koeleria macrantha and Hesperostipa comata (HECO questionable, since it prefers sandy soils, and this type is developed on clay soils). Spartina gracilis has been documented in MZ20 but only in limited areas. Woody plants are rare, except for occassional Gutierrezia sarothrae, Artemisia MFRIgida, Artemisia cana or Symphoricarpos occidentalis. Sarcobatus vermiculatus and basin wildrye (Elymus cinereus) can also be associated with saline playa vegetation in MT, although they are probably not nearly as common as the listed dominants.

For MZ22, there is inland saltgrass, alkali sacaton, alkali cordgrass and Rocky Mmountain glasswort. Vegetation is zones from the center of the depression and is dependent on the gradient of the depression. Other dominant species could be SPGR, SARU and SPAI.

Disturbance Description

Plant communities providing saltgrass habitat are diverse and exhibit a wide range of fire frequencies. Saltgrass is found in desert shrub communities that have fire return intervals of <35yrs to 100yrs+ (Hauser 2006).

Prior to land use changes, grassland communities where saltgrass occurs burned regularly. While there is relatively little fire frequency information available on the time prior to the 1880s, it is estimated that fire occurred every 7-10yrs (Hauser 2006). However, the saltgrass in this BpS is in a wetland system and is therefore thought to burn much less frequently. Also, some of the wet clay and salt acts as a fire retardant. There is also little litter in these systems (Roche, pers comm).

Historical fire size is very dependent upon the surrounding vegetation.
The minimum would be one acre. The maximum would be around 200ac. The average would be eight or nine. Logic is that if the average playa is about 10ac, the whole thing would rarely burn because of the wetness at the center --so say 80-90% of the playa would burn. Because the surrounding grasslands have an MFRI of 10-20yrs, it was thought that small playas or depressional wetland systems would have similar MFRIs, because the fire would just move over them. However, if the playa/system is larger - ie: over an acre, then it would be less likely to burn. Therefore, an overall MFRI, considering both scenarios, was chosen to be 50yrs. This rationale was questioned by a reviewer who thought that the MFRI would be the same as the surrounding grassland or steppe because fire would occur when the playa and grass was dry and would be just as flammable as the uplands. However, many of the plants in these playas aren't grass and just don't dry out or don't burn like grass (Collins and Uno 1983). And also because the MFRI was originally modeled at 100yrs, the lesser 50yrs was retained and not made it even more frequent. Because fire rotation is being considered, the longer interval was retained.

Return interval for fire could be extended by ungulate grazing.

Spartina gracilis, when present, can withstand fire because of deep rhizomes. Sarcobatus might be the only

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species that might be killed by fire.

Episodic disturbance is caused by insect infestation (grasshoppers, range caterpillars and Mormon crickets). This was not modeled.

Grazing by native ungulates such as buffalo and antelope can occur. During droughts, ungulates congregate in these areas.

Adjacency or Identification Concerns

Adjacent to western great plains shortgrass and mixedgrass prairies, saltgrass meadow, greasewood shrubland, mixed desert shrubland and big sagebrush steppe (Knight 1994).

It would be difficult to confuse this system with others in MZ29, as it is so rarely found in MZ29. Using aerial photography it might be possible to confuse an irrigated pasture for this type. Otherwise there are few wetlands not closely associated with rivers or streams.

Large concentrations of ungulates could increase the percent of the landscape dominated by shrubs and forbs compared with reference conditions. Fire return intervals are now in the range of 30yrs plus.

Since the early 1900s, fire has been excluded and nonnative species such as Japanese brome (Bromus japonicus), smooth brome, Kentucky bluegrass, crested wheatgrass (Agropyron cristatum) and Canada thistle (Cirsium arvense) have taken a strong hold in the Great Plains mixedgrass prairies where saltgrass occurs (Hauser 2006).

Bromus japonicus is the most likely exotic to become common in this type. Halogeton could be common in WY.

Shallow wetlands have sometimes been plowed and planted to crested wheatgrass in other parts of MT.

Native Uncharacteristic Conditions

Scale Description

Documentation from outside of MZ22 says playas range from 2-800ac with an average of 17ac. For MZ22, big playas are non-existent --so the average would probably be smaller --maybe about 10ac. For MZ20, calling them playas is stretching the definition. We see these little semi-saline playa-type wetlands here and there but they are rarely much more than two acres. However, there are large alkali lakes in parts of the state, although these are much more saline. MZ20 also contains War Horse Lake, a large playa-type lake, Alakalai Lake south of Browning as well as some large playas south of Fort Benton (White Lake, Big Lake, Shonkin Lake); all of these are on the order of ca. 1000ac.

Historical fire size is very dependent upon the surrounding vegetation.
The minimum would be one acre. The maximum would be around 200ac. The average would be eight or nine. Logic is that if the average playa is about 10ac, the whole thing would rarely burn because of the wetness at the center --so say 80-90% of the playa would burn.

Issues/Problems

Concentrations of ungulates could increase the percent of the landscape dominated by shrubs and forbs compared with reference conditions.

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Comments

This model for MZs 29 and 30 was adopted as-is from the same BpS from MZ20 which was reviewed by Linda Vance.

This model for MZ20 was adapted from the draft model for the same BpS from MZ22. Descriptive changes were made to reflect the system within MZ20 and to more fully describe the system.

This model for MZ22 was adapted from the model from BpS 1149 in MZ28, which was an adjacent western Great Plains shortgrass prairie model. Quantitative and descriptive changes were made, and this is in essence a new model. Therefore, comments and modeler and reviewer names from 281149 have been removed.

Vegetation Classes

Class A **35 %**

Early Development 1 All Structure

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

PASM	Upper
DISP	Upper
HOJU	Upper
ELAC	Upper

Structure Data (for upper layer lifeform)

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

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Dominated by resprouts and seedlings of grasses and post-fire associated forbs. Low to medium height with variable canopy cover. For MZ22, indicator species could also be PUCCI and SPAI.

Persists for 20yrs and then succeeds to class B, a mid-development closed stage. This long span in class A was questioned by a reviewer. It was stated that the only way this would happen is if there was some pretty heavy livestock grazing. Class B would be back in just a few years following a fire. Fire would cause little change in species composition except possible a temporary decline in Puccinellia and Hordeum (bunch grasses). However, in the southern end of MZ29, the dry cycles severely limit vegetation establishment; the southern part of MZ29 is drier and saltier, and gets different precipitation patterns, which slows down vegetation recovery compared to other parts of MT. It takes a long time to get enough cover to move to class B. It might be warranted that there be a different model for a more northern version, with the model cycling to B more quickly. This would cause less percentage to be in A and more to be in B.

Native grazing and herbivory could be heavy (10% of this class each year).

Replacement fire occurs every 50yrs, which is somewhat longer than the MFRI of an adjacent grassland community. Since this is a wetland community, it is thought that fire would impact the landscape much less frequently.

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Class B **65 %**

Mid Development 1 Closed

Upper Layer Lifeform

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

Fuel Model 1

Indicator Species* and Canopy Position

PASM Upper
DISP Upper
PUCCI Upper
HOJU Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	30 %
Height	Herb 0m	Herb 1.0m
Tree Size Class	None	

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

Scattered shrubs may be present.

Description

Greater than 30 percent herb and shrub cover combined. For MZ22, indicator species could also be SPAI and SARU.

Native grazing and herbivory could be heavy (20% of this class each year).

Replacement fire occurs every 50yrs, which is somewhat longer than the MFRI of an adjacent grassland community. Since this is a wetland community, it is thought that fire would impact the landscape much less frequently.

Class C **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

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

Fuel Model

Description

Class D **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

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

Fuel Model

Description

Class E **0 %**

[Not Used] [Not Used]

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

- [ ] Upper layer lifeform differs from dominant lifeform.

Upper Layer Lifeform

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

Fuel Model

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Description

Disturbances

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 10
Min 1
Max 200

Sources of Fire Regime Data

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

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

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

Additional Disturbances Modeled

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

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