16042

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

BpS Model/Description Version: Nov. 2024

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| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
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Vegetation Type

Forest and Woodland

Map Zones

73, 74, 75, 76, 77, 78

Model Splits or Lumps

Western North American Boreal Mesic Black Spruce Forest and Woodland was split into a Boreal and Boreal Transition variant for BpS modeling so that regional differences could be represented. For mapping BpS 16042 should apply in level 2 ecoregions (Nowaki et al. 2001): Alaska Range Transition, Pacific Mountains Transition, Coast Mountains Transition, Coastal Rainforests.

Geographic Range

This Biophysical Setting (BpS) occurs in in the boreal transition regions of Alaska, south of the Alaska Range, extending west into the Bristol Bay lowlands, and including the Susitna and Matanuska Valleys, east to the Copper River Valley and the Kenai Peninsula.

Biophysical Site Description

This system occurs on moderately well-drained to poorly drained sites in the boreal transition region, including old alluvial fans, abandoned floodplains, and inactive terraces and is widespread on upland slopes (all aspects) and remnant alluvial deposits. Sites on lower concave slopes and toeslopes are mesic- wet, while sites on upper slopes, convex slopes and ridges may be mesic. Black spruce occurs up to treeline where it may be stunted due to cold temperatures (Chapin et al. 2006). A peat layer may be absent or well developed, where present it is derived from non-sphagnum mosses. The accumulation of organic matter increases with seral stage and under anaerobic conditions may develop as peat. Permafrost usually is present at depths of 30-60 cm but may be absent in the southern part of the state and where the soil is shallow over bedrock.

Vegetation Description

*Picea mariana* is the dominant overstory species, but *Picea glauca* may be co-dominant on some sites. Total tree canopy cover in mature stands typically ranges from 40-70% in the boreal transition region. Early successional stands will have 10-25% cover of black spruce and may also have a deciduous component dominated by *Betula papyrifera var. keniaca* or *Populus tremuloides. Populus tremuloides* replaces *Betula papyrifera var. kenica* on drier sites (Foote 1983; Chapin et al. 2006). Common understory shrubs include *Betula nana, Ledum* spp*., Linnaea borealis, Vaccinium vitis-idaea, V. uliginosum, Empetrum nigrum*, and sometimes *Rosa acicularis.*

Typically, the herbaceous understory is forb rich with an increased presence of ferns in the boreal transition. Herbaceous species include *Calamagrostis canadensis, Chamerion angustifolium, Equisetum* spp*., Rubus chamaemorus,* and *Carex* spp. Common mosses include *Sphagnum* spp., *Hylocomium splendens*, and *Pleurozium schreberi* (NatureServe 2008).

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| PIMA | *Picea mariana* | Black spruce |
| PIGL | *Picea glauca* | White spruce |
| BEPAK | *Betula papyrifera var. kenica* | Kenai birch |
| POTR5 | *Populus tremuloides* | Quaking aspen |
| BENA | *Betula nana* | Dwarf birch |
| LEDUM | *Ledum spp.* | Labrador tea |
| VAUL | *Vaccinium uliginosum* | Bog blueberry |
| VAVI | *Vaccinium vitis-idaea* | Lingonberry |

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

Disturbance Description

The disturbance regime is characterized by crown fires and ground fires of enough severity to kill overstory trees. De Volder (1999) estimated a fire frequency range of 25-185 years (mean=89 yrs) on the Kenai Peninsula using fire scars. Paleostudies reported means of 150 years (in 2,000 yrs BP) on the Copper Plateau (Lynch et al. 2004), 113 yrs (from 131-1194 AD) for Grizzly Lake near the Copper River (Tinner et al. 2008), and a mean of 98 yrs (from 5,500-2,400 BP) on the Kenai National Wildlife Refuge (Lynch et al. 2002). A paleostudy by Anderson and others (2006) reported 5 to 8 fires per 1,000 years coincident with the arrival of *Picea mariana* in the Kenai Lowlands. A “best guess” for this system without human disturbance has been estimated at 170yrs (FRCC expert’s consultation, 2004). Seasonality affects burn severity. An early season burn can kill the overstory without affecting the ground layer, but a late-season burn can reduce the duff layer and kill the understory plants.

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 co-dominant 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** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 219 | 87 |  |  |
| Moderate (Mixed) | 1424 | 13 |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 190 | 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

Matrix to large patch to small patch

Across AK fires in black spruce communities tend to be small, but a few large fires (e.g. 50,000 ha or larger) account for most of the area burn and have the most ecological impact (see Fryer 2014a and references therein).

Adjacency or Identification Concerns

In some locations, this BpS can be confused with the White Spruce BpS because black and white spruces often mix, especially on sites with transitional moisture and thermal conditions (Murphy and Witten 2006).

Issues or Problems

Native Uncharacteristic Conditions

In recent decades black spruce began encroaching into drying sphagnum bogs, creating “islands” of spruce where spruce were not previously present (Ed Berg, personal communication, March 4, 2004). This drying and resultant encroachment is attributed to the warming climate.

Comments

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

During LANDIFRE National, this model did not receive review specifically for z76. This model was based on the FRCC Guidebook PNVG model for Black Spruce Southcentral (BSSC; Murphy and Witten 2006) and input from the experts who attended the LANDFIRE Fairbanks(Nov. 07) and Anchorage (Dec. 07) modeling meetings. It was refined by Michelle Schuman. The class definitions and age ranges were taken from experts at the Anchorage and Fairbanks meetings with input from Michelle Schuman and the disturbance probabilities are similar to those in the BSSC model.

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 | B | B | B | B | B | B | B | B | B |
| 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 | 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 | 5-10 | D con | D con | D con | D con | D con | D con | E con | E con | E con | E con |
| Tree | 10-25 | D con | D con | D con | D con | D con | D con | E con | E con | E con | E con |
| Tree | 25-50 | D con | D con | D con | D con | D con | D con | E con | E con | E con | E con |
| Tree | >50 | D con | D con | D con | D con | D con | D 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 6 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| BENA | *Betula nana* | Dwarf birch | Upper |
| LEGR | *Ledum groenlandicum* | Bog Labrador tea | Middle |
| VAUL | *Vaccinium uliginosum* | Bog blueberry | Low-Mid |
| VAVI | *Vaccinium vitis-idaea* | Lingonberry | Lower |

Description

Moss, herbs, seedlings of trees and shrubs establish 3 months to three years post fire (Foote 1983). Shrubs and saplings 1.4 to 7 m tall typically begin capturing sites 4-5yrs post fire. The tall shrub and sapling layer is characterized by 60-100% canopy closure. Tree saplings may include spruce, hardwoods or both. Common understory shrubs include *Betula nana, Ledum groenlandicum, Vaccinium uliginosum, V. vitis-idaea* and *Empetrum nigrum*. Common mosses include *Hylocomium splendens* and *Pleurozium schreberi*.

Alternate succession represents the probability that some stands will go through a hardwood (with spruce understory) or spruce-hardwood stage (Class C) rather than following the main successional pathway to a black spruce dominated stage (Class B).

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

Class B 14 Mid Development 1 - All Structures

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 |
| LEGR | *Ledum groenlandicum* | Bog Labrador tea | Lower |

Description

Black or white spruce overtops shrubs and gains dominance. Tree density may be < or > 60% depending on site conditions.

Alternate succession causes a transition to Class E and represents the probability that some stands go directly to a closed spruce stage rather than following the main successional pathway to an open spruce stage (Class D).

Class B should be distinguished from Class D and E based on tree size class but if that is not mapped, Class B can be considered a dwarf tree class for mapping.

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

Class C 3 Mid Development 2 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| BEPAK | *Betula papyrifera var. kenica* | Kenai birch | Upper |
| POTR5 | *Populus tremuloides* | Quaking aspen | Upper |
| PIMA | *Picea mariana* | Black spruce | Mid-Upper |
| PIGL | *Picea glauca* | White spruce | Mid-Upper |

Description

Hardwoods (with spruce in the understory) or 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 var. kenaica* 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 < or > 60% depending on site conditions. Beneath trees shrubs, herbs and mosses exist. As the stage advances spruce and moss become more important.

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

Class D 50 Late Development 1 - Open

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 |
| LEGR | *Ledum groenlandicum* | Bog Labrador tea | Lower |

Description

This class is characterized by open spruce lichen forest or woodland. Spruce gains dominance over hardwoods (if previously present). Tree canopy cover is < 60% and maybe < 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. For spruce lichen woodland, the dominant lichen genus is *Cladina*; 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*.

If fire is absent for long periods paludification may occur (Moss 1953; Harper et al. 2006).

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

Class E 27 Late Development 1 - Closed

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 |
| LEGR | *Ledum groenlandicum* | Bog Labrador tea | Lower |

Description

This class is characterized by closed spruce forest. Site is dominated by mature black or white spruce with > 60% canopy closure although cover generally does not exceed 70%. The understory may include various combinations of tall shrubs, low shrubs, herbs, mosses, and lichens.

*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 | Mid1:ALL | 14 |
| Mid1:ALL | 15 | Late1:OPN | 74 |
| Mid2:ALL | 15 | Late1:OPN | 74 |
| Late1:OPN | 75 | Late1:OPN | 999 |
| Late1:CLS | 75 | 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** |
| Alternative Succession | Early1:ALL | Mid2:ALL | 0.011 | 91 | Yes | 0 |
| Replacement Fire | Early1:ALL | Early1:ALL | 0.006 | 167 | Yes | 0 |
| Mixed Fire | Mid1:ALL | Mid1:ALL | 0.0012 | 833 | No | 0 |
| Alternative Succession | Mid1:ALL | Late1:CLS | 0.015 | 67 | Yes | 0 |
| Replacement Fire | Mid1:ALL | Early1:ALL | 0.0022 | 455 | Yes | 0 |
| Replacement Fire | Mid2:ALL | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Mixed Fire | Late1:OPN | Late1:OPN | 0.0007 | 1429 | No | 0 |
| Replacement Fire | Late1:OPN | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Late1:OPN | 0.001 | 1000 | Yes | 0 |
| Mixed Fire | Late1:CLS | Late1:OPN | 0.0007 | 1429 | Yes | 0 |
| Insects or Disease | Late1:CLS | Late1:OPN | 0.001 | 1000 | Yes | 0 |
| Replacement Fire | Late1:CLS | Early1:ALL | 0.005 | 200 | Yes | 0 |

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