LANDFIRE Biophysical Setting Model

Biophysical Setting 7316012 Western North American Boreal Treeline White Spruce Woodland - Alaska Sub-boreal

☑ *This BPS is lumped with: WNA Boreal Spruce-Lichen Woodland (in part)*

☑ *This BPS is split into multiple models: Western North American Boreal Treeline White Spruce Woodland was split into a boreal and sub-boreal variant for BpS modeling so that regional differences could be represented.*

Boreal Spruce Lichen Woodland may occur as a seral stage or variant of Boreal Treeline White Spruce Woodland, Boreal Mesic Black Spruce Forest, or, less commonly, in these same systems in the sub-boreal region.

General Information

Contributors (also see the Comments field **Date** 3/26/2008

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Vegetation Type

Forest and Woodland

Map Zone

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Model Zone

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

Dominant Species*

PIGL ALVI5
BENA SAPU15
VAUL
LEDUM

General Model Sources

☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

This system occurs throughout the boreal transition region of AK and west to the limit of tree growth. It is not common in the Kenai Mountains, where mountain hemlock dominates treeline forest types, but may be found in western Kenai highlands between Skilak and Tustemena lakes and in higher elevations of Caribou Hills north of Homer.

Boreal Spruce-Lichen Woodland, which is included as a variant of a later seral stage within this type, occurs commonly in the western and southwestern boreal transition region (Nulato Hills and Ahklun Mts).

Biophysical Site Description

This system occurs above White Spruce zone to 900m (Boggs et al. 2001) and below the subalpine shrub and tundra systems and can be seen as the forested transition zone between boreal white spruce forest and non-forested subalpine vegetation. Depending on the topography, this system can occupy a narrow band just below non-forested subalpine or a broad expanse across gently slopes and benches. This system also occurs at lower elevations at the western limit of white spruce. Soils are cold, but peat-forming mosses are not common in the ground layer (NatureServe 2008).

Vegetation Description

The Boreal Transition White Spruce Woodland occurs primarily near the elevational limit and the

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western limit of tree growth. Forest canopy cover is dominated by white spruce and is generally between 10-25% (NatureServe 2008). Picea mariana may be codominant in the overstory. Common shrub species include Betula nana, but other shrubs such as Vaccinium uliginosum, Ledum groenlandicum and Salix pulchra may be common or dominant. In some locations Alnus viridis is the dominant understory shrub. Feathermoss may be common in the in the ground layer (NatureServe 2008). On drier or more exposed sites, Cladina spp. replace feathermosses as the dominant ground cover (Viereck 1979). Lichen species may include Cladina arbuscula, C. mitis, C. rangiferina and C. stellaris, as well as Cetraria cucullata, Cetraria islandica, Cetraria nivalis, Bryoria spp., Alectoria nigricans and Alectoria ochroleuca.

Disturbance Description

There is little information about the fire return interval for this type. Experts at the LANDFIRE Anchorage workshop indicated that White Spruce Woodlands in the AK sub-boreal region burn less frequently than those in the interior boreal region. They estimated a fire return interval of about 300yrs.

Spruce bark beetle (Dendroctonus rufipennis) infestations are a major natural disturbance affecting this BpS. Beetle outbreaks in spruce forest occurred at an estimated return interval of every 52yrs on the Kenai Peninsula over the past 250yrs (Berg and Scott 2006). Outbreaks that thin stands and produce a growth release in surviving trees occur on average every 50yrs in white and Lutz spruce forests on the Kenai Peninsula (Berg 2004). Spruce bark beetle outbreaks that produce a more substantial thinning occur at longer intervals, with the last two severe infestations occurring in the 1870s-1880s and 1987-present (Berg 2004). The bark beetle outbreak that began in 1987 on the Kenai Peninsula has killed over 1.3 million acres of spruce (USDA Forest Service 2002). This recent outbreak is associated with warmer than average growing season temperatures that allowed beetles to mature in one year rather than two (Werner and Holsten 1985, Barber et al. 2000 as cited in Werner et al. 2006). Berg (2004) and Berg and Scott (2006) found no association between spruce bark beetle mortality and fire in the past.

When the canopy of these forests is thinned by spruce bark beetle-mortality, bluejoint grass (Calamagrostis canadensis) may proliferate rapidly from its pre-disturbance low level network of rhizomatous roots and may develop into a thick, seedling-excluding sod within a few years (Berg 2004). Boucher (2003) found that rapid spread of Calamagrostis occurs primarily on sites with deep, loamy soils. Boucher and Mead (2006) found that vegetation response varied following the recent outbreak in different geographic locations on the Kenai Peninsula. Some areas exhibited an increase in early seral species (e.g. Calamagrostis canadensis and Chamerion angustifolium); other areas exhibited an increase in late seral mountain hemlock, while in other areas vegetation composition did not shift substantially (Boucher and Mead 2006).

The following information was taken from the Ecological Systems draft description for Boreal Transition White Spruce Woodland (NatureServe 2008), which notes that fire information is lacking:
A possible scenario for post-fire succession in this type is the resprouting of low shrubs from underground propagules, followed by invasion of Picea glauca by seed from adjacent stands or surviving trees. Betula papyrifera may invade the site if a seed source is available and site conditions are favorable, but the hardwood phase only occurs on a small fraction of the landscape (may be more common in southwest AK). The typical succession sequence for this type does not include a hardwood sere. The rate of succession depends on severity of fire and seed source, and some sites may be shrub-dominated for long periods without spruce invasion.

Boreal Spruce-Lichen Woodland is included in this model as a possible variant of the late successional stage (class C). This is a best guess as to where this system fits, as its successional relationships are poorly

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understood.

Adjacency or Identification Concerns

This BpS is similar to the interior Boreal Treeline White Spruce Woodland BpS but it includes an insects and disease probability and a less frequent MFRI. Adjacent systems may include Alaska Sub-boreal White Spruce-Hardwood Forest or Western North American Boreal Mesic Scrub Birch-Willow Shrubland - Alaska Sub-boreal.

Native Uncharacteristic Conditions

Scale Description

Large patch

Issues/Problems

Very little information is available on the fire return interval for this type.

Comments

This model was based on input from the experts who attended the LANDFIRE Anchorage modeling meeting (Dec. 07) with additional refinement by Tina Boucher and Kori Blankenship. It is similar to Western North American Boreal Treeline White Spruce Woodland - Boreal but includes insects and disease probability and a less frequent MFRI. Beth Schulz reviewed an initial draft of this model.

Vegetation Classes

Class A **5%**

Early Development 1 All Structures

Upper Layer Lifeform

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

Indicator Species* and Canopy Position

BENA	Upper
VAUL	Upper
LEGR	Upper
SAPU15	Upper

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	Open Shrub (25-74% shrub cover)	Closed Shrub (> 75% shrub cover)
Height	Dwarf Shrub (< 20 cm)	Low Shrub (20 cm to 1.5 m)
Tree Size Class	Seedling/Sapling <5"	

☐ Upper layer lifeform differs from dominant lifeform.

This class may uncommonly include tall shrubs.

Description

0-24yrs

Post disturbance regeneration: herbaceous to low shrub. Shrubs resprout from underground propagules and then Picea glauca invades by seed from adjacent stands or surviving trees. The shrub layer typically features Betula nana, but other shrubs such as Vaccinium uliginosum, Ledum groenlandicum and Salix pulchra may be common or dominant. In some locations Alnus viridis is the dominant understory shrub. Feathermoss may be present in the in the ground layer.

The rate of succession depends on severity of fire and seed source, and some sites may be shrub-dominated for long periods without spruce invasion. The typical succession sequence for this type does not include a hardwood sere (class B).

Succession to class C. Replacement MFRI = 400yrs. Alternate succession (probability = 0.04) causes a transition to class B and represents sites where Betula papyrifera may invade if a seed source is available and

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site conditions are favorable.

Class B 5 %

Mid Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Indicator Species* and Canopy Position

PIGL	Upper
BEPA	Upper
BENA	Lower
	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	Woodland (10-24% tree cover)	Open (25-59% tree cover)
Height	Tree (> 3 m)	Tree (> 3 m)
Tree Size Class	Pole 5–9" (swd)/5–11" (hwd)	

☐ Upper layer lifeform differs from dominant lifeform.

Presence of hardwoods distinguishes class B from C.

Description

25-69yrs

Woodland to open hardwood or white spruce-hardwood mix. Tree saplings gain canopy dominance over shrubs. Forest canopy cover is generally 10-25%. Betula papyrifera invades and stands may be either hardwoods or a spruce-hardwood mix.

Succession to class C. Replacement MFRI = 400yrs. Mixed fire (MFRI = 1000yrs) maintains this class.

Class C 90 %

Late Development 1 Open

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Indicator Species* and Canopy Position

PIGL	Upper
BENA	Low-Mid
VAUL	Low-Mid
CLADI3	Lower

Structure Data (for upper layer lifeform)

	Min	Max
Cover	Woodland (10-24% tree cover)	Open (25-59% tree cover)
Height	Tree (> 3 m)	Tree (> 3 m)
Tree Size Class	Med. 9–20" (swd)/11–20" (hwd)	

☐ Upper layer lifeform differs from dominant lifeform.

Absence of hardwoods distinguishes class C from B.

Description

25yrs+

Open white spruce woodland. Site is dominated by mature conifers. Forest canopy cover is generally 10-25%. Hardwoods, if previously present in the stand, lose dominance in overstory during this phase. The understory may include various combinations of low shrubs, herbs and mosses. Feathermoss are often common in the ground layer. On drier or more exposed sites, Cladina spp. replace feathermosses as the dominant ground cover (Viereck 1979). Lichens may become more common in older stands, with some sites developing into Spruce-Lichen Woodland. Clidina species include C. arbuscula, C. mitis, C. rangiferina, and C. stellaris. Other lichens include Cetraria cucullata, C. islandica, C. nivalis, Bryoria spp., Alectoria nigricans and Alectoria ochroleuca.

This class will persist in the absence of disturbance. Replacement MFRI = 400yrs. Mixed fire (MFRI = 1000yrs) maintains this class. Insects and disease (probability = 0.02) will thin large overstory trees but will not cause a state transition.

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Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover		
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover		
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** V

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

☐ Literature
☐ Local Data
☑ Expert Estimate

Fire Intervals

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	398			0.00251	72
Mixed	1036			0.00097	28
Surface					
All Fires	287			0.00349	

Fire Intervals (FI):

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

Additional Disturbances Modeled

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

References

Barber, V.A., Juday, P.A., Finney, B., 2000. Reduced growth of Alaskan white spruce in the twentieth century from temperature induced drought stress. Nature 405: 668–673.

Berg, E. 2004. White spruce fire history on the Kenai Peninsula, Alaska, based on radiocarbon-dated soil charcoal. Unpublished manuscript. Kenai National Wildlife Refuge, Alaska.

Berg, E.E and R.S. Anderson. 2006. Fire history of white and Lutz spruce forests on the Kenai Peninsula, Alaska, over the last two millennia as determined from soil charcoal. Forest Ecology and Management 227(3): 275-283.

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Berg, E.E, J.D. Henry, C.L. Fastie, A.D. De Volder and S.M. Matsuoka. 2006. Spruce beetle outbreaks on the Kenai Peninsula, Alaska, and Kluane National Park and Reserve, Yukon Territory: Relationship to summer temperatures and regional differences in disturbance regimes. Forest Ecology and Management 227(3): 219-232.

Boggs, K., A. Garibaldi, J. Stevens, J. Grunblatt and T. Helt. 2001. Denali National Park and Preserve Landcover mapping project. Volume 2: Landcover classes and plant associations. Alaska Natural Heritage Program, Environment and Natural Resources Institute, University of Alaska Anchorage, 707 A Street, Anchorage, AK. 164 pp.

Boucher, T.V. 2003. Vegetation response to prescribed fire in the Kenai Mountains, Alaska. Research Paper PNW-RP-554. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 59 pp.

Boucher, T.V. and B.R. Mead. 2006. Vegetation change and forest regeneration on the Kenai Peninsula, Alaska following a spruce beetle outbreak, 1987–2000.
Forest Ecology and Management 227(3): 233-246.

Foote, J.M. 1983. Classification, description, and dynamics of plant communities after fire in the taiga of interior Alaska. Res. Pap. PNW-307. Portland, OR. USDA Forest Service. Pacific Northwest Research Station. 108 pp.

Matsuoka, S.M., E.H. Holsten, M.E. Shephard, R.A. Werner and R.E. Burnside. 2006. Spruce beetles and forest ecosystems of south-central Alaska. Forest Ecology and Management 227(3): 193-194.

NatureServe. 2008. International Ecological Classification Standard: Terrestrial Ecological Classifications. Draft Ecological Systems Description for Alaska Boreal and Sub-boreal Regions.

USDA Forest Service. 2002. Revised land and resource management plan, final
environmental impact statement. Alaska Region Chugach National Forest. R10-MB-480d, May 2002.

Viereck, L.A. 1979. Characteristics of treeline plant communities in Alaska. Holarctic Ecology. 2: 228-238.

Werner, R.A. and Holsten, E.H., 1985. Effect of phloem temperature on development of spruce beetles in Alaska. In: Safrankik, L. (Ed.), The Role of the Host in the Population Dynamics of Forest Insects. For. Can., Pac. For. Cent. Victoria, British Columbia, pp. 155–163.

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