Bridger-Teton National Forest Vegetation Condition Assessment

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for:

Bridger-Teton National Forest

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Introduction and Background

The Teton Interagency wildfire response assessment (Scott et al. 2013) was conducted to quantify the expected threat and benefit of wildfire to highly valued resources and assets (HVRAs) within the Bridger-Teton National Forest (BTNF) and Grand Teton National Park (GTNP). One of the HVRAs assessed by both agencies was diverse and resilient vegetation (DRV). The need to quantify expected threat and benefit of wildfire to vegetation communities was determined early in the wildfire response assessment process. Both agencies have the land management plan mandate to manage fire to meet resource objectives over the majority of their land bases. Including DRV – vegetation in a near-reference mix of succession classes – as a HVRA would allow the assessment to capture the potential wildfire effects on the local plant communities and anticipate how wildfire may help achieve resource objectives. An independent assessment of vegetation condition was therefore necessary to characterize and map the DRV HVRA for the BTNF[1]. This report presents the methodology and results of that assessment.

Version 2.2.0 of the Fire Regime Condition Class Mapping Tool (FRCC$_{MT}$ ver. 2.2.0) and LANDFIRE (LANDFIRE 2012) version 1.0.5 ("Refresh 2001") data were used to conduct this assessment. Fire Regime Condition Class (FRCC) methodology provides a systematic process for comparing the current distribution of vegetation composition and structure to a reference distribution and quantifying departure[2] (Barrett et al. 2010). In this assessment, reference condition refers to an estimate of the vegetation composition and structure that may have existed under the landscape's historical disturbance regime prior to Euro-American settlement. The following subsections provide an overview of several key FRCC terms and concepts important to understanding the methodology and interpreting the results presented in this report.

Biophysical Setting and Succession Class

Biophysical settings (BpSs) represent the natural plant communities that may have been dominant on the landscape during the reference period and are the primary units for conducting FRCC assessments. BpSs are based on both the current biophysical environment (e.g., soil, topography, precipitation, growing degree days) and an estimation of the historical disturbance regime.

Succession class (S-Class) refers to a successional state of vegetation within a BpS as defined by specific compositional and structural traits. S-Class therefore can be thought of as an attribute of the BpS. An individual BpS may have up to five natural S-Classes in LANDFIRE. Two additional uncharacteristic classes are used to describe current vegetation conditions that did not exist during the reference period. These include native vegetation with compositional or structural components outside the range of variation estimated for the reference period and introduced exotic vegetation. Table 1 provides a general example of the natural S-Classes used by LANDFIRE to describe the successional states of an individual BpS. Note however, that the actual number of S-Classes and the compositional and structural traits used to define them vary by BpS. Specific definitions for each of the BpSs included in this assessment are provided later in this report.

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[1] GTNP possessed adequate data for characterizing the DRV HVRA and chose not to use the results of this assessment.

[2] Note that current FRCC methodology allows for the assessment of both vegetation departure and fire frequency and severity departure. This assessment assesses vegetation departure only. The most recently released version of the FRCC$_{MT}$ (FRCC$_{MT}$ ver. 3.1.0) does include functionality for estimating fire frequency and severity departure.

Table 1: General LANDFIRE S-Class descriptions.

S-Class	General Description[a]
Early Development	Post stand-replacement disturbance. Composition generally consists of pioneer species of herbs, shrubs, and trees. Trees generally less than 5 inch dbh** and 5 meters height.
Mid-Development, Closed	Immature trees, generally 5-9 inch dbh[b] and less than 25 meters height. Composition generally dominated by earl seral species. Canopy cover generally greater than 50 percent.
Mid-Development, Open	Immature trees, generally 5-9 inch dbh and less than 25 meters height. Composition generally dominated by earl seral species. Canopy cover generally less than 50 percent.
Late Development, Open	Mature trees, generally greater than 9 inch dbh and 10 meters height. Late seral species dominant or co-dominant. Canopy cover generally less than 50 percent.
Late Development, Closed	Mature trees, generally greater than 9 inch dbh and 10 meters height. Late seral species dominant. Canopy cover generally greater than 50 percent.

[a] The number of S-Classes and the compositional and structural traits of each vary by BpS. These descriptions provide only a general example.

[b] The acronym "dbh" refers to the standard of measuring the diameter of a tree 4.5 feet above the ground.

Historical Range of Variation and Reference Condition

The interrelationship between vegetation development and the frequency, type, and severity of disturbance is both spatially and temporally variable. Understanding the historical range of this variability provides a useful reference, or benchmark, for describing conditions representative of diverse and resilient ecosystems. The historical range of variation (HRV) framework provides context for understanding ecological systems and guidance on their management today (Landres et al. 1999, Keane et al. 2009), and is fundamental to FRCC assessment.

Each BpS is associated with a vegetation dynamics model (LANDFIRE 2007) which is used to quantitatively assess the interrelationship of vegetation development and natural disturbance dynamics during the reference period. Each model was built within the Vegetation Dynamics Development Tool (VDDT) and run to determine a reference distribution of S-Classes. The reference S-Class distribution represents the *average* proportion of each S-Class as estimated by simulation of historical disturbance probabilities in VDDT over multiple simulations[3].

The disturbance regime and distribution of S-Classes within a BpS are tightly interrelated. Alteration of the regime may affect the distribution of S-Classes and associated ecosystem function (e.g., increased fire-free intervals may lead to large areas of closed canopy structure thus affecting hydrologic function or wildlife habitat). Likewise, alteration of the S-Class distribution may affect the characteristics of the fire regime (e.g., large, homogenous patches of mid- or late development closed conditions may result in uncharacteristically large and severe fires). As discussed above, vegetation condition analysis compares the current distribution of S-Classes (i.e., under the current disturbance regime) to the reference distribution (i.e., under the historical disturbance regime) and provides an estimate of departure. Understanding the degree of departure is the objective of this assessment.

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[3] Each vegetation dynamics model was created at regional modeling workshops held by the LANDFIRE program and underwent a review process that engaged regional experts from around the country and is based on expert knowledge and published literature.

Assessment Scale

Because disturbance regimes are spatially and temporally variable and operate at a landscape level it is important to understand and evaluate vegetation condition at the appropriate spatial and temporal scales[4]. In FRCC methodology, a *landscape* is defined as a contiguous area large enough to include the variation in vegetation composition and structure (i.e., S-Classes) that would have existed under the historical disturbance regime. Therefore, the size of the landscape used to assess vegetation condition is based on the dominant disturbance regime of each BpS. If the landscape is too small relative to the typical size of disturbances, there may not be good representation of the variability among S-Classes within a BpS and the $FRCC_{MT}$ will often produce departure metrics that are too high. For example, one S-Class might dominate the landscape as the result of one large stand-replacement fire. Conversely, if the landscape is too large, small changes in departure metrics after future treatments or disturbances will be washed out.

Where wildfire is the dominant natural disturbance, as on the BTNF, the Interagency FRCC Guidebook (Barrett et al. 2010) recommends delineating assessment landscapes based on the dominant fire regime group. That is, fire regimes with historically small patch-size variation can be assessed at finer spatial scales (i.e., smaller landscapes) than those with large patch-size variation. The FRCC Guidebook defines a natural fire regime as "a general classification of the role fire would play across a landscape in the absence of modern human intervention but including the possible influence of aboriginal fire use" and defines five natural fire regime groups based on historical wildfire frequency and severity (Table 2). Each BpS is associated with one of the five fire regime groups.

Table 2: Natural fire regime group descriptions.

Group	Frequency	Severity	Severity Description
I	0 – 35 years	Low / Mixed	Generally low-severity fires replacing less than 25% of the dominant overstory vegetation; can include missed-severity fires that replace up to 75% of the overstory
II	0 – 35 years	Replacement	High-severity fires replacing greater than 75% of the dominant overstory vegetation
III	35 – 200 years	Low / Mixed	Generally mixed-severity; can also include low-severity fires
IV	35 – 200 years	Replacement	High-severity fires
V	200+ years	Replacement / Any	Generally replacement-severity; can include any severity type in this frequency range

From Barrett et al. 2010.

Vegetation Condition Metrics

Three vegetation condition metrics are discussed in this report: stratum vegetation departure, stratum vegetation condition class[5] (VCC), and S-Class relative amount. In FRCC terminology, a stratum refers to the combination of a BpS and landscape. For example, if the Rocky Mountain

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[4] Temporal variability is accounted for in the VDDT modeling used to determine the reference S-Class distribution by assigning a probability of disturbance based on the historical range.

[5] Stratum vegetation departure and stratum vegetation condition class were referred to as strata departure and strata FRCC, respectively, in the Interagency FRCC Guidebook version 1.3.0 (Hann et al., 2008) and $FRCC_{MT}$ version 2.2.0 ($FRCC_{MT}$ ver. 2.2.0). Although this assessment was conducted using the version 1.3.0 guidebook and version 2.2.0 mapping tool the most current terminology is used in this report.

Aspen Forest and Woodland BpS is present in two assessment landscapes, there are then two separate Rocky Mountain Aspen Forest and Woodland strata. The stratum departure metric describes vegetation departure across *all* succession classes within a particular BpS and landscape (i.e., strata) as a single value on a scale from zero (indicating no departure) to 100 (indicating full departure) (Barrett et al. 2010). Stratum VCC classifies the stratum departure into three classes (Table 3). These first two metrics are useful for quantifying the relative departure of an individual BpS among landscapes or comparing departure among BpSs but it does not provide information about why a BpS is departed. That is, there is no information on whether the BpS has too much or too little of a particular S-Class. Stratum VCC may be used to prioritize BpSs for restoration (stratum VCC 2 and 3) or maintenance (stratum VCC 1)—assuming the goal is to emulate reference conditions.

Table 3: Stratum vegetation condition class and departure interpretation.

Stratum Vegetation Condition Class	Range of Stratum Vegetation Departure	HRV Interpretation
VCC 1	≤ 33%	Within the HRV
VCC 2	> 33% to ≤ 66%	Moderately departed from the HRV
VCC 3	> 66%	Highly departed from the HRV

The S-Class relative amount metric indicates *individual* S-Classes that are departed within a given BpS and landscape. This metric is especially informative because it indicates whether the current amount of an individual S-Class is deficient or excessive relative to the reference proportion and therefore provides information on whether a particular S-Class needs to be reduced, maintained, or recruited to move the BpS towards the reference condition. S-Class relative amount is divided into five categories: Trace, Under-represented, Similar, Over-represented, and Abundant (Table 4).

Table 4: S-Class relative amount classes.

S-Class Relative Amount	Range of Percent Difference from Reference Proportion[6]
Trace	< -66%
Under-represented	≥ -66% and < -33%
Similar	≥ -33% and ≤ 33%
Over-represented	>33% and ≤ 66%
Abundant	> 66%

Methodology

Biophysical Setting Model Selection

In February 2012 a conference call was held with BTNF and GTNP resource specialists to critique the vegetation dynamics model and S-Class mapping rules of each BpS and develop S-Class transition rules to update for recent disturbances not captured in the LANDFIRE version 1.0.5 (2001 Refresh) data. There are 29 BpSs mapped within the BTNF; excluding barren-rock,

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[6] This assessment was conducted using the Interagency FRCC Guidebook version 1.3.0 (Hann et al., 2008) methodology and version 2.2.0 of the $FRCC_{MT}$ ($FRCC_{MT}$ ver. 2.2.0). Version 3.0 of the Guidebook (Barrett et al., 2010) and $FRCC_{MT}$ ($FRCC_{MT}$ ver. 3.1.0) use new thresholds.

open water, and perennial ice and snow categories. Eleven of the BpSs account for 90 percent of the area. Barren-rock, open water, and perennial ice and snow account for two percent. Resource specialists grouped the Columbia Plateau Low Sagebrush Steppe and Inter-Mountain Basins Montane Sagebrush Steppe BpSs due to similarities in their vegetation dynamics models. Four additional BpSs were dropped from the analysis because resource specialists felt the LANDFIRE geospatial data were not at a fine enough resolution to represent the differences between S-Classes represented in the vegetation dynamics models. The final six BpSs account for 82 percent of the BTNF land area (Table 5). Figure 1 shows the final spatial distribution of the BpSs assessed.

Table 5: Biophysical settings and associated vegetation dynamics models used in the assessment.

Biophysical Setting	Vegetation Dynamics Model	Acres	Percent of BTNF
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	2110550	1,266,918	37%
Northern Rocky Mountain Subalpine Woodland and Parkland	2110460	386,564	11%
Inter-Mountain Basins Montane Sagebrush Steppe	2111260	368,869	11%
Rocky Mountain Aspen Forest and Woodland	2010110	328,323	9%
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	2110560	318,555	9%
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	2111660	173,649	5%
Barren-Rock, Open Water, Perennial Ice and Snow	--	63,663	2%
Other	--	558,620	16%
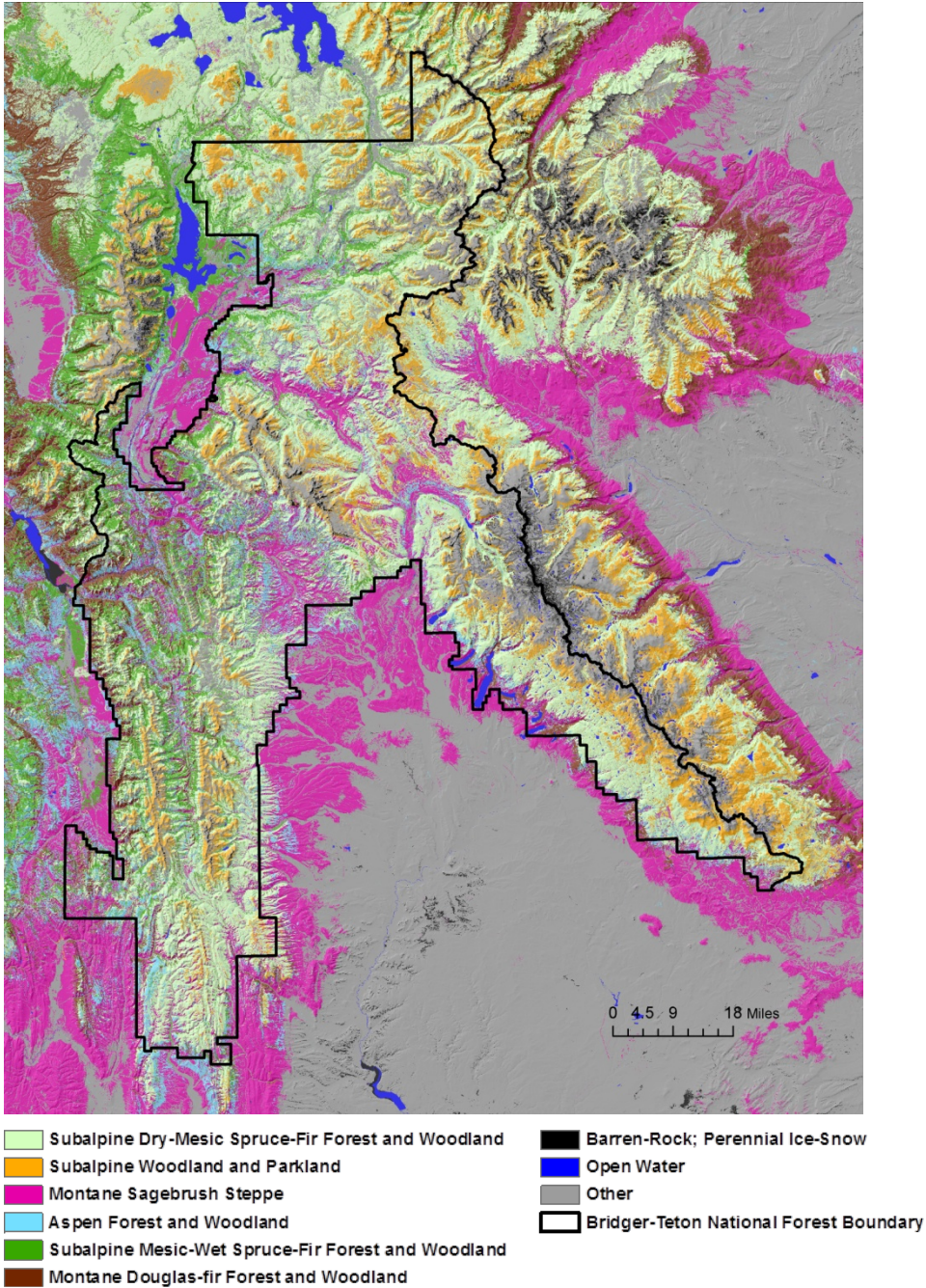
Figure 1: Spatial distribution of the biophysical settings assessed on the Bridger-Teton National Forest and surrounding area.

The BTNF resides primarily (i.e., 99.8%) in LANDFIRE map zone 21. The zone 21 vegetation dynamics model was used for every BpS except Rocky Mountain Aspen Forest and Woodland where resource specialists thought the zone 20 model was a better fit (LANDFIRE 2007).

Resource specialists critiqued the LANDFIRE S-Class mapping rules for errors and local relevance. Adjustments were made to fix issues with overlap and relevance of uncharacteristic native conditions (Appendix A). The adjusted rules were applied using a custom S-Class mapping tool and GIS software.

Finally, resource specialists developed S-Class transition rules in order to update the spatial data for recent disturbance not accounted for in the LANDFIRE version 1.0.5 data (Appendix B). Spatial data of wildfire severity (2000-2010) were acquired from the Teton-Interagency Fire Ecologist. Spatial data of overstory canopy loss due to insects and disease (2000-2008) were acquired from the USDA Forest Service Remote Sensing Applications Center (Goetz et al., 2009). These data were applied to the updated S-Class layer to provide the most up to date representation of S-Classes available.

Landscape Delineation

As discussed above, choosing the appropriate assessment scale is critical to accurate vegetation condition analysis. Two landscape levels were delineated for this assessment (Figure 2). The largest uses major rivers and hydrologic unit boundaries to delineate the major mountain ranges of the BTNF and was used to assess BpSs associated with fire regime groups IV and V (Table 6). Four mountain ranges were delineated, including the Absaroka Range (includes the Teton Wilderness), Wind River Range (includes the Gros Ventre Mountains and Mount Leidy Highlands), Teton Range (includes the Palisades Wilderness Study Area), and the Wyoming Range. Sub-basins[7] (i.e., 4th level HUC) within the larger landscapes represent the second landscape level and were used to assess BpSs associated with fire regime group III. These landscape levels were determined to be the most ecologically appropriate based on the historical disturbance regimes and spatial distribution of the BpSs within the analysis area.

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[7] Some adjustment was made to remove slivers or small polygons resulting from the intersection with the larger landscape level.
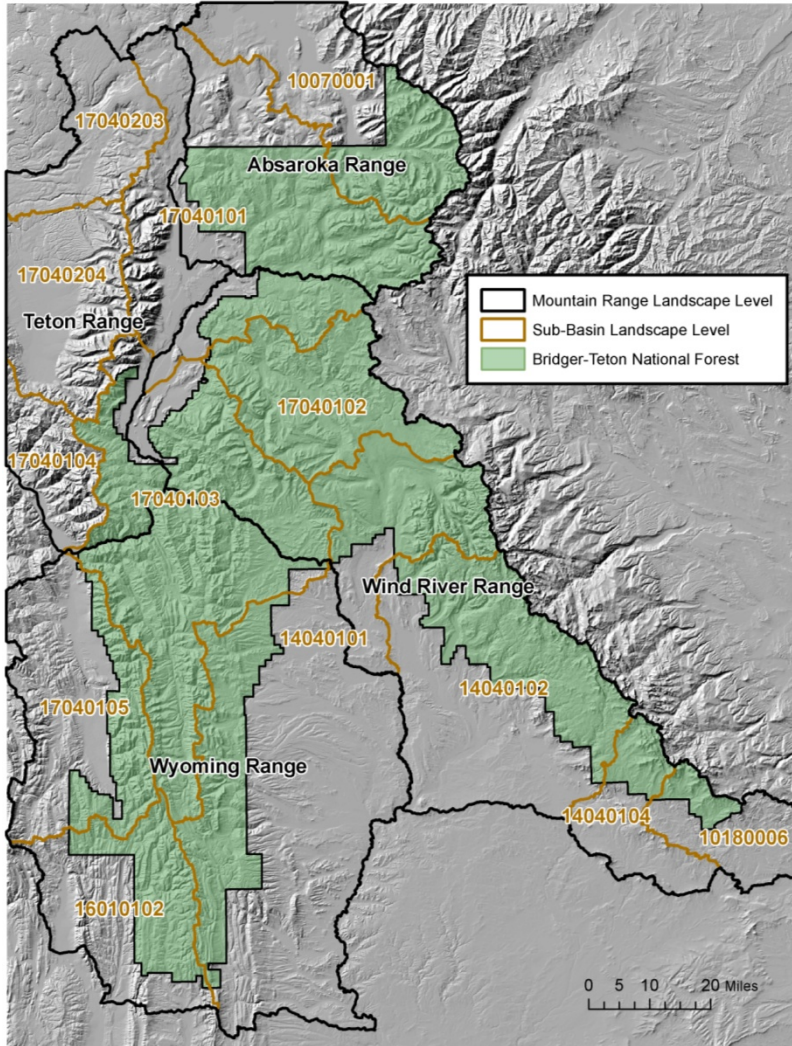
Figure 2: Landscape delineations used in the assessment.

Table 6: Associated fire regime group and landscape level of each biophysical setting.

Biophysical Setting	Fire Regime Group	Landscape Level
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	V	Mountain Ranges
Northern Rocky Mountain Subalpine Woodland and Parkland	III	Sub-basins
Inter-Mountain Basins Montane Sagebrush Steppe	IV	Mountain Ranges
Rocky Mountain Aspen Forest and Woodland	IV	Mountain Ranges
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	V	Mountain Ranges
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	III	Sub-basins

Results and Discussion

Recall from above that the term *stratum* refers to the combination of a specific BpS and landscape. At the stratum level, the vegetation composition and structure is moderately departed (VCC 2) from the reference condition across 84 percent of the land area covered by the BpSs assessed (Figure 3). Within the Northern Rocky Mountain Subalpine Dry-Mesic Spruce-Fir BpS it is moderately departed in the Wind River and Wyoming landscapes and within the HRV (VCC 1) in the Teton and Absaroka landscapes (Figure 4). The vegetation composition and structure of the Middle Rocky Mountain Montane Douglas-fir BpS is within its HRV throughout the BTNF at the stratum level.
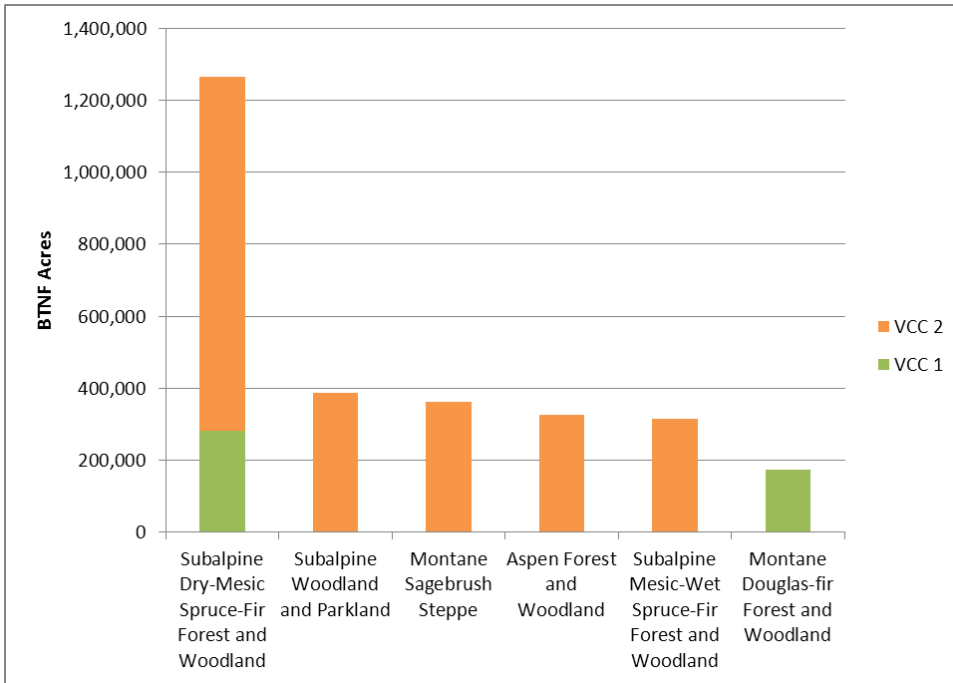
Figure 3: Distribution of vegetation condition class within the Bridger-Teton National Forest.

Each of the following subsections provides a general description of the vegetation and disturbance characteristics of the BpS and discussion of the stratum and S-Class level results. General descriptions represent a synthesis of information from the LANDFIRE vegetation dynamics model descriptions (LANDFIRE 2007) and Teton Interagency Fire Ecologist.
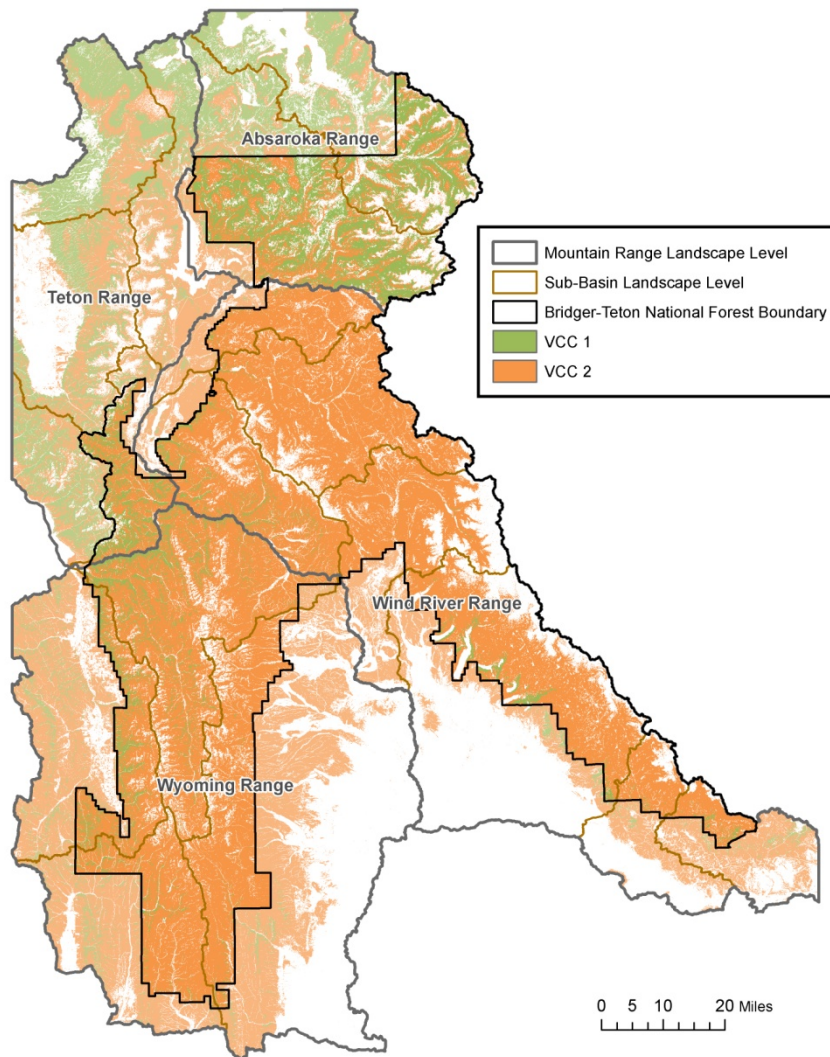
Figure 4: Spatial distribution of vegetation condition class. The assessment area outside of the Bridger-Teton National Forest is slightly greyed-out to highlight the within Forest values shown in (Figure 3).

Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

The Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland BpS is mapped to 37 percent of the BTNF. Lodgepole pine dominates this cold, subalpine system; while inclusions of aspen and mixed-conifer stands may be present where topography and soil conditions allow. Understories may consist of shrubs and/or grasses or be absent of vegetation.

The BpS is associated with an infrequent, high severity fire regime (fire regime group V; Table 2). The mean fire return interval is thought to be 200-400 years for a stand-replacing event, but this varies with elevation and local climate. Following stand-replacement fire, areas with high

cone serotiny[8] will rapidly colonize and develop into dense even-aged stands of lodgepole pine. In areas with low cone serotiny, lodgepole will gradually seed in and originally form less dense stands. If aspen is present, it may dominate lodgepole during this early development stage. After approximately 80-100 years without fire, forests will typically experience some level of mortality from insects and disease, as is evident from mountain pine beetle on much of the BTNF today.

Table 7 provides an overview of the composition, structure, and reference proportion of each S-Class in the BpS. These proportions are representative of a modeled stand-replacement fire interval ranging between 90 and 350 years with a mean interval of 300 years. This BpS was assessed at the mountain range landscape level (Table 6). As mentioned above, the BpS has a VCC 1 rating in the Absaroka and Teton landscapes and a VCC 2 rating in the Wind River and Wyoming landscapes. It should be noted, however, that the strata vegetation departure in all landscapes is relatively close to the 33 percent breakpoint between the two classes. The Wyoming landscape shows the highest departure, followed by the Wind River, Absaroka, and Teton (Table 8).

Table 7: Description of S-Classes within the Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland biophysical setting.

S-Class Description	Composition/Structure[a]	Reference Proportion
A: Early development, all structures	Post-replacement disturbance vegetation of grasses, forbs, shrubs, and lodgepole pine seedlings-saplings. Aspen may also be present. Canopy cover: 0- 100%. Tree height: 0-5 meters. Transitions to S-Class B after approximately 20 years.	5%
B: Mid-development, all structures	Pole-sized lodgepole pine. Aspen and subalpine fir may be present in the mid-story. Canopy cover: 10-100%. Tree height: 5-10 meters. Transitions to S-Class C after approximately 60 years without stand-replacing disturbance.	30%
C: Late development, all structures	Medium-sized lodgepole pine. Subalpine fir present in the mid- to upper-story. Canopy cover: 10-100%. Tree height: 10-50 meters. Class transitions to S-Class D after approximately 270 years without stand-replacing disturbance.	50%
D: Late development, all structures	Mature Engelmann spruce/subalpine fir forest. Canopy cover: 10-100%. Tree height: 5-50 meters. This class is distinguished from S-Classes B and C by species composition (spruce-fir dominance rather than lodgepole pine).	15%

[a] Reflects adjustments made to original vegetation dynamics models (Appendix A).

Figure 5 graphically compares the current S-Class distribution in each of the four landscapes to the reference distribution. Across each of the landscapes, there is a deficit of S-Class B and surplus of S-Classes A and D. The relative amount of S-Class C is similar to the HRV in all landscapes (Table 8).

In the Absaroka landscape the abundance of S-Class A coincides well with the 1988 Yellowstone fires. However, in the other landscapes it is also mapped, perhaps incorrectly, to areas that resemble the composition and structure of early post-fire communities such as natural meadows interspersed with lodgepole pine, krummholz, or areas of sparse vegetation outside of recent fire perimeters. S-Class A therefore may be slightly over-mapped in these landscapes due to limitations of the BpS mapping process (see Summary and Conclusions section below).

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[8] A serotinous cone is one which remains on the tree without opening for one or more years. In the case of lodgepole pine cones open and spread seeds when heat is provided by wildfire (FireWords 2012).
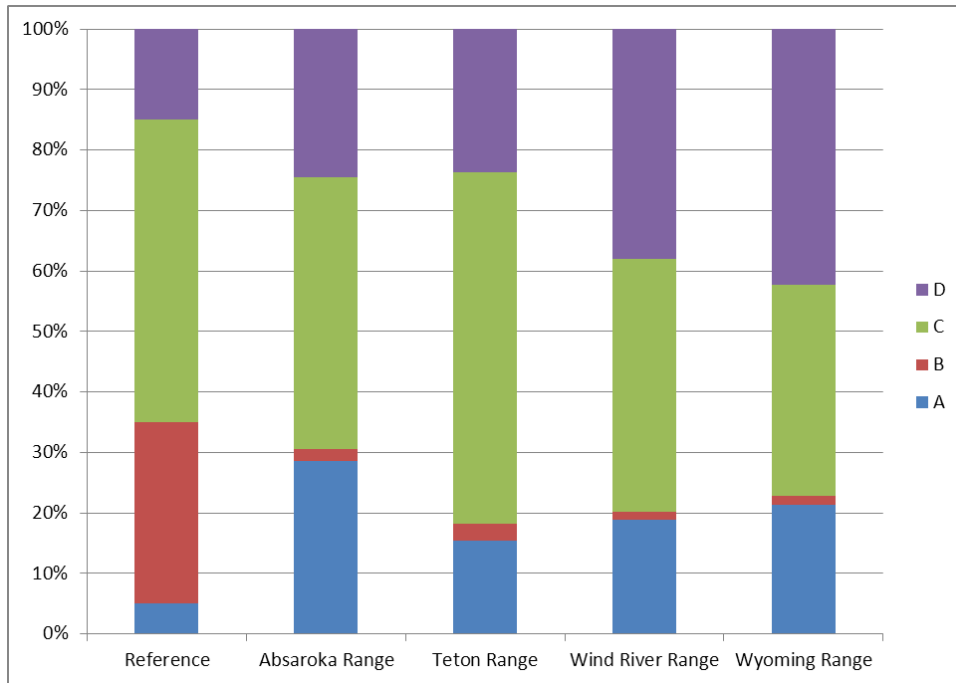
Figure 5: Graphical representation of reference and current S-Class distribution within the Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland biophysical setting.

Table 8: Current S-Class distribution and departure results for the Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland biophysical setting.

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
Absaroka	A	5	29	Abundant	33	1	113,658	62,312
	B	30	2	Trace			-135,344	5,435
	C	50	45	Similar			-23,721	118,184
	D	15	24	Over-represented			45,379	77,472
Teton	A	5	15	Abundant	27	1	27,914	2,247
	B	30	3	Trace			-72,810	615
	C	50	58	Similar			21,783	7,851
	D	15	24	Over-represented			23,051	7,982
Wind River	A	5	19	Abundant	37	2	80,645	108,003
	B	30	1	Trace			-166,622	6,847
	C	50	42	Similar			-47,151	231,176
	D	15	38	Over-represented			133,111	216,177
Wyoming	A	5	21	Abundant	44	2	82,289	81,906

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	B	30	1	Trace			-143,466	5,958
	C	50	35	Similar			-75,614	140,156
	D	15	42	Over-represented			136,714	191,026

[a] Uncharacteristic values accounting for less than 0.5 percent are not shown in table.

[b] This column shows the difference between current and reference acres of each S-Class within the assessment landscape. A positive value indicates a surplus of acres in the class; a negative value indicates a deficit.

[c] This column shows the current acreage of each S-Class that is on the BTNF within the landscape.

Northern Rocky Mountain Subalpine Woodland and Parkland

The Northern Rocky Mountain Subalpine Woodland and Parkland BpS is mapped to 11 percent of the BTNF. This is a high elevation, subalpine parkland setting where small to moderate size patches of trees are interspersed with meadows or areas of sparse vegetation. Trees are often stunted and damaged by the harsh windswept environment.

The BpS is associated with fire regime group III (Table 2); however there is much variability in the frequency and severity of fire in this system based on local fuel and climatic conditions. For example, lightning is frequent, but sparse fuel and cool, moist conditions often inhibit fire spread resulting in small, patchy, surface fires. Large, stand-replacing fires also occur albeit less frequently. Other prominent natural disturbances include mountain pine beetle, spruce budworm, white pine blister rust, and wind/weather events.

Table 9 provides an overview of the composition, structure, and reference proportion of each S-Class in the BpS. These proportions are representative of a modeled stand-replacement fire interval ranging between 100 and 1,000 years with a mean interval of 500 years, and a mixed severity fire interval ranging between 55 and 1,000 years with a mean interval of 300 years.

This BpS was assessed at the sub-basin landscape level (Table 6). As mentioned above, the BpS has a VCC 2 rating across all sub-basin landscapes. The BpS is most departed in the Wind River Sub-basin 17040101 landscape and least departed in the Wyoming Sub-basin 16010102 landscape (Table 10).

Table 9: Description of S-Classes within the Northern Rocky Mountain Subalpine Woodland and Parkland biophysical setting.

S-Class Description	Composition/Structure[a]	Reference Proportion
A: Early development, all structures	Post-replacement disturbance vegetation of typically whitebark pine and Engelmann spruce seedlings and saplings. Lodgepole pine, limber pine, and herbaceous species may also be early pioneers. Canopy cover: 0- 40%. Tree height: 0-5 meters. This class transitions to S-Class B or C after approximately 50 years.	25%
B: Mid-development, closed structure	Mix of pole-sized whitebark pine, subalpine fir, Engelmann spruce, and lodgepole pine. Some sites may exhibit krummholz growth form. Canopy cover: 30-100%. Tree height: 5-10 meters. Class transitions to S-Class E after approximately 80 years without disturbance.	35%
C: Mid-development, open structure	Mix of pole-sized whitebark pine, subalpine fir, Engelmann spruce, and lodgepole pine. Some sites may exhibit krummholz growth form. Canopy cover: 10-30%. Tree height: 5-10 meters. Class transitions to S-Class E or alternatively to S-Class B after approximately 80 years without disturbance.	10%
D: Late development, open structure	Mix of medium to large diameter whitebark pine, subalpine fir, Engelmann spruce, and lodgepole pine. Limber pine may be present. Generally found in small to moderate size patches on southerly aspects or sites where soil is less developed. Canopy cover: 10-40%. Tree height: 10-50 meters. This S-Class is persistent in the absence of disturbance, although a small percentage will eventually transition to S-Class E.	5%
E: Late development, closed structure	Mix of medium to large diameter whitebark pine, subalpine fir, Engelmann spruce, lodgepole pine, and limber pine. Generally found in small to moderate size patches on more protected northerly aspects or sites where soil is more developed than in S-Class D. Canopy cover: 40-100%. Tree height: 10-50 meters. This S-Class is persistent in the absence of disturbance.	25%

[a] Reflects adjustments made to original vegetation dynamics models (Appendix A).

Figure 6 graphically compares the current S-Class distribution in each of the sub-basin landscapes to the reference distribution. There is an absence or relatively trace amount of S-Class B, and abundance of S-Class D across all of the sub-basin landscapes; the relative amount of other S-Classes is variable (Table 10).
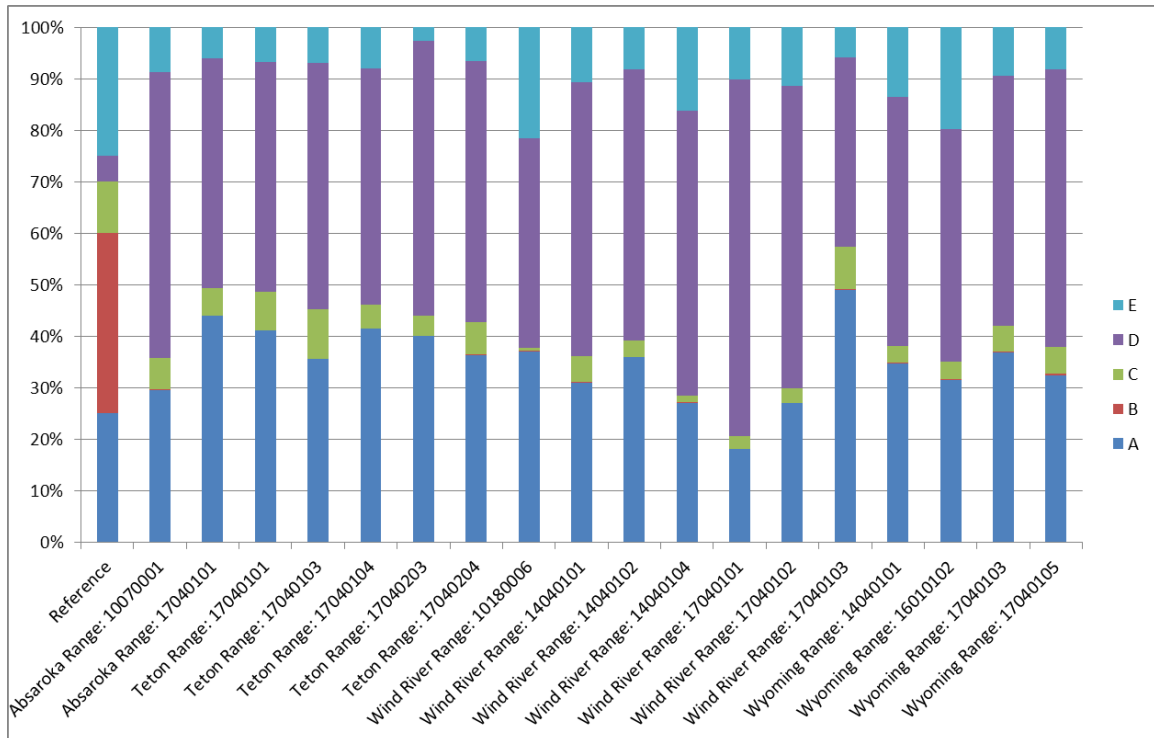
Figure 6: Graphical representation of reference and current S-Class distribution within the Northern Rocky Mountain Subalpine Woodland and Parkland biophysical setting.

Table 10: Current S-Class distribution and departure results for the Northern Rocky Mountain Subalpine Woodland and Parkland biophysical setting.

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
Absaroka: 10070001	A	25	30	Similar	55	2	3,627	11,752
	B	35	0	Trace			-27,738	125
	C	10	6	Under-represented			-3,116	2,748
	D	5	55	Abundant			40,219	25,473
	E	25	9	Under-represented			-12,992	4,164
Absaroka: 17040101	A	25	44	Over-represented	59	2	14,299	22,124
	B	35	0	Trace			-26,414	37
	C	10	5	Under-represented			-3,497	3,223
	D	5	45	Abundant			29,961	26,226
	E	25	6	Trace			-14,349	3,117
Teton:	A	25	36	Similar	53	2	662	815

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Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
17040103	B	35	0	Trace			-2,197	0
	C	10	10	Similar			-18	228
	D	5	48	Abundant			2,688	942
	E	25	7	Trace			-1,135	93
Wind River: 10180006	A	25	37	Similar	48	2	2,017	2,727
	B	35	0	Trace			-5,815	4
	C	10	1	Trace			-1,565	85
	D	5	41	Abundant			5,936	4,839
	E	25	22	Similar			-573	2,395
Wind River: 14040101	A	25	31	Similar	54	2	1,698	8,726
	B	35	0	Trace			-9,827	13
	C	10	5	Under-represented			-1,410	1,402
	D	5	53	Abundant			13,584	14,988
	E	25	11	Under-represented			-4,045	2,984
Wind River: 14040102	A	25	36	Similar	58	2	6,600	21,750
	B	35	0	Trace			-21,190	21
	C	10	3	Trace			-4,096	1,961
	D	5	53	Abundant			28,847	31,655
	E	25	8	Trace			-10,162	4,969
Wind River: 14040104	A	25	27	Similar	52	2	372	4,738
	B	35	0	Trace			-6,102	11
	C	10	1	Trace			-1,518	226
	D	5	55	Abundant			8,777	9,529
	E	25	16	Under-represented			-1,528	2,833
Wind River: 17040101	A	25	18	Similar	64	2	-1,071	2,818
	B	35	0	Trace			-5,437	8
	C	10	2	Trace			-1,168	388
	D	5	69	Abundant			9,995	10,773
	E	25	10	Under-represented			-2,320	1,569
Wind River: 17040102	A	25	27	Similar	56	2	1,249	16,729
	B	35	0	Trace			-21,636	36
	C	10	3	Trace			-4,469	1,723
	D	5	59	Abundant			33,267	36,363

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
	E	25	11	Under-represented			-8,411	7,070
Wind River: 17040103	A	25	49	Over-represented	56	2	4,291	8,760
	B	35	0	Trace			-6,232	25
	C	10	8	Similar			-330	1,458
	D	5	37	Abundant			5,678	6,571
	E	25	6	Trace			-3,407	1,061
Wyoming: 14040101	A	25	35	Similar	53	2	3,116	8,953
	B	35	0	Trace			-11,126	56
	C	10	3	Trace			-2,163	1,028
	D	5	48	Abundant			13,829	14,832
	E	25	14	Under-represented			-3,656	4,034
Wyoming: 16010102	A	25	32	Similar	47	2	440	1,796
	B	35	0	Trace			-2,346	11
	C	10	3	Trace			-449	223
	D	5	45	Abundant			2,708	2,983
	E	25	20	Similar			-353	1,301
Wyoming: 17040103	A	25	37	Similar	55	2	3,040	9,461
	B	35	0	Trace			-8,950	40
	C	10	5	Under-represented			-1,286	1,283
	D	5	49	Abundant			11,209	12,493
	E	25	9	Under-represented			-4,014	2,407
Wyoming: 17040105	A	25	32	Similar	56	2	959	4,142
	B	35	0	Trace			-4,455	28
	C	10	5	Under-represented			-612	666
	D	5	54	Abundant			6,266	6,897
	E	25	8	Trace			-2,157	1,036

[a] Uncharacteristic values accounting for less than 0.5 percent are not shown in table.

[b] This column shows the difference between current and reference acres of each S-Class within the assessment landscape. A positive value indicates a surplus of acres in the class; a negative value indicates a deficit.

[c] This column shows the current acreage of each S-Class that is on the BTNF within the landscape.

Inter-Mountain Basins Montane Sagebrush Steppe

The Inter-Mountain Basins Montane Sagebrush Steppe BpS is mapped to 11 percent of the BTNF. Vegetation is generally composed of mountain big sagebrush, antelope bitterbrush, and mountain snowberry with moderate to abundant herbaceous cover.

The BpS is associated with a low to moderate frequency, replacement severity fire regime (fire regime group IV; Table 2); however, this is a matter of considerable debate. A lack of historical information, and variability among factors such as elevation, soil depth, slope, aspect, adjacent vegetation, overgrazing, frequency of lightning, and climate across the BpS all contribute to the difficulty of assigning a fire regime and reference conditions.

Table 11 provides an overview of the composition, structure, and reference proportion of each S-Class in the BpS. These proportions are representative of a modeled stand-replacement fire interval ranging between 30 and 200 years with a mean interval of 50 years. This BpS was assessed at the mountain range landscape level (Table 5). As mentioned above, the BpS has a VCC 2 rating across all landscapes. The Teton Range landscape shows the highest departure, followed by the Absaroka, Wyoming, and Wind River ranges (Table 12).

Table 11: Description of S-Classes within the Inter-Mountain Basins Montane Sagebrush Steppe biophysical setting.

S-Class Description	Composition/Structure[a]	Reference Proportion
A: Early development, all structures	Post-replacement disturbance vegetation dominated by grasses and forbs. Shrub cover less than 10%. Herbaceous cover 0-30%. This S-Class will transition to S-Class B after approximately 13 years.	25%
B: Mid-development, open structure	Shrub cover: 10-30%. Herbaceous cover: 0-40%. After 30-40 years this S-Class usually transitions to S-Class C in the absence of disturbance. On very dry sites, however, a closed structure may never be attained.	45%
C: Late development, closed structure	Shrub cover 30-50%. Herbaceous cover is variable. Other disturbances such as drought stress and insects may cause this S-Class to transition to S-Class B.	30%

[a] Reflects adjustments made to original vegetation dynamics models (Appendix A).

Figure 7 graphically compares the current S-Class distribution in each of the four landscapes to the reference distribution. There is a deficit of S-Classes A and C in each of the assessment landscapes. The relative amount of S-Class B is similar to the HRV in the Absaroka landscape and over-represented in the other three. This BpS also shows a considerable amount of acres in the uncharacteristic native (UN) S-Class. 83% of the UN designation is due to exceeding the S-Class A mapping thresholds (i.e., greater than 30% herbaceous cover without a shrub component), 11% exceeding 50% shrub cover, and the remainder due to tree encroachment. In other words, if the herbaceous cover threshold for S-Class A were higher most of the UN would be in S-Class A. The uncharacteristic exotic (UE) class refers to non-native plant communities becoming established on the BpS.
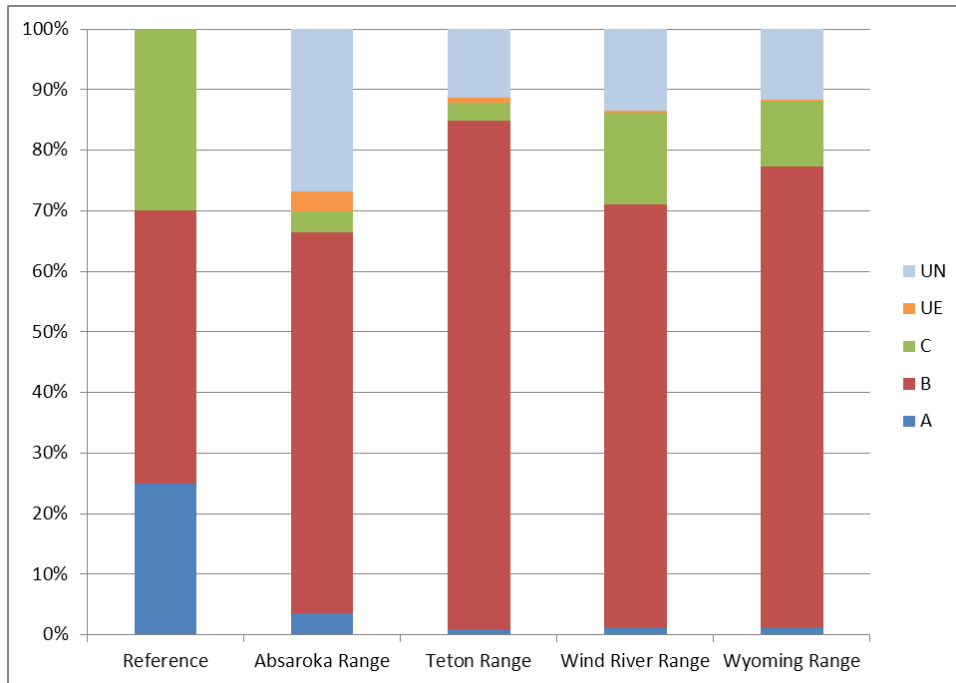
Figure 7: Graphical representation of reference and current S-Class distribution within the Inter-Mountain Basins Montane Sagebrush Steppe biophysical setting.

Table 12: Current S-Class distribution and departure results for the Inter-Mountain Basins Montane Sagebrush Steppe biophysical setting.

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
Absaroka	A	25	4	Trace	48	2	-3,225	455
	B	45	63	Similar			2,680	5,083
	C	30	4	Trace			-3,964	403
	UE	0	3	Abundant			-478	364
	UN	0	27	Abundant			-4,031	3,077
Teton	A	25	1	Trace	51	2	-16,774	147
	B	45	84	Over-represented			27,100	11,372
	C	30	3	Trace			-18,838	89
	UE	0	1	Abundant			-572	214
	UN	0	11	Abundant			-7,941	3,061
Wind River	A	25	1	Trace	38	2	-122,833	3,798
	B	45	70	Over-represented			128,088	134,881
	C	30	15	Under-represented			-76,726	2,840

	UN	0	14	Abundant			-70,210	54,509
Wyoming	A	25	1	Trace	43	2	-156,037	2,610
	B	45	76	Over-represented			204,251	101,482
	C	30	11	Under-represented			-127,393	915
	UN	0	12	Abundant			-76,843	34,132

[a] Uncharacteristic values accounting for less than 0.5 percent are not shown in table.

[b] This column shows the difference between current and reference acres of each S-Class within the assessment landscape. A positive value indicates a surplus of acres in the class; a negative value indicates a deficit.

[c] This column shows the current acreage of each S-Class that is on the BTNF within the landscape.

Rocky Mountain Aspen Forest and Woodland

The Rocky Mountain Aspen Forest and Woodland BpS is mapped to nine percent of the BTNF. The system is dominated by quaking aspen but may include a significant conifer component of Douglas-fir, lodgepole pine, subalpine fir, limber pine, or Engelmann spruce. Understory vegetation may include a mix of grasses, forbs, and shrubs. Communities are usually small in spatial extent (<25 acres) and intermixed with other BpSs. Distribution of the system is primarily limited by soil moisture and secondarily by growing season or low temperatures. This system is most prevalent in the ecotone between grasslands/shrublands and montane/subalpine coniferous forest.

The BpS is associated with a moderately frequent, replacement severity fire regime (fire regime group IV; Table 2); however, frequency is highly variable based on adjacent community disturbance dynamics. For example, frequency was likely higher where aspen was adjacent to grassland/shrubland communities and lower where it was adjacent to subalpine conifer communities. Fires in aspen communities tend to have patchy fire effects, which can be associated with a mixed-severity fire regime at certain scales.

Aspen can persist through long periods without disturbance due to its clonal root system. The root system rapidly responds to disturbance through sprouting and suckering. With long fire free periods aspen may be replaced by conifer, shrubland, or grassland systems. Other disturbances in this system include herbivory, insect/disease, avalanches, and mud/rock slides.

Table 13 provides an overview of the composition, structure, and reference proportion of each S-Class in the BpS. These proportions are representative of a modeled stand-replacement fire interval ranging between 4 and 200 years with a mean interval of 110 years. This BpS was assessed at the mountain range landscape level (Table 5). As mentioned above, the BpS has a VCC 2 rating across all landscapes. The BpS is most departed in the Absaroka and Teton landscapes, followed by the Wind River and Wyoming landscapes (Table 14).

Table 13: Description of S-Classes within the Rocky Mountain Aspen Forest and Woodland biophysical setting.

S-Class Description	Composition/Structure[a]	Reference Proportion
A: Early development, all structures	Post-replacement disturbance dominated by aspen suckers, grasses, forbs, and shrubs. Canopy cover: 0-100%. Tree height:0-5 meters. After 15 years succeeds to S-Class B (unless inhibited by overbrowsing).	15%
B: Mid-development, all structures	Sapling to pole-sized aspen dominates. Canopy cover: 10-100%, although usually closed. Tree height: 5-10 meters. Transitions to S-Class C after approximately 25 years without stand-replacement disturbance.	20%
C: Late development, closed structure	Medium-sized aspen dominate. Canopy cover: 40-100%. Tree height: 10-50 meters. This stage may persist indefinitely with continued regeneration and overstory recruitment. Canopy die-off and lack of recruitment from herbivory may result in transition to S-Class D. In the absence of disturbance this class may transition to mixed-conifer, S-Class E.	25%
D: Late development, open structure	Medium-sized aspen dominate with conifers in the low to mid-canopy. Canopy cover: 10-40%. Tree height: 10-50 meters. This class transitions to S-Class E after approximately 100 years in the absence of disturbance, or in some cases, to a shrub/herbaceous community as a result of mortality without recruitment due to high herbivory.	25%
E: Late development, closed structure	Conifer or aspen-mixed conifer overstory. Canopy cover: 40-100%. Tree height: 10-50 meters. This class is distinguished from S-Classe C by species composition (aspen is being replaced by conifer or other vegetation types).	15%

[a] Reflects adjustments made to original vegetation dynamics models (Appendix A).

Figure 8 graphically compares the current S-Class distribution in each of the four landscapes to the reference distribution. In each landscape there is a deficit of S-Class B and over-representation of S-Class D. S-Class D is a transitional state where overstory recruitment is inhibited by herbivory, insects, disease, or a combination of these factors and with a continued absence of fire will transition to S-Class E or to a non-forested existing vegetation type—resulting in such stands being mapped as S-Class A or UN.
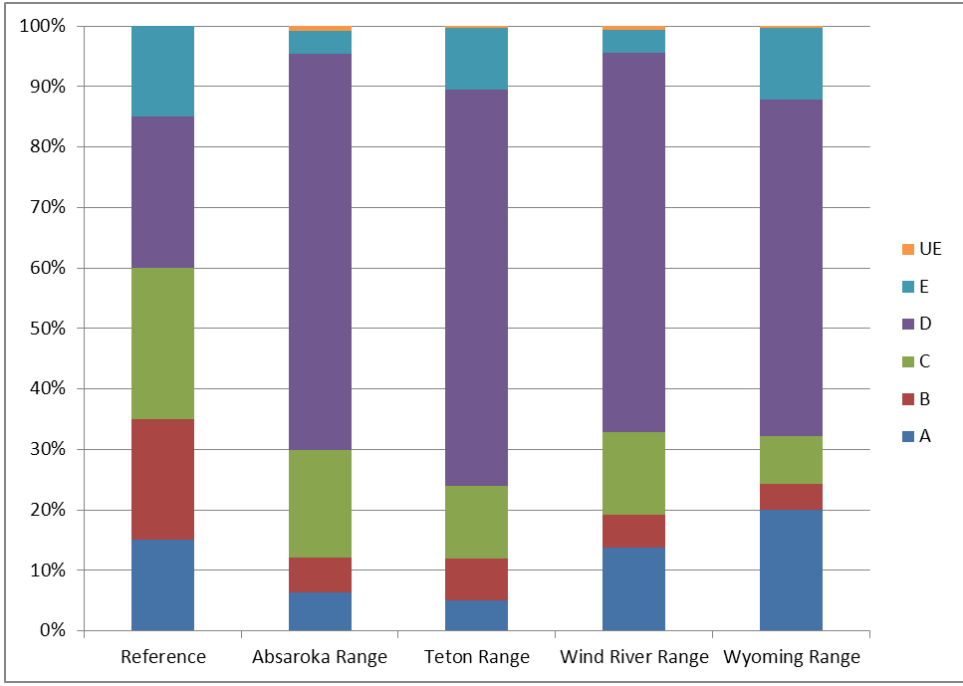
Figure 8: Graphical representation of reference and current S-Class distribution within the Rocky Mountain Aspen Forest and Woodland biophysical setting.

Table 14: Current S-Class distribution and departure results for the Rocky Mountain Aspen Forest and Woodland biophysical setting.

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
Absaroka	A	15	6	Under-represented	41	2	-2,897	1,426
	B	20	6	Trace			-4,823	1,517
	C	25	18	Similar			-2,420	4,374
	D	25	66	Over-represented			13,671	15,745
	E	15	4	Trace			-3,783	620
	UE	0	1	Abundant			-251	124
Teton	A	15	5	Trace	41	2	-8,865	1,154
	B	20	7	Under-represented			-11,709	1,771
	C	25	12	Under-represented			-11,588	2,505
	D	25	66	Over-represented			36,103	18,102
	E	15	10	Similar			-4,222	1,524
Wind River	A	15	14	Similar	38	2	-1,979	16,353
	B	20	5	Trace			-23,161	6,291

	C	25	14	Under-represented				-18,211	18,934
	D	25	63	Over-represented				60,134	83,130
	E	15	4	Trace				-17,714	4,980
	UE	0	1	Abundant				-916	763
Wyoming	A	15	20	Similar				16,179	21,121
	B	20	4	Trace				-50,078	6,617
	C	25	8	Trace	36	2		-54,533	11,915
	D	25	55	Over-represented				97,221	87,492
	E	15	12	Similar				-10,053	19,537

[a] Uncharacteristic values accounting for less than 0.5 percent are not shown in table.

[b] This column shows the difference between current and reference acres of each S-Class within the assessment landscape. A positive value indicates a surplus of acres in the class; a negative value indicates a deficit.

[c] This column shows the current acreage of each S-Class that is on the BTNF within the landscape.

Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland

Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland BpS is mapped to nine percent of the BTNF. This system is typically found on north facing slopes, high elevation ravines, or other areas where cold, mesic conditions exist. Engelmann spruce and subalpine fir dominate the overstory but lodgepole pine may be found on drier sites or in early successional stages. Mesic understory shrubs are common.

The BpS is associated with an infrequent, replacement severity fire regime (fire regime group V; Table 2). The fire regime is primarily driven by climate in this BpS and therefore climate change and interannual climatic variability will affect the fire frequency within the system. Spruce beetle and balsam bark beetle are other disturbances that may affect this system.

Table 15 provides an overview of the composition, structure, and reference proportion of each S-Class in the BpS. These proportions are representative of a modeled stand-replacement fire interval ranging between 100 and 600 years with a mean interval of 455 years, and a mean mixed severity interval of 900 years (the interval range was not reported in the model description). This BpS was assessed at the mountain range landscape level (Table 5). As mentioned above, the BpS has a VCC 2 rating across all landscapes. The BpS is most departed in the Absaroka and Teton landscapes, followed by the Wind River and Wyoming landscapes (Table 16). However, reviewers of this model noted that overall this system probably isn't departed because the proportion of S-Classes normally fluctuates widely and the system does not achieve a state of equilibrium.

Table 15: Description of S-Classes within the Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland biophysical setting.

S-Class Description	Composition/Structure[a]	Reference Proportion
A: Early development, all structures	Post-replacement disturbance vegetation of grass and Engelmann spruce, lodgepole pine, and subalpine fir seedlings. Canopy cover: 0-100%. Tree height:0-5 meters. This stage transitions to S-Class B after approximately 40 years or alternatively to S-Class C.	10%
B: Mid-development, closed structure	Mix of pole-sized Engelmann spruce, lodgepole pine, and subalpine fir. Canopy cover: 40-100%. Tree height: 5-10 meters. In the absence of stand-replacement fire this class transitions to S-Class E after approximately 110 years. Wind or weather stress may thin this class causing transition to S-Class C.	20%
C: Mid-development, open structure	Mix of pole-sized Engelmann spruce, lodgepole pine, and subalpine fir. Canopy cover: 40-100%. Tree height: 5-10 meters. This class transitions to S-Class D after approximately 110 years in the absence of stand-replacement fire.	10%
D: Late development, open structure	Mix of medium to large-sized Engelmann spruce, subalpine fir, and lodgepole pine. Canopy cover: 10-50%. Tree height: 10-50 meters. This class may persist in the absence of disturbance or transition to S-Class E with increased canopy closure.	40%
E: Late development, closed structure	Mix of medium to large-sized Engelmann spruce, subalpine fir, and lodgepole pine. Canopy cover: 50-90%. Tree height: 10-50 meters.	20%

[a] Reflects adjustments made to original vegetation dynamics models (Appendix A).

Figure 9 graphically compares the current S-Class distribution in each of the four landscapes to the reference distribution. In each of the landscapes there is an absence of S-Class B, deficit of S-Class C, and over-representation of S-Class D.

Figure 9: Graphical representation of reference and current S-Class distribution within the Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland biophysical setting.

Table 16: Current S-Class distribution and departure results for the Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland biophysical setting.

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
Absaroka	A	10	20	Over-represented	42	2	12,264	12,219
	B	20	0	Trace			-24,004	0
	C	10	2	Trace			-9,794	1,419
	D	40	71	Over-represented			37,685	47,557
	E	20	7	Trace			-16,192	5,340
Teton	A	10	13	Similar	39	2	7,871	3,922
	B	20	0	Trace			-51,011	0
	C	10	3	Trace			-17,523	724
	D	40	76	Over-represented			92,120	19,744
	E	20	8	Under-represented			-31,489	1,766
Wind River	A	10	15	Similar	35	2	3,380	8,978
	B	20	0	Trace			-14,268	1
	C	10	7	Under-represented			-2,413	4,266
	D	40	70	Over-represented			21,745	46,957
	E	20	8	Under-represented			-8,466	5,633
Wyoming	A	10	17	Over-represented	35	2	15,473	21,981
	B	20	0	Trace			-43,820	1
	C	10	3	Under-represented			-14,344	6,093
	D	40	68	Over-represented			60,982	114,644
	E	20	12	Under-represented			-18,426	15,139

[a] Uncharacteristic values accounting for less than 0.5 percent are not shown in table.

[b] This column shows the difference between current and reference acres of each S-Class within the assessment landscape. A positive value indicates a surplus of acres in the class; a negative value indicates a deficit.

[c] This column shows the current acreage of each S-Class that is on the BTNF within the landscape.

Middle Rocky Mountain Montane Douglas-fir Forest and Woodland

The Middle Rocky Mountain Montane Douglas-fir Forest and Woodland BpS is mapped to five percent of the BTNF. Vegetation is generally dominated by Douglas-fir but may include codominant species according to site conditions and disturbance history. Understory vegetation varies from sparse to dense cover of grasses, shrubs, and conifer seedlings and saplings.

The BpS is associated with a moderately frequent, mixed severity fire regime (fire regime group III; Table 2). The mean fire return interval is thought to be 20-50 years, with longer intervals for stand-replacing events. Douglas-fir beetle and mountain pine beetle are common insects causing mortality in this system.

Table 17 provides an overview of the composition, structure, and reference proportion of each S-Class in the BpS. These proportions are representative of a modeled stand-replacement mean fire interval ranging between 200 and 300 years with a mean interval of 300 years, a mixed severity fire interval ranging between 20 and 80 years with a mean interval of 50 years, and a surface fire interval ranging between 200 and 400 years (no mean was reported in the model description).

This BpS was assessed at the sub-basin landscape level (Table 5). As mentioned above, the BpS has a VCC 1 rating across all sub-basin landscapes. The BpS is most departed in the Absaroka Sub-basin 10070001 landscape; however, it accounts for only 723 acres of the sub-basin. The BpS is least departed in the Wind River Sub-basin 14040104 landscape (Table 18).

Table 17: Description of S-Classes within the Middle Rocky Mountain Montane Douglas-fir Forest and Woodland biophysical setting.

S-Class Description	Composition/Structure[a]	Reference Proportion
A: Early development, all structures	Post-replacement disturbance vegetation dominated by grasses and seedling/sapling Douglas-fir and possibly lodgepole pine. Canopy cover 0-100%. Tree height: 0-5 meters. This class transitions to S-Class C or alternately to S-Class B after approximately 40 years.	10%
B: Mid-development, closed structure	Pole-size to medium Douglas-fir and possibly lodgepole pine. Canopy cover: 40-100%. Tree height: 5-10 meters. In the absence of disturbance this class transitions to S-Class E after approximately 80 years.	10%
C: Mid-development, open structure	Pole-size to medium Douglas-fir and possibly lodgepole pine. Canopy cover: 10-40%. Tree height: 5-10 meters. In the absence of stand-replacing disturbance this class transitions to S-Class D or alternately S-Class B after approximately 60 years.	10%
D: Late development, open structure	Medium to large Douglas-fir and possibly lodgepole pine. Canopy cover: 10-40%. Tree height: 10-50 meters. In the absence of disturbance this class may transition to S-Class E in approximately 45 years.	50%
E: Late development, closed structure	Multi-storied mature Douglas-fir stand. Lodgepole may be present. Canopy cover: 40-100%. Tree height 10-50 meters. Insect, weather, or mixed severity fire may transition this class to S-Class D.	20%

[a] Reflects adjustments made to original vegetation dynamics models (Appendix A).

It is important to note that S-Class D accounts for 50% of the reference distribution therefore giving it more "weight" in the calculation of stratum vegetation departure. However, individual S-Classes still show departure and may provide opportunity for restoration or maintenance. For example, S-Class B is absent to relatively trace across the sub-basins indicating a need to recruit more acres into the class. Also, without fire or another form of maintaining an open canopy, S-

Class D will succeed to the late, closed S-Class E; which is already similar or over-represented relative to the reference proportion across all sub-basins (Figure 10; Table 18).
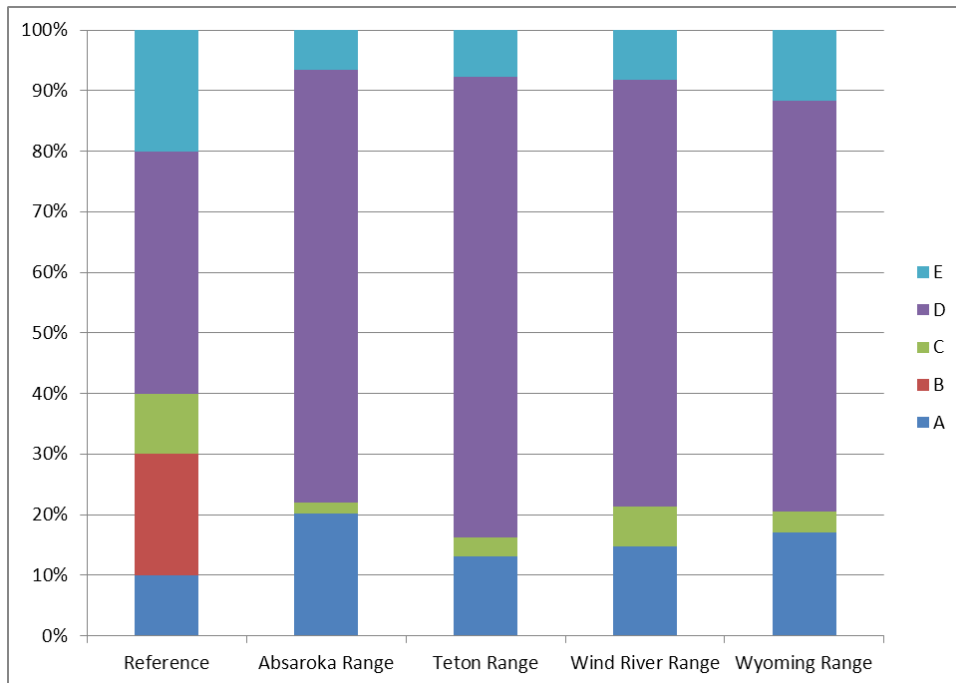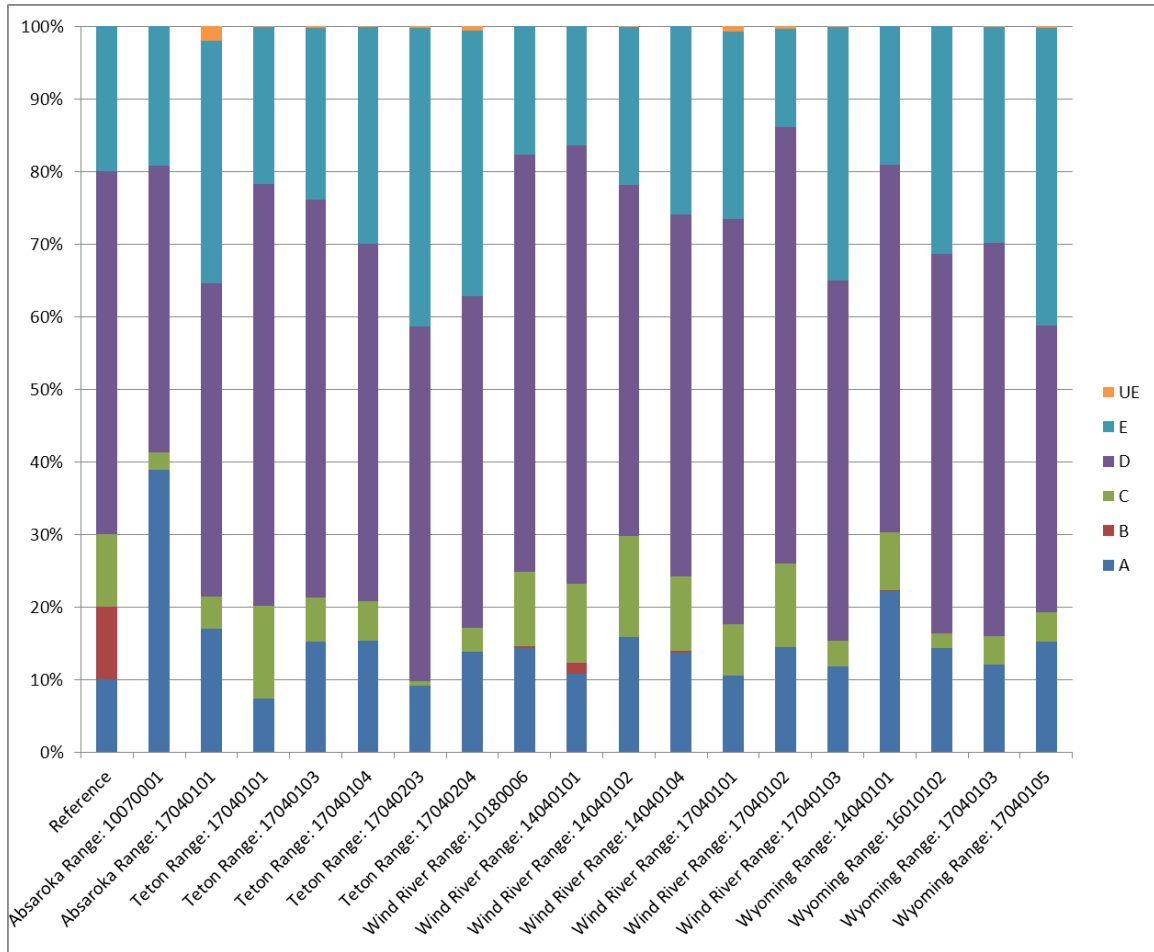

Figure 10: Graphical representation of reference and current S-Class distribution within the Middle Rocky Mountain Montane Douglas-fir Forest and Woodland biophysical setting.

Table 18: Current S-Class distribution and departure results for the Middle Rocky Mountain Montane Douglas-fir Forest and Woodland biophysical setting.

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
Absaroka: 10070001	A	10	39	Abundant	29	1	208	107
	B	10	0	Trace			-72	
	C	10	2	Trace			-55	10
	D	50	39	Similar			-76	67
	E	20	19	Similar			-6	6
Absaroka: 17040101	A	10	17	Over-represented	22	1	415	455

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
	B	10	0	Trace			-588	
	C	10	4	Under-represented			-330	204
	D	50	43	Similar			-401	1,615
	E	20	33	Over-represented			786	1,294
	UE	0	2	Abundant			-118	89
Teton: 17040103	A	10	15	Over-represented	14	1	1,363	3,615
	B	10	0	Trace			-2,603	1
	C	10	6	Under-represented			-1,028	1,283
	D	50	55	Similar			1,216	12,466
	E	20	24	Similar			971	5,543
Wind River: 10180006	A	10	14	Similar	12	1	372	105
	B	10	0	Trace			-847	0
	C	10	10	Similar			32	179
	D	50	57	Similar			646	1,470
	E	20	18	Similar			-204	765
Wind River: 14040101	A	10	11	Similar	12	1	6	78
	B	10	2	Trace			-67	
	C	10	11	Similar			7	65
	D	50	60	Similar			82	397
	E	20	16	Similar			-29	95
Wind River: 14040102	A	10	16	Over-represented	12	1	1,184	1,899
	B	10	0	Trace			-2,009	5
	C	10	14	Similar			779	1,856
	D	50	48	Similar			-340	6,813
	E	20	22	Similar			370	3,071
Wind River: 14040104	A	10	14	Similar	10	1	90	43
	B	10	0	Trace			-235	0
	C	10	10	Similar			7	66
	D	50	50	Similar			-3	337
	E	20	26	Similar			141	299
Wind River: 17040101	A	10	10	Similar	13	1	21	239
	B	10	0	Trace			-431	0
	C	10	7	Similar			-124	131

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
	D	50	56	Similar			251	1,410
	E	20	26	Similar			249	564
	UE	0	1	Abundant			-34	21
Wind River: 17040102	A	10	14	Similar	16	1	97	308
	B	10	0	Trace			-219	0
	C	10	12	Similar			33	237
	D	50	60	Similar			223	1,242
	E	20	14	Similar			-142	265
Wind River: 17040103	A	10	12	Similar	17	1	406	2,264
	B	10	0	Trace			-2,316	1
	C	10	4	Under-represented			-1,491	674
	D	50	50	Similar			-84	10,438
	E	20	35	Over-represented			3,459	7,696
Wyoming: 14040101	A	10	22	Over-represented	13	1	1,491	640
	B	10	0	Trace			-1,203	0
	C	10	8	Similar			-254	232
	D	50	51	Similar			81	1,566
	E	20	19	Similar			-116	825
Wyoming: 16010102	A	10	14	Similar	18	1	1,318	1,596
	B	10	0	Trace			-3,042	0
	C	10	2	Trace			-2,432	288
	D	50	52	Similar			701	4,986
	E	20	31	Over-represented			3,436	4,191
Wyoming: 17040103	A	10	12	Similar	16	1	1,241	7,076
	B	10	0	Trace			-5,853	0
	C	10	4	Under-represented			-3,593	2,212
	D	50	54	Similar			2,454	31,106
	E	20	30	Similar			5,676	17,155
Wyoming: 17040105	A	10	15	Over-represented	26	1	3,708	5,009
	B	10	0	Trace			-7,144	0
	C	10	4	Under-represented			-4,198	1,445
	D	50	39	Similar			-7,556	13,516

Landscape	S-Class[a]	Reference Proportion (%)	Current Proportion (%)	Relative Amount	Stratum Departure	Stratum VCC	Current - Reference Acres[b]	BTNF Acres[c]
	E	20	41	Over-represented			14,938	11,499

[a] Uncharacteristic values accounting for less than 0.5 percent are not shown in table.
[b] This column shows the difference between current and reference acres of each S-Class within the assessment landscape. A positive value indicates a surplus of acres in the class; a negative value indicates a deficit.
[c] This column shows the current acreage of each S-Class that is on the BTNF within the landscape.

Summary and Conclusions

Overall Trends

In the majority of the six BpSs analyzed the distribution of S-Classes was determined to be moderately departed (VCC 2) from the reference distribution. The exceptions were the Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland BpS—in the Absaroka and Teton landscapes—and the Middle Rocky Mountain Montane Douglas-fir Forest and Woodland BpS, where S-Class distributions were calculated to be within the HRV of the reference condition (VCC 1).

The characteristics leading to this departure are variable by BpS and landscape but there are some general trends worth noting. First, there is a surplus of late development and deficit of mid-development S-Classes across the forested BpSs. This trend may be in part due to minimal disturbance events occurring in the mid- to late 1900's. In the Inter-Mountain Basins Montane Sagebrush Steppe BpS—the only non-forested BpS assessed—the trend is for a deficit of late development, closed structure and surplus, or near surplus, of mid-development, open structure. There is also a deficit in S-Class A, however as discussed above this is mainly due to herbaceous vegetation exceeding the mapping rule cover threshold and thus being mapped as UN—an important consideration in interpreting the results.

Lastly, there is a surplus of early development, S-Class A among many of the BpSs. This trend may in part be due to limitations of the geospatial data used for the assessment. For instance, an herbaceous or shrub EVT mapped to a forested BpS typically results in an S-Class A assignment. However, BpS data is "coarser" in concept than EVT data because it is mapped using a biophysical gradient modeling approach without integration of remotely sensed imagery as in EVT (Rollins 2009). Therefore, one consideration is whether the EVT is picking up subtleties expressed by the remotely sensed vegetation that are missed by the BpS mapping process. For example, as noted above, much of the S-Class A within the Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland BpS is located in areas of small natural meadows, krummholz, or sparse vegetation that resemble the composition and structure of early post-fire communities. The question then becomes whether these areas are truly capable of supporting the tree species of the BpS or if this is an artifact of the mapping process.

Another consideration in the surplus of S-Class A is data currency. LANDFIRE version 1.0.5 data were used for this assessment. These data are based on circa 2000 imagery and were not adjusted for growth and development. In the case of the 1988 Yellowstone Fires in the Absaroka landscape, thousands of acres within the Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest

and Woodland BpS that burned 25 years ago are now on the cusp between S-Class A and S-Class B, however, this is not reflected in the data or results of this assessment.

Recommended Uses of the Bridger-Teton Vegetation Condition Assessment

This assessment was initially conducted to provide a way for the Teton Interagency wildfire response assessment to capture the benefits of fire to fire-adapted ecosystems. In addition to this primary purpose, the vegetation condition assessment can also be used as a stand-alone product: this assessment provides a synthesis of BpS information and a mid-scale comparison of reference and current succession class distribution for the predominant BpSs on the Forest.

Input for the Teton Interagency Wildfire Response Assessment

The vegetation condition assessment estimates the distribution of successional classes present on the BTNF landscape relative to a reference distribution for each of the six primary BpSs on the Forest. This comparison indicates whether a particular S-Class needs to be recruited or diminished in order to move the BpS towards the reference condition. The wildfire response assessment (Scott et al., 2013) generated geospatial data of burn probability and wildfire intensity that was combined with expert judgment-based response functions which characterize the expected effect of wildfire on S-Class distribution and ultimately diverse and resilient vegetation. The wildfire response assessment provides information about where on the BTNF wildfire will likely move a BpS towards the reference condition and where wildfire will likely drive the BpS away from the reference condition.

Providing these data to the Teton Interagency wildfire response assessment is crucial to ensure that the assessment captures the benefit of wildfire to fire-adapted ecosystems. Combined with other locally identified HVRAs, the integration of DRV provides a more holistic look at potential wildfire effects. Without an HVRA to capture fire's ecological role, the response assessment would fail to portray the benefits of fire and call into question the validity of decisions to manage wildfire for resource objectives. The Teton Interagency wildfire response assessment is described in detail in the project report (Scott et al., 2013).

Stand-alone uses for the Bridger-Teton Vegetation Condition Assessment

In addition to providing a spatial input for the wildfire response assessment, this vegetation condition assessment can be used independently for several additional purposes. First, the assessment provides a user-friendly synthesis of vegetation dynamics for the six predominant BpSs on the Forest. Each synthesis includes information on the primary disturbance regime, reference succession class distribution, the reference vegetation structure and composition within each succession class, and the disturbance pathways to other succession classes. In addition, Appendix B houses a summary of disturbance pathways used to update S-Class data for high, moderate, and low severity fire as well as beetle kill-induced canopy mortality. Although brief, this BpS information can be useful for determining a general baseline reference condition without needing to delve into the BpS models themselves.

Second, the vegetation condition assessment provides a mid-scale comparison of reference to current succession class distribution for the six predominant BpSs on the BTNF. In turn, this mid-scale comparison has applications for project development and effects analysis. The vegetation assessment may be used to identify and prioritize areas for restoration and/or maintenance, to identify maintenance and/or restoration management opportunities, to evaluate the effect of

proposed treatments or policies on vegetation condition, and for Fire Regime Condition Class (FRCC) reporting. These applications are described further below:

- *Identify and prioritize areas of the BTNF for restoration and/or maintenance*: The stratum VCC metric broadly identifies the degree to which the S-Class distribution of individual strata (e.g., Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland within the Wyoming landscape) is departed from the reference distribution. For example, stratum VCC 2 indicates that the stratum is moderately departed from the reference condition and merits restoration, whereas a stratum VCC 1 indicates the stratum is within the range and variability of the reference condition and merits maintenance. Strata with the same VCC value may be further prioritized based on the stratum departure, which assesses the departure on a scale from 0 (no departure) to 100 (full departure).

- *Identify maintenance and/or restoration management opportunities*: The S-Class relative amount metric further identifies whether the individual S-Classes within a particular stratum need to be reduced or recruited to move the stratum towards the reference condition. This provides a broad filter for identifying target S-Classes for particular treatments. For example, thinning or moderate severity wildland fire may be effective at reducing a surplus of closed canopy structure while at the same time recruiting open canopy structure, whereas these treatments would not be effective at reducing a surplus of open canopy structure.

- *Evaluate the effect of proposed treatments or policies on vegetation condition*: The current S-Class distribution and departure summary tables within this report provide the surplus and deficit acres of each S-Class by stratum. In addition, the acreage of each S-Class on the BTNF is provided. Together, these two values may be used to quickly evaluate the effect of a proposed treatment or policy. For example, if there is a 1,000 acre deficit of a particular S-Class and a 1,000 acre surplus of a suitable S-Class to recruit from through treatment (e.g., thinning closed stands to create open stands), then the treatment would move both classes back to the reference proportion. However, if there are only 500 acres of the surplus S-Class on BTNF land, the treatment would be ineffective at completely restoring the S-Classes. In addition, the geospatial data and summary spreadsheet results from this assessment are available for more detailed analysis (Appendix C).

- *Fire Regime Condition Class (FRCC) reporting*: The stand FRCC metric may be used for the reporting of treatment accomplishments in national databases such as the National Fire Plan Operations and Reporting System (NFPORS) and the Forest Service Activity Tracking System (FACTS). Although we did not discuss stand FRCC directly in this report, it is derived by grouping the S-Class relative amount metric into three classes (Table 19). The overall premise behind stand FRCC is that, from a departure perspective, there is no reason to modify the proportion of an S-Class that is either similar or deficit compared to the reference proportion. The information in the current S-Class distribution and departure summary tables within this report may be used to determine the pre- and post-treatment stand FRCC for meeting reporting requirements. Further direction is available in the 2010 Interagency Fire Regime Condition Class Guidebook (Barrett et al.2010).

Table 19: Relationship between S-Class relative amount and stand FRCC.

S-Class Relative Amount	Stand FRCC
Trace, under-represented, and similar	1
Over-represented	2
Abundant	3

Assumptions and Limitations

Given the uncertainty of any modeling exercise, the results of this report are best used to compare the relative, rather than absolute differences across the landscape. Interpretation, professional judgment, and local knowledge of vegetation dynamics and disturbance ecology were used to evaluate the inputs and outputs of the models used in this assessment, and adjustments were made as necessary to refine the predictions. This section discusses the primary assumptions and limitations of the data and modeling approach used in this assessment.

- The reference condition refers to an estimate of the vegetation composition and structure that may have existed under the landscape's historical disturbance regime prior to Euro-American settlement. It is assumed that the reference conditions used in this analysis represent conditions that are resilient to natural disturbances and capable of supporting future biodiversity at the landscape scale.

- Reference conditions may portray climatic conditions that are not representative of current or future conditions. It is assumed that reference conditions still provide an appropriate benchmark for assessing, and managing for, the ecological integrity of vegetative systems.

- Reference S-Class distributions are determined using non-spatial state and transition modeling methods. Reference conditions therefore do not account for topographic conditions unique to the area and their influence on disturbance processes and resulting spatial distribution of vegetation.

- Reference conditions used in this assessment represent the central tendency of S-Class distribution. The range and variation of reference condition modeling are not provided.

- The vegetation departure methodology used in this assessment describes only the current S-Class distribution in relation to reference distribution. Vegetation departure metrics presented in this report do not address the question of natural spatial patterns. For example, a low departure rating such as VCC 1 can result even where patch sizes and arrangements currently are beyond the natural range and variation.

- The BpS layer represents an estimate of the ecological systems that may have existed historically given an approximation of the historical disturbance regime. It is assumed that the BpSs and associated reference conditions are an appropriate estimate of that which existed on the landscape historically.

- Vegetation departure metrics are sensitive to the S-Class layer. It is assumed that the distribution of S-Classes as mapped by LANDFIRE and updated by project members accurately represent the current distribution of vegetation composition and structure on the landscape.

- LANDFIRE version 1.0.5 data were used for this assessment. These data are based on circa 2000 imagery and have not been adjusted for growth and development. It is assumed that the currency of the data will be considered when interpreting these results.

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Appendix A: Adjustments to S-Class Mapping Rules

This appendix shows changes made to S-Class mapping rules from those shown in the LANDFIRE vegetation dynamics models (LANDFIRE 2007). Model numbers are shown in parentheses.

Northern Rocky Mountain Subalpine Dry-Mesic Spruce-Fir (2110550)

- Raised max tree height of S-Classes C and D from 25 to 50 meters.
- Lowered minimum tree cover in S-Classes B and C from 20% to 10%.
- Remapped S-Class C to D where dry-mesic (2055) or mesic-wet (2056) existing vegetation types are present. This was necessary because the current LANDFIRE S-Class mapping rules are based solely on structure; but in the case of the Northern Rocky Mountain Subalpine Dry-Mesic Spruce-Fir BpS, the vegetation dynamics model specifies composition as a mapping variable.

Northern Rocky Mountain Subalpine Woodland and Parkland (2110460)

- Raised max tree height of S-Classes D and E from 25 to 50 meters.

Inter-Mountain Basins Montane Sagebrush Steppe (2111260)

- Raised minimum shrub cover in S-Class C from 20% to 30% to eliminate overlap.
- Raised max shrub height from 1 meter to "any" in S-Classes B and C.

Rocky Mountain Aspen Forest and Woodland (2010110)

- Raised max tree height of S-Classes C, D, and E from 25 to 50 meters.
- Lowered minimum tree cover in S-Class B from 20% to 10%.
- Remapped S-Class C to E where the existing vegetation type is not Rocky Mountain Aspen (2011). Like BpS 2110550 above, this is due to current LANDFIRE mapping rules not accounting for composition as in the vegetation dynamics models.

Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland (2120560)

- Raised max tree height of S-Classes D and E from 25 to 50 meters.

Middle Rocky Mountain Montane Douglas-fir Forest and Woodland (2111660)

- Lowered minimum tree cover in S-Classes C and D from 20% to 10%.

Appendix B: S-Class Transition Rules

The following table shows the updates made to S-Classes for wildfire (2000-2010) and insect disturbances (2000-2008). Not applicable (N/A) indicates that the disturbance did not occur in the BpS/S-Class combination.

Table 20: S-Class transitions by disturbance type and severity.

Biophysical Setting	S-Class	Wildfire Disturbance			Insect Disturbance		
		Low Severity	Moderate Severity	High Severity	3-13% Canopy Loss	15-39% Canopy Loss	>40% Canopy Loss
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	A	A	A	A	A	A	A
	B	B	B	A	B	B	B
	C	C	C	A	C	C	D
	D	D	D	A	D	D	D
	UN	UN	N/A	N/A	N/A	N/A	N/A
Northern Rocky Mountain Subalpine Woodland and Parkland	A	A	A	A	A	A	A
	B	B	C	A	B	B	C
	C	C	C	A	C	C	C
	D	D	D	A	D	D	D
	E	E	D	A	E	D	D
	UN	N/A	N/A	N/A	N/A	N/A	N/A
Inter-Mountain Basins Montane Sagebrush Steppe	A	A	A	A	N/A	N/A	N/A
	B	B	A	A	N/A	N/A	N/A
	C	C	A	A	N/A	N/A	N/A
	UN	UN	N/A	N/A	UN	UN	N/A
Rocky Mountain Aspen Forest and Woodland	A	A	A	A	A	A	A
	B	B	B	A	B	B	B
	C	C	C	A	N/A	N/A	N/A
	D	D	C	A	D	D	D
	E	E	C	A	E	E	D
	UN	UN	N/A	N/A	N/A	N/A	N/A
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	A	A	A	A	A	A	A
	B	B	C	A	B	C	C
	C	C	C	A	C	C	C
	D	D	D	A	D	D	C
	E	E	D	A	E	D	C
	UN	UN	N/A	N/A	UN	UN	N/A
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	A	A	A	A	A	A	A
	B	B	C	A	B	B	C
	C	C	C	A	C	C	C
	D	D	D	A	D	D	C
	E	E	D	A	E	D	C
	UN	N/A	N/A	N/A	N/A	N/A	N/A

Appendix C: – Data Overview

This appendix provides a general description of each of the data products that have been developed as a result of this assessment. Further application of these data will depend on the analysis objectives.

Directory	Subdirectory\File	Description
frccAnalysis	Ancillary\TetonBpSModels.pdf	Original LANDFIRE BpS model descriptions.
	Ancillary\Landscapes.shp	ESRI shapefile of assessment landscapes.
	Ancillary\teton_dst	Raster of disturbances (ESRI grid format) used to update S-Class for wildfire (2000-2010) and insect (2000-2008) disturbances.
	Input\frcc_bps	Raster (ESRI grid format) of the six BpSs assessed.
	Input\frcc_scls	Raster (ESRI grid format) of S-Class.
	Input\landscape	Raster (ESRI grid format) of assessment landscapes.
	Output\Logs	Directory of log files created by the FRCCmt.
	Output\ModifiedRasters	Directory of intermediate data created by FRCCmt.
	Output\Output.mdb	Geodatabase of tables created by FRCCmt.
	Output\Output	Output combine raster (ESRI grid format) created by FRCCmt.
	Output\RasterLayers	Directory containing ArcGIS layer files (.lyr) for displaying standard FRCC Mapping Tool symbology in ArcMap.
	Output\sclassrelamt	Raster (ESRI grid format) of S-Class relative amount.
	Output\standfrcc	Raster (ESRI grid format) of stand FRCC.
	Output\stratafrcc	Raster (ESRI grid format) of stratum VCC.
	Output\Output_Summary Report.xlxs	Standard FRCCmt summary report.
	Output\ResultsCMB.xlxs	Standard FRCCmt summary report reformatted with pivot table and pivot chart.