16041

Western North American Boreal Mesic-Wet Black Spruce Forest and Woodland – Boreal

Model Date: 03/12/08 Report Date: 9/11/15

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| --- | --- | --- | --- |
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Reviewer

Janet Fryer

Vegetation Type

Forest and Woodland

Map Zones

68, 69, 70, 71, 72, 73, 74, 76

Model Splits or Lumps

Western North American Boreal Mesic-Wet Black Spruce Forest and Woodland was split into a Boreal and Sub-boreal variant for BpS modeling so that regional differences could be represented.

Western North American Boreal Spruce-Lichen Woodland (BpS 1602) 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.

Geographic Range

This type occurs throughout the boreal region of AK and into MZ76.

Biophysical Site Description

This type is typically found on upland slopes and inactive alluvial deposits (NatureServe 2008). Soils are poorly- to well-drained and permafrost is present on some sites. A peat layer may be absent or well developed; there may be an organic layer derived from non-sphagnum mosses.

Vegetation Description

Picea mariana is the dominant overstory species, but Picea glauca may be codominant on some sites (NatureServe 2008). Early successional stands may be dominated by Betula papyrifera or Populus tremuloides (NatureServe 2008). Populus tremuloides replaces Betula papyrifera on drier sites (Foote 1983, Chapin et al. 2006). Common understory shrubs include Rosa acicularis, Betula nana, Ledum spp., Vaccinium vitis-idaea, V. uliginosum, and Empetrum nigrum

Herbaceous species include Calamagrostis canadensis, Chamerion angustifolium (Epilobium angustifolium), Equisetum spp., Rubus chamaemorus, and Carex spp. Common mosses include Sphagnum spp., Hylocomium splendens, and Pleurozium schreberi (NatureServe 2008). Lichens, such as Cladina spp., may be abundant, especially in later seral stages (NatureServe 2008). Feathermosses are typical of cooling soils, which can lead to permafrost development. Sites where permafrost is closer to the surface will have more sphagnum.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| PIMA | Picea mariana | Black spruce |
| BEPA | Betula papyrifera | Paper birch |
| POTR5 | Populus tremuloides | Quaking aspen |
| PIGL | Picea glauca | White spruce |
| BENA | Betula nana | Dwarf birch |
| LEDUM | Ledum | Labrador tea |
| SALIX | Salix | Willow |
| VAUL | Vaccinium uliginosum | Bog blueberry |
| CACA4 | Calamagrostis canadensis | Bluejoint |
| SPGI70 | Sphagnum girgensohnii | Girgensohn's sphagnum |

Disturbance Description

Crown fires and ground fires of enough severity to kill overstory trees are the dominant disturbance influencing black spruce forest. Fire is facilitated by an abundance of fine fuels and ladder fuels in this type. Moderate-severity fire sometimes occurs in a mosaic fire where black spruce is mixed with hardwoods (Lentile et al. 2007), but for a predominantly black spruce forest, fires are almost always stand-replacement crown fires or a mix of crown and lethal surface fire (see literature cited in Fryer 2014a). Fire history studies report fire frequencies from 73 to 113 years for black spruce forests in interior AK (Drury & Grissom 2008, Fastie et al. 2002, Kasischke et al. 2008, Kurkowski et al. 2008, Yarie 1981). See Fryer (2014a and 2014b) for literature reviews on black spruce including fire regime information.

The post-fire successional trajectory may be self-replacement, with black spruce following the early seral herb and shrub stages; alternatively, black spruce-hardwood may follow the early seral stages before returning to black spruce (Chapin et al. 2006). High severity fire may lead to an increased deciduous tree component (Johnstone and Kasischke 2005). The pre-burn stand composition will influence the likely successional trajectory, with pre-burn spruce stands more likely to succeed to spruce and pre-burn hardwood stands more likely to succeed to hardwood after the fire. If white spruce is present in the conifer initiation, then white and black spruce can be codominant in the conifer canopy throughout the successional stages.

Wind and insect damage affect this type but very little research exists to help describe or model that effect. These disturbances are also much smaller in their impacts than the dominant, stand-replacement disturbances caused by fire.

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Min FI** | **Max FI** | **Percent of All Fires** |
| Replacement | 116 |  |  |  |
| Moderate (Mixed) | 213 |  |  |  |
| Low (Surface) |  |  |  |  |
| **All Fires** | **75** |  |  |  |

Scale Description

Matrix

Non-Fire Disturbances

Insects/Disease

Wind/Weather/Stress

Adjacency or Identification Concerns

Issues or Problems

The probability of fire in the mixed spruce-hardwood stage (class C) relative to the spruce dominated stages (class D and E) is unclear. It was assumed that the herb and shrub dominated stages (class A and B) are less fire prone, and therefore have a lower fire probability, than the later seral stages. The probability and effects of insects, disease and wind/weather events in this system are unclear and are included in the old-growth stage (class E) of the model as a place holder.

Native Uncharacteristic Conditions

Comments

REVIEW QUESITON:

-What are the relative proportions of mixed and replacement severity fire in this BpS?

More information on black spruce forest can be found in the Fire Effects Information System Synthesis: [Fire regimes of Alaskan black spruce communities](http://www.fs.fed.us/database/feis/fire_regimes/AK_black_spruce/all.html) (Fryer 2014a); and in the species review: [Picea mariana](http://www.fs.fed.us/database/feis/plants/tree/picmar/all.html) (Fryer 2014b).

During a 2016 BpS review it was noted by a reviewer that the literature reports that fires are typically stand replacing in black spruce forest, but mixed effects are possible if hardwoods are present. Reviewer comments also suggested the possibility of adjusting the mid and late successional stage age ranges, but exact changes were not specified. Blankenship contacted the original model author, Johnston, who offered the following response: “Teresa Hollingsworth's detailed study of black spruce community composition in interior Alaska found no relationship between stand age and vegetation structure or composition, across an age range of 50-300+ years (Hollingsworth et al. 2006). Some recent work from my lab on moss succession dynamics suggests that the moss understory does not start to differentiate between deciduous-dominated and spruce stands until somewhere between 40-60 years old (Jean et al. 2017). On that basis, I would tend to put the break from early-mid succession at 40 years, and I think the choice between mid-late succession is probably arbitrary, as factors other than stand age appear to be driving the structural and compositional differences that we might use to define "old growth" conditions.” Based on this feedback Blankenship changed the start age of the Mid1All and Mid2All classes from 30 to 40 years and the end age of Early2Opn from 29 to 39 years. This resulted in slight changes to the succession class amounts (+ or – 5%) and fire frequency (+ or – 7yr change in MFRI).

In 2021 NatureServe merged Western North American Boreal Black Spruce Wet-Mesic Slope Woodland (BpS 1622) and Western North American Boreal Mesic Black Spruce Forest (BpS 1604) into one Ecological System: Western North American Boreal Mesic-Wet Black Spruce Forest and Woodland. Kori Blankenship merged the BpS description for 1622 created by Joan Foote and Colleen Ryan and reviewed by Michelle Schuman, William Putnam, and Lisa Saperstein and 16041 created by Jill Johnstone and reviewed by William Putnam to reflect the new Ecological System concept and adopted the state-and-transition model from 16041 to represent the merged system in the Boreal region.

For LANDFIRE National, this system was created for the AK Boreal region and did not receive review during LANDFIRE National for other regions in the state. This model was based on input from the experts who attended the LANDFIRE Fairbanks (Nov. 07) and Anchorage (Dec. 07) modeling meetings. During LANDFIRE National Will Putnam expressed concern that the distinction between this BpS and Western North American Boreal White Spruce-Hardwood Forest is ambiguous. They can occur on similar sites, and in many cases the relative dominance of P. mariana vs. P. glauca is mostly a function of succession and/or disturbance history.

**Model Parameters**

*Using Track Changes in Word you may suggest changes to any of the parameters indicated in the following tables. If you wish to see how those changes impact model results, go to the “Simulation Model Review Instructions” section on* <http://www.landfirereview.org/models.html>*. If you do not wish to edit and run the actual model, the TNC LANDFIRE will do so and if requested provide the reviewer with the results.*

**Deterministic Transitions**

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Early2:OPN | 4 |
| Early2:OPN | 5 | Mid1:ALL | 39 |
| Late1:OPN | 120 | Late1:OPN | 999 |
| Mid1:ALL | 40 | Late1:OPN | 119 |
| Mid2:ALL | 40 | Late1:OPN | 119 |

**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** |
| ReplacementFire | Early1:ALL | Early1:ALL | 0.0040 | 250 | No | 0 |
| ReplacementFire | Early2:OPN | Early1:ALL | 0.0040 | 250 | Yes | 0 |
| AltSuccession | Early2:OPN | Mid2:ALL | 0.0200 | 50 | Yes | 0 |
| ReplacementFire | Late1:OPN | Early1:ALL | 0.0125 | 80 | Yes | 0 |
| Insect/Disease | Late1:OPN | Mid2:ALL | 0.0010 | 1,000 | Yes | 0 |
| MixedFire | Late1:OPN | Mid2:ALL | 0.0075 | 133 | Yes | 0 |
| Wind/Weather/Stress | Late1:OPN | Mid2:ALL | 0.0100 | 100 | Yes | 0 |
| ReplacementFire | Mid1:ALL | Early1:ALL | 0.0067 | 149 | Yes | 0 |
| MixedFire | Mid1:ALL | Mid1:ALL | 0.0040 | 250 | No | 0 |
| ReplacementFire | Mid2:ALL | Early1:ALL | 0.0125 | 80 | Yes | 0 |
| MixedFire | Mid2:ALL | Mid2:ALL | 0.0075 | 133 | No | 0 |

Succession Classes

Class A 3 Early Development 1 - All Structures

Structural Information

Tree Size Class: None

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| CACA4 | Calamagrostis canadensis | Bluejoint | Upper |
| CHAN9 | Chamerion angustifolium | Fireweed | Upper |
| EQUIS | Equisetum | Horsetail | Upper |

Description

Post-disturbance, herbaceous vegetation dominates. Common herbaceous species include Calamagrostis canadensis, Chamerion angustifolium (Epilobium angustifolium) and Equisetum spp. (NatureServe 2008). Black spruce seedlings and common liverwort-fire moss mats can dominate (Viereck 1983). Shrubs may sprout in areas that burned at low to moderate severity (Viereck 1983).

Class B 20 Early Development 2 - Open

Structural Information

Tree Size Class: Seedling/Sapling <5"

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| SALIX | Salix | Willow | Upper |
| BENA | Betula nana | Dwarf birch | Upper |
| LEDUM | Ledum | Labrador tea | Upper |
| ROAC | Rosa acicularis | Prickly rose | None |

Description

Shrubs dominate as the cover of mat-forming and herbaceous species decreases (Viereck 1983). Common species include willow, Betula nana, Ledum spp., Rosa acicularis, Vaccinium uliginosum, V. vitis-idaea and Empetrum nigrum. Both hardwoods and spruce regeneration may be present.

The successional trajectory of the shrub stage will depend on the pre-burn stand composition. If hardwoods dominated the site before the burn, they are likely to vigorously resprout and gain dominance after the fire. If spruce dominated the site before a burn, they are likely to regain dominance in the post-fire stand.

One possible successional trajectory would include a hardwood phase (represented by class C), but this class can also take an alternative successional pathway directly to a spruce dominated phase (represented by class D).

Class C 29 Mid Development 1 - All Structures

Structural Information

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

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| BEPA | Betula papyrifera | Paper birch | Upper |
| POTR5 | Populus tremuloides | Quaking aspen | Upper |
| PIMA | Picea mariana | Black spruce | Upper |
| PIGL | Picea glauca | White spruce | Upper |

Description

Mixed hardwood-spruce forest. Hardwoods and spruce overtop shrubs and gain dominance. Early in this age class trees are at least 2.5 cm DBH and 4-8 m tall (Foote 1983). Populus tremuloides replaces Betula papyrifera on drier sites (Foote 1983, Chapin et al. 2006). Spruce may occur as an understory, subdominant and/or co-dominant component. Tree density may be less or greater than 60% depending on site conditions. Beneath trees, shrubs, herbs and mosses exist. As the stage advances, spruce and moss become more important.

Class D 31 Mid Development 2 - All Structures

Structural Information

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

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIMA | Picea mariana | Black spruce | Upper |
| PIGL | Picea glauca | White spruce | Upper |
| BENA | Betula nana | Dwarf birch | Lower |
| LEDUM | Ledum | Labrador tea | Lower |

Description

Mid-seral black spruce/feathermoss. Picea mariana dominates but Picea glauca may be codominant on some sites. Spruce overtops the shrubs. Spruce canopy cover is commonly 50-70%. Increasing cover (up to 50%) of feathermosses and Sphagnum ssp. contributes to the development of a thick organic layer (Viereck 1983). If the organic layer increases, permafrost may refreeze (Viereck 1983).

Class E 17 Late Development 1 - Open

Structural Information

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

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIMA | Picea mariana | Black spruce | Upper |
| PIGL | Picea glauca | White spruce | Upper |
| BENA | Betula nana | Dwarf birch | Lower |
| LEDUM | Ledum | Labrador tea | Lower |

Description

Open, old-growth black spruce. Picea mariana dominates, but Picea glauca may be codominant on some sites. Spruce gains dominance over hardwoods (if previously present). Tree canopy cover is generally <60% and may be <25% (woodland) depending on site conditions. Occasional hardwoods may remain. The understory may include various combinations of tall shrubs, low shrubs, herbs, mosses and lichens. If fire is absent for long periods paludification may occur, resulting in an opening of the tree canopy to woodland conditions.

Black Spruce-Lichen Woodland may occur in this class.

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