16030

**Western North American Boreal Spruce-Lichen Woodland**

BpS Model/Description Version: Nov. 2024

|  |  |  |  |
| --- | --- | --- | --- |
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Vegetation Type

Forest and Woodland

Map Zones

67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78

Model Splits or Lumps

The Western North American Boreal White Spruce-Hardwood Forest Biophysical Setting (BpS) is lumped into this BpS.

Geographic Range

This BpS is found from the southern slopes of the Brooks Range to southcentral Alaska, west to the limit of tree growth, and throughout interior boreal Alaska, extending south and eastward into adjacent provinces and territories of Canada.

Biophysical Site Description

The montane *Picea glauca* forests occur on rolling hills, inactive terraces, and mountain side slopes up to the elevational limit of treeline. Soils are typically derived from glacial or other depositional processes. This BpS is found on a variety of landforms including forests stabilized dunes, lacustrine deposits (former lake beds), moraines, drumlins, eskers, kettle-kame, colluvial mountain and hill slopes, alluvial fan, floodplains, and loess deposits. These systems commonly occur on well-drained upland terrain on west, east, and south aspects, but are possible on all aspects. Continuous permafrost underlies this system in map zones 68, 69, 71, 70 and becomes discontinuous moving south in zones 73 and 74. Soil surveys of the Yukon Flats Lowlands found permafrost was common under well to moderately well drained white spruce forests on inactive terraces as long as there were thick layers of silty loess and/or alluvium.

Boreal Spruce-Lichen Woodland (a BpS lumped in with this BpS) occurs most commonly on cool, well-drained sites with thin soils and can also occur on somewhat excessively drained soils of inactive terraces that have sand and gravels at the soil surface ([ECOLOGICAL SITE XA232X01Y250).](https://edit.jornada.nmsu.edu/catalogs/esd/232X/XA232X01Y250)

Vegetation Description

Canopy cover in mature stands is dominated by *Picea glauca* and typically ranges from 25-80%, except in the case of Boreal Spruce-Lichen Woodland, which has a more open canopy (10-25% cover). Other hardwood species such as *Betula neoalaskana*, *Populus balsamifera,* and *Populus tremuloides* may be subdominant in the overstory, but *Picea glauca* contributes at least 75 % of the total forest canopy in the forested type (NatureServe 2008). Mature stands are often open-canopied with a well-developed shrub layer. The woodland type may be dominated by *Picea mariana* in select abandoned floodplains found adjacent to moist *Picea mariana* wetland types. The understory is open shrub or herbaceous.

Common understory shrubs include *Alnus* spp., *Arctostaphylos uva-ursi, Vaccinium vitis-idaea, V. uliginosum, Betula nana, Empetrum nigrum, Ledum glandulosum, Rosa acicularis, Salix glauca, Viburnum edule*, and *Linnaea borealis*. *Arctostaphylos rubra* and *Shepherdia canadensis* are typically found on dryer sites (Viereck et al. 1992). In the Nulato Hills, *Spirea stevenii* and *Cornus suecica* are relatively consistent indicators of this BpS. Common herbaceous species include *Chamerion angustifolium* ssp*. angustifolium* and *Calamagrostis canadensis*. Other herbaceous species can include *Equisetum sylvaticum, E. arvense, Geocaulon lividum, Mertensia paniculata, Pyrola* spp., *Cnidium cnidiifolium*, *Calamagrostis purpurascens*, and *Goodyera repens* (Viereck et al. 1992). Feather mosses such as *Hylocomium splendens* and *Pleurozium schreberi* are common in the ground layer of the forested type (Boggs and Sturdy 2005). In the mature woodland type, feather mosses are less important, while lichens, primarily *Cladina* spp. and *Flavocetraria cucullate,* form a very important component of the understory.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| PIGL | *Picea glauca* | White spruce |
| PIMA | *Picea mariana* | Black spruce |
| BEPA | *Betula papyrifera* | Paper birch |
| POTR5 | *Populus tremuloides* | Quaking aspen |
| ARUV | *Arctostaphylos uva-ursi* | Kinnikinnick |
| VAVI | *Vaccinium vitis-idaea* | Lingonberry |
| CHANA2 | *Chamerion angustifolium ssp. angustifolium* | Fireweed |

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

Disturbance Description

The disturbance regime of boreal white spruce forests is characterized by large crown fires with estimates of mean fire frequency varying widely (Abrahamson 2014). Boreal white spruce fire regimes are influenced by the surrounding vegetation matrix and are therefore difficult to distinguish (Abrahamson 2014). White spruce has thin bark and is typically killed by fire. Except in the case of severe fires, post-fire succession tends to return to the pre-disturbance forest type (Foote 1983). After moderately severe fire this system is most likely to return to a hardwood-dominant phase before recovery to a mixed spruce-hardwood system. On light to moderate burns, pre-burn species colonize the site via rhizomes, root sprouts, and trunk sprouts. A variety of herbaceous communities dominate, primarily *Chamerion angustifolium* ssp*. angustifolium* and *Calamagrostis canadensis*. *Betula neoalaskana, Populus tremuloides,* or *Picea glauca* may individually invade and dominate sites, but eventually *Picea glauca* gains dominance over hardwoods. In severe portions of fires, the organic layer is consumed, killing the underground propagules, and revegetation of the site is by seed from in-situ seed banks, windblown seed and from nearby *Populus tremuloides* suckers that sprout post-fire (Howard 1996). *Picea glauca* establish in severe burned areas with the seeds coming from offsite (Cater and Chapin 2000; Johnstone and Chapin 2003; Mann and Plug 1999; Viereck 1973; Zasada et al. 1992). *Picea mariana* is better adapted than *Picea glauca* to cold ground and quickly recolonizes the shadier sites following severe fire (Boggs and Sturdy 2005). This is also largely due to *Picea mariana* having serotinous cones.

A typical successional sequence progresses from herbaceous to shrub to hardwood/hardwood-spruce and finally to spruce after 100 to 150 years (Foote 1983). Successional trajectories vary regionally across the boreal region and are locally affected by slope, aspect, and hydrology however, dominant patterns of post-fire community composition and abundance are primarily related to gradients in fire severity (Hollingsworth et al. 2013). Other factors affecting successional sequence include permafrost depth, elevation, soil temperature, and soil moisture. At higher latitudes, *Betula neoalaskana* is often absent from the early-seral forests. In upland spruce stands post-burn succession occasionally skips the hardwood/hardwood-spruce stage and proceeds directly to a spruce dominated stage (Viereck et al. 1992). The former successional scenario is typical of the Fairbanks area and the Yukon Flats Lowlands while the latter is more common around Yukon Charley, Noatak, NE boreal, and at higher elevations. Boreal Spruce-Lichen Woodland may occur as an early successional phase on recently abandoned floodplains or as a very late successional stage of this system.

Post-fire regeneration of white spruce appears to be more successful when fires occur in mast years (Peters et al. 2005). This interaction between fire, masting, and subsequent tree regeneration could have implications for historical stand structure and successional dynamics over time (Peters et al. 2005).

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 253 | 60 |  |  |
| Moderate (Mixed) | 373 | 40 |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 151 | 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

This BpS most commonly manifests on the landscape as an extensive and contiguous type, but it can also occur in a matrix with other vegetation types. Crown fires were typically large patch occurrences.

Adjacency or Identification Concerns

This system may be found alongside any boreal black spruce or hardwood system.

Issues or Problems

It should be noted that there is a considerable variation across the range of this community type. This description and the associated model attempt to capture the most common attributes of the system across its range.

Only a few studies report fire regime information for white spruce forests and they are limited primarily to map zone 70, which may not be representative of fire regimes elsewhere in Alaska (Abrahamson 2014).

Native Uncharacteristic Conditions

Recent warmer and drier conditions, along with human activities including fire suppression and some logging practices have likely increased the current frequency and severity of spruce bark beetle outbreaks compared with pre-settlement conditions.

Comments

12/2022 – The fire frequency of this system was adjusted based on feedback from experts who

attended the Boreal Forest BpS Review Work Session in February 2022. At that session,

participants ranked the boreal forest BpS by relative fire frequency. Based on that ranking it was

estimated that this BpS would have a mean fire return interval of approximately 150-200 years.

More information on fire in Alaskan white spruce communities can be found in the Fire Effects Information System Synthesis: [Fire regimes of Alaskan white spruce communities](https://www.fs.fed.us/database/feis/fire_regimes/AK_white_spruce/all.html) (Abrahamson 2014).

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.

This system was created during LANDFIRE National for the AK Boreal region and reviewed by Tina Boucher for that region. It did not receive review for other regions in the state.

This model was based on input from the experts who attended the LANDFIRE Fairbanks modeling meeting (Nov. 07) and refined by Robert Lambrecht. Experts from this workshop indicated the potential need for a self-replacement spruce model and another for the short-term mix of spruce and hardwood. This model represents both concepts using a deterministic pathway to represent the more common spruce-hardwood pathway and an alternate succession pathway to represent the less common spruce-spruce pathway.

This model may need to be split into two regional variants: this model to cover most of the boreal region and a variant with a lower fire return interval and no birch, to apply to the Copper River Basin and the Wrangell Mountains.

Though Robert Lambrect originally lumped Western North American Boreal Spruce-Lichen Woodland into this model as a late seral stage, a reviewer suggested that the Spruce Lichen Woodland would be a better fit as a seral stage of the Boreal and Sub-boreal Treeline White Spruce Woodland and the Mesic Black Spruce Forest models. Colleen Ryan removed the reference to the lump in this model but did not alter the description or state-and-transition simulation model. The model still includes a seral stage with lichens.

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 | B | B | B | B | B | B | B | B | B | B |
| Shrub | 0.5-1.0 | B | B | B | B | B | B | B | B | B | B |
| Shrub | 1.0-3.0 | B | B | B | B | B | B | B | B | B | B |
| Shrub | >3.0 | B | B | B | B | B | B | B | B | B | B |
| Tree | 0-5 | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf |
| Tree | 5-10 | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf |
| Tree | 10-25 | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf |
| Tree | 25-50 | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf |
| Tree | >50 | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf |
| Tree | 0-5 | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix |
| Tree | 5-10 | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix |
| Tree | 10-25 | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix |
| Tree | 25-50 | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix |
| Tree | >50 | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix |
| Tree | 0-5 | D con | D con | D con | D con | D con | D con | D con | D con | D con | D con |
| Tree | 5-10 | D con | D con | D con | D con | D con | D con | D con | D con | D con | D con |
| Tree | 10-25 | E con | E con | E con | E con | E con | E con | E con | E con | E con | E con |
| Tree | 25-50 | E con | E con | E con | E con | E con | E con | E con | E con | E con | E con |
| Tree | >50 | E con | E con | E con | E con | E con | E con | E con | E con | E con | E 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 2 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| CHANA2 | *Chamerion angustifolium* ssp*. angustifolium* | Fireweed | Upper |
| EQSY | *Equisetum sylvaticum* | Woodland horsetail | Upper |
| EQAR | *Equisetum arvense* | Field horsetail | Upper |

Description

Post disturbance regeneration. A variety of herbaceous communities dominate; primarily *Chamerion angustifolium* ssp*. angustifolium* and *Calamagrostis canadensis*. Other herbaceous species can include *Equisetum sylvaticum* and *E. arvense* (Viereck et al. 1992). Shrubs and trees resprout from root stocks, but woody cover is low.

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

Class B 8 Early Development 2 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| ARUV | *Arctostaphylos uva-ursi* | Kinnikinnick | Upper |
| VAVI | *Vaccinium vitis-idaea* | Lingonberry | Upper |
| BENA | *Betula nana* | Dwarf birch | Upper |
| LEGL | *Ledum glandulosum* | Western Labrador tea | Upper |

Description

This stage is dominated by shrubs and saplings. Common shrub species include *Rosa acicularis, Viburnum edule, Betula nana, Ledum glandulosum, Vaccinium vitis-idaea, V. uliginosum,* and *Empetrum nigrum*. *Arctostaphylos uva-ursi, Arctostaphylos rubra,* and *Shepherdia canadensis* are typically found on dryer sites (Viereck et al. 1992). *Betula neoalaskana* and *Populus tremuloides* saplings are common on some sites.

The alternate succession pathway represents self-replacing white spruce stands in areas where there is no adjacent hardwood seed source (e.g., Noatak, NE boreal and higher elevation) or suckering from *Populus tremuloides*.

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

Class C 23 Mid Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| BEPA | *Betula neoalaskana* | Paper birch | Upper |
| POTR5 | *Populus tremuloides* | Quaking aspen | Upper |
| PIGL | *Picea glauca* | White spruce | Upper |
| ROAC | *Rosa acicularis* | Prickly rose | Upper |

Description

This is predominantly a hardwood forest although conifers may be present and mixed with the hardwoods. Trees begin to shade out the shrub understory. The overstory dominants include *Betula neoalaskana* and *Populus tremuloides*. *Picea glauca* and *P. mariana* may be present. Common understory species include *Rosa acicularis, Viburnum edule, Arctostaphylos* spp., *Linnaea borealis, Chamerion angustifolium,* and *Geocaulon lividum*.

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

Class D 7 Mid Development 2 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIGL | *Picea glauca* | White spruce | Upper |
| BENA | *Betula nana* | Dwarf birch | Lower |
| ROAC | *Rosa acicularis* | Prickly rose | Lower |
| VIED | *Viburnum edule* | Squashberry | Lower |

Description

This class represents mid-seral, self-replacing white spruce stands in areas where there is no adjacent hardwood seed source or geographic areas that tend to lack the hardwood component such as the Noatak, NE boreal region, and higher elevations. *Picea glauca* dominates the overstory but *P. mariana* may be present.

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

Class E 60 Late Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIGL | *Picea glauca* | White spruce | Upper |
| ARRU | *Arctostaphylos rubra* | Red fruit bearberry | Lower |
| VAVI | *Vaccinium vitis-idaea* | Lingonberry | Lower |
| BENA | *Betula nana* | Dwarf birch | Lower |

Description

Mature spruce forest. Hardwoods senesce. Accumulation of evergreen litter begins to change soil characteristics and allows feather mosses to form a carpet. *Picea glauca* dominates the overstory but *P. mariana* may be present. Common understory species include *Shepherdia canadensis, Vaccinium vitis-idaea, Arctostaphylos* spp., *Linnaea borealis,* and *Geocaulon lividum*.

This stage incorporates the concept of Boreal Spruce-Lichen Woodland. On colder, organic rich soils, the understory develops to a feather moss carpet with minor contributions of forbs (e.g., *Mertensial paniculata*) and Thallose lichens (e.g. *Peltigera apthosa*). Less commonly and on well-drained mineral soils with shallow bedrock this system may transition to a spruce-lichen woodland where lichens, primarily *Cladina* spp., are a very important component of the understory. Feather mosses are not as important as in other white spruce systems.

*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 | Early2:ALL | 4 |
| Early2:ALL | 5 | Mid1:OPN | 29 |
| Mid1:OPN | 30 | Late1:OPN | 129 |
| Mid2:OPN | 30 | Late1:OPN | 129 |
| Late1:OPN | 130 | 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** |
| Replacement Fire | Early1:ALL | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Alternative Succession | Early2:ALL | Mid2:OPN | 0.01 | 100 | Yes | 0 |
| Replacement Fire | Early2:ALL | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Mixed Fire | Mid1:OPN | Mid1:OPN | 0.003 | 333 | No | 0 |
| Replacement Fire | Mid1:OPN | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Mixed Fire | Mid2:OPN | Mid2:OPN | 0.003 | 333 | No | 0 |
| Replacement Fire | Mid2:OPN | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Mixed Fire | Late1:OPN | Late1:OPN | 0.003 | 333 | No | 0 |
| Replacement Fire | Late1:OPN | Early1:ALL | 0.004 | 250 | Yes | 0 |

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