10110
Rocky Mountain Aspen Forest and Woodland

BpS Model/Description Version: Aug. 2020

Modelers		Reviewers	
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None	None	None	None
None	None	None	None

Vegetation Type
Forest and Woodland

Map Zones
20, 29

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

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

Biophysical Site Description
Most aspen in MZ21 occur at elevations from 1,525-2,285m (5,000-7,500ft) in the northern portion of the zone and up to 8,500ft or 2,590m in the southern portion of the zone. Aspen typically occur in the ecotone between grasslands/shrublands and the coniferous forest (montane/subalpine), usually in close association with Douglas-fir forest as well as other conifer forests. Aspen are occasionally found at lower and higher elevations, but these stands are often isolated and small. Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand and, secondarily, is limited by the length of the growing season or low temperatures. In the long-term absence of fire, these sites may transition to Douglas-fir or spruce, so there is likely some overlapping with those BpSs.

The MZ29 description stated: “In the Pine Ridge escarpment of Nebraska, this system encompasses small areas in protected canyons/small valleys with a northerly aspect. However,

the elevation of the Pine Ridge is mostly lower than that described above, although near the Wyoming border there are areas within the given range."

Vegetation Description

These are upland forests dominated by *Populus tremuloides* both with and without a significant conifer component (<5% to >40% relative conifer tree cover). Conifer species include Douglas-fir, lodgepole pine, subalpine fir, limber pine, and Engelmann spruce. The understory structure may be complex, with multiple shrub and herbaceous layers, or simple, with just an herbaceous layer. The herbaceous layer may be dense or sparse and dominated by graminoids or forbs.

Common shrubs include *Amelanchier alnifolia*, *Artemisia tridentata*, *Prunus virginiana*, *Rosa woodsii*, *Shepherdia canadensis*, *Potentilla gracilis*, *Symphoricarpos albus*, and *Vaccinium* spp. Native grasses include *Calamagrostis canadensis*, *Calamoagrostis rubescens*, *Carex geyeri*, *Carex rossii*, *Elymus glaucus*, *Elymus trachycaulus*, and *Hesperostipa comata*. Associated forbs may include *Taraxacum officinale*, *Achillea millefolium*, *Aster conspicuus*, *Delphinium* spp., *Geranium viscosissimum*, *Solidago missouriensis*, *Senecio triangularis*, *Lupinus* spp., *Osmorhiza berteroi* (=*Osmorhiza chilensis*), *Rudbeckia occidentalis*, *Thalictrum occidentale*, *Valeriana occidentalis*, and many others.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
POTR5	*Populus tremuloides*	Quaking aspen
PSME	*Pseudotsuga menziesii*	Douglas-fir
PICO	*Pinus contorta*	Lodgepole pine
ARTR2	*Artemisia tridentata*	Big sagebrush
PIEN	*Picea engelmannii*	Engelmann spruce
GRASS		

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

Disturbance Description

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

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

absence of fire. Moreover, they included native ungulate browsing as a disturbance regime that could influence successional pathways.

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

This BpS can display varying fire severities (fire regime groups [FRGs] II, III, and IV), depending on tree species composition, but we chose to model for sites heavily dominated by aspen (FRG IV). Fire return intervals in aspen are heavily influenced by adjacent community disturbance dynamics and can vary dramatically on a landscape and through time as conditions change (20-150yrs between disturbances).

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

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	123	83	4	200
Moderate (Mixed)	598	17		
Low (Surface)				
All Fires	102	100		

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

Patch size for this type ranges from <1ha-10ha; occasionally, aspen occur in patches >10ha in the northern portion of the zone. In the southern portion of the zone, patches from 10-40ha are more common in low elevations. Patches may be linear along riparian areas and the forest/grassland ecotone. Nonlinear patches are often localized in swales, depressions, and toe-slopes.

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

Adjacency or Identification Concerns

In this zone, aspen stands tend to be dynamic in size and distribution, and interact with adjacent communities. Because patch sizes tend to be small, and because one state in the disturbance

model can include aspen in the understory of a predominantly coniferous stand, they may be difficult to map and identify.

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

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

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

Herbivory also affects the growth rates of aspen sprouts or suckers and, at high levels, has the potential to overwhelm the sprouting or suckering response and prevent overstory recruitment from occurring. The MZ29 description stated: "Current browsing regimes are likely not to be representative of historical browsing regimes. Cattle and elk can hamper young aspen seedlings/resprouts."

Issues or Problems

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

Native Uncharacteristic Conditions

Comments

MZs 20 and 29 were combined during the 2015 BpS review. The few descriptive differences between the zones are noted in the revised description.

MZ29 was reviewed by Mary Lata.

Succession Classes

Mapping Rules

Upper Layer Lifeform	Height (m)	Canopy Cover (%)									
		0-10	11-20	21-30	31-40	41 - 50	51-60	61-70	71-80	81-90	91-100
Herb	0-0.5	A	A	A	A	A	A	A	A	A	A
Herb	0.5-1.0	A	A	A	A	A	A	A	A	A	A

Herb	>1.0	A	A	A	A	A	A	A	A	A	A
Shrub	0-0.5	A	A	A	A	A	A	A	A	A	A
Shrub	0.5-1.0	A	A	A	A	A	A	A	A	A	A
Shrub	1.0-3.0	A	A	A	A	A	A	A	A	A	A
Shrub	>3.0	A	A	A	A	A	A	A	A	A	A
Tree	0-5	A	A	A	A	A	A	A	A	A	A
Tree	5-10	B	B	B	B	B	B	B	B	B	B
Tree	10-25	D brdlf	D brdlf	D brdlf	D brdlf	C brdlf	C brdlf	C brdlf	C brdlf	C brdlf	C brdlf
Tree	10-25	D con	D con	D con	D con	E con	E con	E con	E con	E con	E con
Tree	10-25	D mix	D mix	D mix	D mix	E mix	E mix	E mix	E mix	E mix	E mix
Tree	25-50	E	E	E	E	E	E	E	E	E	E
Tree	>50	E	E	E	E	E	E	E	E	E	E

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

Description

Class A 16 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	Populus tremuloides	Quaking aspen	Upper

Description

Aspen suckers are <2m tall. Understory species include a wide variety of shrubs, forbs, and grasses. Under moderate to intense browsing, this condition could persist for long periods.

This structure is an established, persistent, shrub-type aspen clone maintained in this state either because of continual browsing or sub-optimal site conditions. As such, it was the starting point in which to model asexual regeneration in the face of disturbance. This condition does not represent uncommon site establishment via sexual reproduction, which would revert to grass 3yrs after seedling establishment. This is in response to reviewers' suggestion that this class would be eliminated and returned to grass in 3yrs under intense browsing; however, that scenario is not an accurate depiction of this class. Also, although aspen suppression by herbivores is important in the greater Yellowstone ecosystem (which would more likely be a current condition, not a reference condition scenario being described), there seems to be insufficient evidence that this process can extirpate a patch in 3yrs. Aspen appear relatively persisting and certainly can be extirpated, but it is believed that this occurs far less frequently.

Native grazing returns the class to the beginning of the state.

Maximum Tree Size Class

Seedling <4.5ft

Class B 18 Mid Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	Populus tremuloides	Quaking aspen	Upper

Description

Aspen >2m up to 10m tall dominate. Canopy cover usually closed, representing dense sapling stand. Fire frequency is highly variable because of site conditions and adjacent vegetation. Original modelers chose a 60-yr interval for an average; however, reviewers recommended a 100-yr interval. The 100-yr interval was chosen for the model based on several reviews.

Insect/disease outbreaks are rare, but were not modeled to result in successional pathway changes. Because herbivory was insufficient to prevent succession, it was not modeled.

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

Maximum Tree Size Class

Pole 5-9" DBH

Class C 26 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	Populus tremuloides	Quaking aspen	Upper

Description

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

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

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

Without herbivory, this condition can persist indefinitely, with continued regeneration and overstory recruitment. The cumulative effect of sustained herbivory eventually results in an open-canopy, mature stand due to canopy die-off and a lack of recruitment.

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

Subalpine fir might be encroaching into the understory, per reviewers of this model.

Insect/disease outbreaks cause stand thinning.

Succession maintains vegetation in this class. However, without disturbance and under certain site conditions, a small percentage of this class may transition to mixed-conifer forest.

Maximum Tree Size Class
Medium 9-21" DBH

Class D 26 Late Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	Populus tremuloides	Quaking aspen	Upper
ARTR2	Artemisia tridentata	Big sagebrush	Lower
GRASS	<NOT FOUND IN NRCS>	<NOT FOUND IN NRCS>	Lower
PSME	Pseudotsuga menziesii	Douglas-fir	Low-Mid

Description
Aspen (>10m) widely spaced, open canopy existing until the overstory succumbs to mortality. This is a transitional state caused by insect infestation, disease, herbivory, or interactions among these factors. Continued moderate to high herbivory prevents the recruitment of overstory trees. Native herbivory was added to the model.

MFRIs for fire are highly variable. An MFRI of 60yrs was originally used for the model, but was changed to 100yrs per reviews.

In the absence of fire, this state transitions to conifer, sagebrush, or grassland dominated. This was modeled as a main successional pathway.

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

Reviewers recommended adding insect/disease disturbance at 0.005 probability. This was input into the model with little impact. Thus far there are no data to support the impact of insect/disease.

Maximum Tree Size Class
Medium 9-21" DBH

Class E 14 Late Development 2 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	Pseudotsuga menziesii	Douglas-fir	Upper
PICO	Pinus contorta	Lodgepole pine	Upper
PIEN	Picea engelmannii	Engelmann spruce	Upper
ARTR2	Artemisia tridentata	Big sagebrush	Low-Mid

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

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

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

Maximum Tree Size Class
Very Large >33" DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:ALL	15
Mid1:ALL	16	Late1:CLS	39
Late1:CLS	40	Late1:CLS	999
Late1:OPN	40	Late2:CLS	149
Late2:CLS	150	Late2:CLS	999

Probabilistic Transitions

Disturbance Type	Disturbance occurs In	Moves vegetation to	Disturbance Probability	Return Interval (yrs)	Reset Age to New Class Start Age After Disturbance?	Years Since Last Disturbance
Native Grazing	Early1:ALL	Early1:ALL	0.04	25	Yes	0
Replacement Fire	Mid1:ALL	Early1:ALL	0.01	100	Yes	0

Insects or Disease	Late1:OPN	Late1:OPN	0.005	200	No	0
Native Grazing	Late1:OPN	Late1:OPN	0.01	100	No	0
Replacement Fire	Late1:OPN	Early1:ALL	0.01	100	Yes	0
Alternative Succession	Late1:CLS	Late2:CLS	1	1	Yes	200
Insects or Disease	Late1:CLS	Late1:OPN	0.005	200	Yes	0
Mixed Fire	Late1:CLS	Late1:CLS	0.0067	149	No	0
Native Grazing	Late1:CLS	Late1:OPN	0.01	100	Yes	0
Replacement Fire	Late1:CLS	Early1:ALL	0.01	100	Yes	0
Replacement Fire	Late2:CLS	Early1:ALL	0.01	100	Yes	0

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