16012

Western North American Boreal Treeline White Spruce-Hardwood Woodland - Boreal Transition

BpS Model/Description Version: Nov. 2024

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| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
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| None | None | None | None |

Reviewer: Ilana Abrahamson, Lindsey Flagstad, Beth Schulz, Anjanette Steer

Vegetation Type

Forest and Woodland

Map Zones

73, 74, 75, 77, 78

Model Splits or Lumps

This Biophysical Setting (BpS) is split into multiple models:

This BpS was split into Boreal and Boreal Transition variants so that regional differences in disturbance regimes could be modeled. The Hardwood split represent areas where hardwoods dominate. For mapping BpS 16012 should apply in level 2 ecoregions (Nowaki et al. 2001): Alaska Range Transition, Pacific Mountains Transition, Coast Mountains Transition, Coastal Rainforests.

Geographic Range

This system occurs commonly throughout the boreal transition region of Alaska, including the mountain ranges of southcentral Alaska, from the Alaska Range, west along the southern Alaska Peninsula 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. This BpS description and model focuses on the boreal transition region.

Biophysical Site Description

This BpS occurs near the elevational limits of white spruce tree growth. Topographies include sideslopes, rolling hills, and relatively level terrain. Soils are generally well-drained, cold, shallow, and develop on colluvial deposits, glacial till, or bedrock. High elevation sites are typically well-drained uplands with southerly aspects. At its elevational limits, the system can be conceptualized as the transition zone between white spruce forest and non-forested subalpine vegetation. Depending on the topography, the elevational expression of this system can occupy a narrow band just below non-forested subalpine or a broad expanse across gentle slopes and benches. This system also occurs at lower elevations at the western limit of white spruce growth where terrain is typically gentle, and permafrost is continuous.

Vegetation Description

Forest canopy cover is dominated by *Picea glauca* and is generally between 10% and 25% (NatureServe 2008). *Picea mariana* may be codominant in the overstory on some sites. *Betula papyrifera* *var*. *kenaica* may also be present. Trees are often stunted on exposed sties (Jorgenson et al. 2003).

Common understory shrubs include *Betula nana*, but other shrubs such as *Vaccinium uliginosum, Vaccinium vitis-idaea, Ledum groenlandicum, Ledum* *palustre* ssp. *decumbens, Empetrum nigrum, Salix pulchra, Salix glauca, Viburnum edule, Rosa acicularis,* and *Arctostaphylos* spp. may be common or dominant. In some locations *Alnus viridis* ssp*. sinuata* is the dominant understory shrub.

Herbaceous species are sparse but may include a variety of species such as *Calamagrostis canadensis, Pyrola* spp., and *Aconitum delphinifolium* (Viereck 1979, Jorgenson et al. 2003). Feathermosses 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 *Flavocetraria cucullata, Cetraria islandica, Cetraria nivalis, Bryoria* spp., *Alectoria nigricans,* and *Alectoria ochroleuca*.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| PIGL | *Picea glauca* | White spruce |
| BEPAK | *Betula papyrifera var. kenaica* | Kenai birch |
| BENA | *Betula nana* | Dwarf birch |
| VAUL | *Vaccinium uliginosum* | Bog blueberry |
| LEGR | *Ledum groenlandicum* | Bog Labrador tea |
| ALVIS | *Alnus viridis ssp. sinuata* | Sitka alder |
| SAPU15 | *Salix pulchra* | Tealeaf willow |

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

Disturbance Description

There is little information about the fire return interval for this type (Abrahamson 2014). White spruce woodlands in the sub-boreal region burn less frequently than those in the interior boreal region (Abrahamson 2014). Experts at the LANDFIRE National Anchorage workshop estimated a fire return interval of about 300yrs. As of 2014 there was no information on fire type, fire severity, fire intensity, fire pattern, or fire size in this BpS (Abrahamson 2014).

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 these woodlands are 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).

A possible scenario for post-fire succession in this BpS is the resprouting of low shrubs from underground propagules, followed by invasion of *Picea glauca* by seed from adjacent stands or surviving trees (NatureServe 2008). *Betula papyrifera var. kenaica* 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 and may be more common in southwestern 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. In 2022 a reviewer noted that research on the Swan Lake fire (2019) will help answer some of these questions about successional patterns in the areas of the treeline where it burned.

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 401 | 73 |  |  |
| Moderate (Mixed) | 1062 | 27 |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 291 | 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

Large patch

Adjacency or Identification Concerns

Adjacent systems may include Alaska Sub-boreal White Spruce-Hardwood Forest or Western North American Boreal Mesic Scrub Birch-Willow Shrubland - Alaska Sub-boreal.

Issues or Problems

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

Native Uncharacteristic Conditions

The frequency and severity of beetle outbreaks will likely increase under a warmer climate. Spruce bark beetle has had substantial effects on spruce communities in southcentral Alaska, increasing fire danger and fueling lightning strikes.

Abrahamson (2014) includes more information about the effects of climate change on white spruce treeline communities.

Comments

Review Comments:

-A reviewer questioned whether the Berg and Scott 2006 estimate for beetle frequency was appropriate for treeline sites? See Disturbance Description.

-A reviewer asks: “Is it odd that the neighboring (and lower elevation) system Alaska Sub-boreal White Spruce-Hardwood Forest (19790) has a much longer modeled mean fire return interval (MRFI) of 625 years? Wouldn’t you expect a treeline site to have a longer MFRI due to shorter snow-free season and less fuel?”

10/2021 This description was updated by NatureServe staff and Kori Blankenship based on the updated Ecological Systems classification for Alaska. Edits focused on adjusting the Geographic Range, Biophysical Site Descriptions, and Vegetation Description sections.

For LANDFIRE National 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 fire return interval. Beth Schulz reviewed an initial draft of this model. This model did not receive review specifically for z76.

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 | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf |
| Tree | 5-10 | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf |
| Tree | 10-25 | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf |
| Tree | 25-50 | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf |
| Tree | >50 | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf | B brdlf |
| Tree | 0-5 | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix |
| Tree | 5-10 | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix |
| Tree | 10-25 | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix |
| Tree | 25-50 | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix |
| Tree | >50 | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix | B mix |
| Tree | 0-5 | C con | C con | C con | C con | C con | C con | C con | C con | C con | C con |
| Tree | 5-10 | C con | C con | C con | C con | C con | C con | C con | C con | C con | C con |
| Tree | 10-25 | C con | C con | C con | C con | C con | C con | C con | C con | C con | C con |
| Tree | 25-50 | C con | C con | C con | C con | C con | C con | C con | C con | C con | C con |
| Tree | >50 | C con | C con | C con | C con | C con | C con | C con | C con | C con | C con |

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 4 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| BENA | *Betula nana* | Dwarf birch | Upper |
| VAUL | *Vaccinium uliginosum* | Bog blueberry | Upper |
| LEGR | *Ledum groenlandicum* | Bog labrador tea | Upper |
| SAPU15 | *Salix pulchra* | Tealeaf willow | Upper |

Description

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* ssp*. sinuata* is the dominant understory shrub. Feathermoss may be present 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. *Betula papyrifera var. kenaica* may invade if a seed source is available and site conditions are favorable.

*Maximum Tree Size Class*  
Seedling/Sapling <5"

Class B 6 Mid Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIGL | *Picea glauca* | White spruce | Upper |
| BEPA | *Betula papyrifera var. keniaca* | Paper birch | Upper |
| BENA | *Betula nana* | Dwarf birch | Lower |

Description

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 var. kenica* invades and stands may be either hardwoods or a spruce-hardwood mix.

*Maximum Tree Size Class*  
Pole 5–9" (swd)/5–11" (hwd)

Class C 90 Late Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIGL | *Picea glauca* | White spruce | Upper |
| BENA | *Betula nana* | Dwarf birch | Low-Mid |
| VAUL | *Vaccinium uliginosum* | Bog blueberry | Low-Mid |
| CLADI3 | *Cladina* spp. | Reindeer lichen | Lower |

Description

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. Cladina species include *C. arbuscula, C. mitis, C. rangiferina,* and *C. stellaris*. Other lichens include *Flavocetraria cucullata, C. islandica, C. nivalis, Bryoria* spp., *Alectoria nigricans,* and *Alectoria ochroleuca*. Insects and disease can thin large overstory trees.

*Maximum Tree Size Class*  
Med. 9–20" (swd)/11–20" (hwd)

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Late1:OPN | 24 |
| Mid1:OPN | 25 | Late1:OPN | 69 |
| Late1:OPN | 25 | Late1:OPN | 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** |
| Alternative Succession | Early1:ALL | Mid1:OPN | 0.04 | 25 | Yes | 0 |
| Replacement Fire | Early1:ALL | Early1:ALL | 0.0025 | 400 | Yes | 0 |
| Mixed Fire | Mid1:OPN | Mid1:OPN | 0.001 | 1000 | No | 0 |
| Replacement Fire | Mid1:OPN | Early1:ALL | 0.0025 | 400 | Yes | 0 |
| Mixed Fire | Late1:OPN | Late1:OPN | 0.001 | 1000 | No | 0 |
| Insects or Disease | Late1:OPN | Late1:OPN | 0.02 | 50 | No | 0 |
| Replacement Fire | Late1:OPN | Early1:ALL | 0.0025 | 400 | Yes | 0 |

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