10460
Northern Rocky Mountain Subalpine Woodland and Parkland

BpS Model/Description Version: Aug. 2020

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Vegetation Type
Forest and Woodland

Map Zones
10, 19, 20

Geographic Range
Central and western Montana, and northern and central Idaho; limited distribution in northeastern Oregon and Washington.

Biophysical Site Description
Upper subalpine zone (6,000-9,500ft) on moderate to steep terrain (e.g., 40-70% slope). Landforms include ridgetops, mountain slopes, glacial trough walls and moraines, talus slopes, land and rock slides, and cirque headwalls and basins. Some sites have little snow accumulation because of high winds and sublimation, which increases summer drought conditions.

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

Vegetation Description
Forest communities range from nearly homogeneous stands of five-needled pines on the harshest, highest elevation sites to mixed species, including shade-tolerant subalpine fir, Engelmann spruce, and mountain hemlock on lower, moderate sites.

This Biophysical Site (BpS) has whitebark pine forests that occur in two high-mountain BPSs. On productive, upper subalpine sites, whitebark pine is the major seral species replaced by the more shade-tolerant subalpine fir, Engelmann spruce, and mountain hemlock, depending on geographic region (Arno and Weaver 1990). These sites, referred to as “seral whitebark pine sites,” support upright, closed-canopy forests in the upper subalpine lower transition to timberline, just above or overlapping the elevational limit of the shade-intolerant lodgepole pine, and the two species often share dominance. Other minor species found with whitebark pine on these sites are Douglas-fir, limber pine, and alpine larch. Sites where whitebark pine is the only tree species able to dominate high-elevation settings successfully (called “climax whitebark pine sites”) are on harsh sites in the upper subalpine forests and at treeline on relatively dry, cold slopes (Keane et al. 2012). Other species, such as subalpine fir, spruce, and lodgepole pine, can occur on these sites, but as scattered individuals with truncated growth forms. Alpine larch is often found on north-facing climax whitebark pine sites, often in association with sub-surface water (Arno and Habeck 1972). Whitebark pine can also occur as krummholz, elfin forests, clusters, groves, tree islands, and timber atolls in the alpine treeline ecotone and as a minor seral in lower subalpine sites. Limber pine may be present in southeastern and eastern Idaho, but in these MZs it is not typically a subalpine species (it favors lower treeline habitat). In this harsh, windswept environment, trees are often stunted and flagged from wind damage.

Whitebark pine is a keystone and foundation species in many of these forests (Tomback and Achuff 2010). Mature whitebark pine trees ameliorate local conditions on harsh sites and facilitate the establishment of less-hardy subalpine species. The seeds of whitebark pine provide an important food source for wildlife, particularly grizzly bears and Clark's nutcrackers. Whitebark pine also depends exclusively upon Clark's nutcrackers for seed dispersal and subsequent tree establishment.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
PIAL	*Pinus albicaulis*	Whitebark pine
ABLA	*Abies lasiocarpa*	Subalpine fir
PIEN	*Picea engelmannii*	Engelmann spruce
LALY	*Larix lyallii*	Subalpine larch
TSME	*Tsuga mertensiana*	Mountain hemlock

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

Disturbance Description

Fire regime is variable, typically mixed severity (25-75% top kill), with fire return interval (FRI) estimates ranging from 30- to 500-yr fires (Morgan et al. 1994; Arno 1986; Brown et al. 1994). As "seral" whitebark pine succeeds to subalpine fir over time, the fire regime shifts from mixed to stand-replacement severity (Keane 2001). Ignitions are frequent due to lightning, although fires seldom carry due to high-fuel moisture during most years and a possible lack of fuel from the slow-growing vegetation (Keane and Parsons 2010). Individual tree torching is more common. Non-lethal surface fires may dominate where continuous light fuel loading (i.e., grasses) exists (Kapler-Smith and Fischer 1995), but fires are typically small in extent and are not modeled here. Recent dendroecological data collected in whitebark pine forests near Missoula, in western Montana, found numerous small fires (mean fire return interval [MFRI] <50yrs) punctuated by less frequent larger fires (MFRI, 75-100yrs) and implicated large-scale climate variability (e.g., the Little Ice Age) as a driver of temporal changes in the fire regimes of these forest systems (Larson 2005). In the model for this BpS, a 200- to 300-yr return interval was used for mixed-severity fires following the Keane (2001) "Seral Whitebark Pine Model" for the Northern Rockies region.

Mountain pine beetle is a natural agent of mortality affecting five-needle pine. Infestations occur periodically and are a natural agent of disturbance in these systems. During epidemics, mountain pine beetle typically kills most large whitebark pine. Snow, wind, and other weather events may cause damage and transitions between classes.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI

Replacement	396	46	100	1000
Moderate (Mixed)	336	54		
Low (Surface)				
All Fires	182	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

Fires can range from individual trees to hundreds of acres, although topography and continuity of fuel beds influence fire spread.

Adjacency or Identification Concerns

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

Whitebark pine blister rust has decimated whitebark pine in the more mesic sites of whitebark pine ranges of this BpS (e.g., near Glacier National Park). Upper subalpine whitebark pine forests are rapidly declining throughout western North America because of the interacting and cumulative effects of historical and current mountain pine beetle (*Dendroctonus ponderosae Hopkins Coleopteran*: *Curculionidae*, *Scotlytinae*) outbreaks, fire exclusion policies, and the introduced pathogen *Cronartium ribicola*, which causes the disease whitepine blister rust in five-needle white pines (Keane and Arno 1993; Kendall and Keane 2001; Murray and Rasumussen 2003; Schwandt 2006; Tomback and Achuff 2010). To make matters worse, many feel that projected warmer future climates will severely reduce whitebark pine high-elevation habitat, restricting populations to the tops of mountains or to north of the Canadian border

Early grazing, fire suppression, and climate change may have altered natural fire frequency. Fire suppression tends to favor subalpine fir over whitebark pine. Subalpine fir stands are more likely to experience high-severity fire (due to lower crowns, greater crown bulk density, decreased fuel decomposition, etc.); this tends to shift the fire regime from mixed to stand replacement (Keane 2001). Live and dead trees are potential dendroclimatic resources.

Issues or Problems

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

Native Uncharacteristic Conditions

Comments

In 2016, Robert Keane (rkeane@fs.fed.us) reviewed this model and made descriptive edits to the text and changes to the ages for each s-class, and increased the FRI for mixed fire in the Open classes from 143yrs to 200yrs to make all FRIs fall within the 200- to 300-yr range suggested for the “Seral Whitebark Pine Model” for the Northern Rockies region by Keane (2001). MZ10, MZ19, and MZ20 were combined during 2015 BpS review.

For MZ19, additional reviewers included Steve Barrett (sbarrett@mtdig.net), Evan Larson (lars2859@umn.edu), Susan Miller (smiller03@fs.fed.us), Steve Rawlings (srawlings@fs.fed.us), and Cathy Stewart (cstewart@fs.fed.us).

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

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	C	C	C	B	B	B	B	B	B	B
Tree	10-25	D	D	D	D	E	E	E	E	E	E
Tree	25-50	D	D	D	D	E	E	E	E	E	E
Tree	>50	D	D	D	D	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 30 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	Pinus albicaulis	Whitebark pine	Upper
LALY	Larix lyallii	Subalpine larch	Upper
PICO	Pinus contorta	Lodgepole pine	Upper

Description

Early succession after moderately long to long interval replacement fires, and highly variable mixed-severity fire intervals. On more productive sites, trees can establish immediately after fire. Whitebark pine, limber pine, and subalpine larch are typically early pioneers. Lodgepole pine may be present. Trees establish as clumps or scattered individuals. Higher elevation sites are dominated by herbaceous species.

This class encompasses the extended shrub-herb-shrub-grass-forb stage defined by Keane (2001) to represent the possibility of delayed conifer regeneration for 10-50yrs following high-severity fires at upper elevations. The severity of the fire and the site conditions dictate the duration of this stage. *Vaccinium scoparium* and *Luzula hitchcockii* are indicators.

Maximum Tree Size Class
Sapling >4.5ft; <5" DBH

Class B 31 Mid Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	Pinus albicaulis	Whitebark pine	Upper
ABLA	Abies lasiocarpa	Subalpine fir	Upper
PIEN	Picea engelmannii	Engelmann spruce	Mid-Upper
PICO	Pinus contorta	Lodgepole pine	Upper

Description
Stands dominated by small diameter, with a mix of shade-tolerant and -intolerant species. High elevation or harsh sites may exhibit krummholz growth forms. Whitebark pine and subalpine larch are typically early pioneers on harsh sites.

Maximum Tree Size Class
Pole 5-9" DBH

Class C 12 Mid Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	Pinus albicaulis	Whitebark pine	Upper
LALY	Larix lyallii	Subalpine larch	Upper
PICO	Pinus contorta	Lodgepole pine	Upper

Description
Stands dominated by small diameter, with a mix of shade-tolerant and -intolerant species. High elevation or harsh sites may exhibit krummholz growth forms. Whitebark pine (especially on southern aspects) and subalpine larch (especially on northern aspects) are typically early pioneers on harsh sites. Limber pine may also occur on these sites.

Maximum Tree Size Class
Pole 5-9" DBH

Class D 5 Late Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	Pinus albicaulis	Whitebark pine	Upper
LALY	Larix lyallii	Subalpine larch	Upper
PICO	Pinus contorta	Lodgepole pine	Upper
			Upper

Description
Mid- to large-diameter mixed-conifer species in small to moderate size patches generally on southern aspects. Open canopy conditions occur on sites where soil is less developed or on wind-exposed, south-facing aspects. Whitebark pine (especially on southern aspects) and subalpine larch (especially on northern aspects) typically dominate.

Maximum Tree Size Class
Medium 9-21" DBH

Class E 22 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	Pinus albicaulis	Whitebark pine	Upper
ABLA	Abies lasiocarpa	Subalpine fir	Upper
PIEN	Picea engelmannii	Engelmann spruce	Upper

Description
Mid- to larger diameter mixed-conifer species in small to moderate patches. Subalpine fir is likely to encroach upon these sites. As elevation increases and high snowpack becomes limiting, stands are often only composed of subalpine fir; the snow is too deep for whitebark pine.

Maximum Tree Size Class
Medium 9-21" DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:CLS	79
Mid1:OPN	80	Late1:OPN	149
Mid1:CLS	80	Late1:CLS	149

Late1:OPN	150	Late1:OPN	999
Late1:CLS	150	Late1: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
Replacement Fire	Early1:ALL	Early1:ALL	0.001	1000	Yes	0
Wind or Weather or Stress	Early1:ALL	Early1:ALL	0.005	200	Yes	0
Competition or Maintenance	Early1:ALL	Early1:ALL	0.005	200	Yes	0
Alternative Succession	Early1:ALL	Mid1:OPN	0.01	100	Yes	0
Insects or Disease	Mid1:OPN	Mid1:OPN	0.002	500	No	0
Insects or Disease	Mid1:OPN	Early1:ALL	0.002	500	Yes	0
Wind or Weather or Stress	Mid1:OPN	Early1:ALL	0.003	333	Yes	0
Replacement Fire	Mid1:OPN	Early1:ALL	0.003	333	Yes	0
Mixed Fire	Mid1:OPN	Mid1:OPN	0.005	200	No	0
Alternative Succession	Mid1:OPN	Mid1:CLS	0.05	20	Yes	0
Competition or Maintenance	Mid1:CLS	Mid1:CLS	0.002	500	No	0
Replacement Fire	Mid1:CLS	Early1:ALL	0.002	500	Yes	0
Insects or Disease	Mid1:CLS	Mid1:OPN	0.003	333	Yes	0
Insects or Disease	Mid1:CLS	Early1:ALL	0.003	333	Yes	0
Mixed Fire	Mid1:CLS	Mid1:OPN	0.004	250	Yes	0
Wind or Weather or Stress	Mid1:CLS	Mid1:OPN	0.005	200	Yes	0
Insects or Disease	Late1:OPN	Mid1:OPN	0.001	1000	Yes	0
Insects or Disease	Late1:OPN	Late1:OPN	0.002	500	No	0
Insects or Disease	Late1:OPN	Early1:ALL	0.002	500	Yes	0
Replacement Fire	Late1:OPN	Early1:ALL	0.003	333	Yes	0
Mixed Fire	Late1:OPN	Late1:OPN	0.005	200	No	0
Wind or Weather or Stress	Late1:OPN	Late1:OPN	0.007	143	No	0

Alternative Succession	Late1:OPN	Late1:CLS	0.05	20	Yes	0
Insects or Disease	Late1:CLS	Mid1:OPN	0.002	500	Yes	0
Insects or Disease	Late1:CLS	Late1:OPN	0.002	500	Yes	0
Insects or Disease	Late1:CLS	Early1:ALL	0.003	333	Yes	0
Mixed Fire	Late1:CLS	Late1:OPN	0.004	250	Yes	0
Replacement Fire	Late1:CLS	Early1:ALL	0.005	200	Yes	0
Wind or Weather or Stress	Late1:CLS	Late1:OPN	0.006	167	Yes	0

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