13652

Boreal White Spruce-Fir-Hardwood Forest - Coastal

BpS Model/Description Version: Aug. 2020

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| **Modelers** |  | **Reviewers** |  |
| Peggy Burkman | peggy\_burkman@nps.gov | Dave Cleland | dcleland@fs.fed.us |
| None | None | None | None |
| None | None | None | None |

Vegetation Type

Forest and Woodland

Map Zones

41

Model Splits or Lumps

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

This BpS (Boreal White Spruce-Fir-Hardwood Forest) has been split into a Great Lakes coastal system and an inland system. We describe the coastal system here. The split is based on a difference in return interval of catastrophic fire with more frequent fires in inland systems and less frequent fires along the Great Lakes shoreline.

Geographic Range

Boreal forest is a circumboreal formation that has existed as a dominant assemblage in the northern Great Lakes region of the United States and Canada for approximately 5-10,000yrs, following the retreat of the glaciers. Within North America, boreal forest is primarily found throughout Canada, ranging into Alaska. Within the Lake States and Ontario province, boreal forest is found in central Ontario, throughout northern Minnesota, along the tip of the Door Peninsula in Lake Michigan and along the Lake Superior shoreline in Wisconsin, and within northern Michigan. The Boreal White Spruce-Fir-Hardwood Forest-Coastal type is predominantly found within approximately one km of the Great Lakes shorelines. This is due primarily to lake effect and can extend beyond the one km range if there exists significant elevation which exhibit cooler and moister conditions. More specifically, within Michigan and Wisconsin this forest type is predominantly found on Great Lakes islands and along coastal areas. In Michigan it is also found along coastal areas of the northernmost portion of the Lower Peninsula and throughout the Upper Peninsula; less frequently, boreal forest occurs in localized inland areas of the Upper Peninsula. Interpretation of notes of the general land surveyors indicate that circa 1800, boreal forest primarily occurred in the northern Lower Peninsula in Alpena, Cheboygan, Charlevoix, and Emmet Counties and in the Upper Peninsula, boreal forest was concentrated in Keweenaw, Chippewa, Ontonagon, Delta and Mackinac Counties. Coastal boreal forest occurs in the northern Lower Peninsula in section 212H and subsubsections 212Hi, 212Hj, and 212Hf and throughout the Upper Peninsula in sections 212R, 212S, 212Y, 212J and subsections 212Rd, 212Re, 212Ra, 212Rc, 212Sc, 212Sq, 212Sn, 212Sb, 212Ya, and 212Jb along the Great Lakes shoreline. (Flakne 2003, Comer et al. 1995, Stearns et al. 1982, Maycock and Curtis 1960, Curtis 1959, Nichols 1935).

Biophysical Site Description

Boreal forest typically occupies upland sites (often with local wet places) along shores of the Great Lakes, on islands in the Great Lakes (e.g. Isle Royale, Apostle Islands, Drummond Island and Beaver Island) and locally inland (e.g. restricted areas in the Negaunee Michigamme Highlands). Coastal boreal forests occur primarily on sand dunes, in glacial lakeplains, and on thin soil over bedrock, both igneous and calcareous (e.g., limestone and dolomite cobble or pavement). Farther inland, moderately drained lakeplain and outwash deposits occasionally support these forests. Within lakeplain, boreal forest is often found in areas with poorly expressed dune and swale topography. Coastal boreal forests occurring along the mainland often form narrow, linear bands while archipelagic boreal forests often occupy broader areas of variable shape along the island shoreline, especially along the southwestern portion of the island (Harman and Plough 1986). Near shore boreal forests occupy peninsulas, former embayments, and coves. Topography of these systems ranges widely from gently sloping on lakeplain systems too steep topography on high dune fields, especially where eolian features have been deposited on moraines.

Proximity to the Great Lakes results in modified climate with cool, relatively equable temperature, short growing season, abundant available moisture during the growing season often in the form of fog or mist, and deep snows in the winter (Potzger 1941, Curtis 1959, Harman and Plough 1986). Sand, loamy sand and sandy loam soils are typically moderately acid to neutral, but heavier soils (e.g., silty loam and clay loams) and more acid and alkaline conditions are found. Boreal forests that occur over limestone bedrock or cobble often are characterized by shallow organic soils or mull humus. Conifer dominance in the canopy results in a litter layer that is typically more acidic than the underlying organic and mineral soils. Water-retaining capacity of the soils is variable with sandy soils typically being well-drained and soils with heavier texture, such as loams, ranging from moderately drained to poorly drained. Inland boreal forest systems usually occur on moderately drained lakeplain or outwash (Curtis 1959, Comer et al. 1995, Stearns et al. 1982).

Vegetation Description

Dominated by *Abies balsamea, Picea glauca* and *Thuja occidentalis* with *Betula papyrifera* and *Populus tremuloides*, shifting toward *Betula* and *Populus* following fire events, and towards conifers in the absence of fire. *Thuja occidentalis* dominance is most prevalent in sand dunes and on thin soils over neutral-alkaline bedrock or glacial deposits, such as in the Straits of Mackinac and in the northeastern Lower Peninsula (Comer et al. 1995). White spruce is more prevalent on drier sites while balsam fir is more common on wetter sites (Curtis 1959). Additional canopy associates include *Pinus strobus, Populus balsamifera*, and *Tsuga canadensis* and less frequently *Picea mariana, Pinus resinosa, Pinus banksiana*, and *Acer rubrum*. In contrast to coastal boreal forests, inland systems are often characterized by an increased canopy component of Pinus strobus and *Tsuga canadensis* and deciduous species as the result of more frequent fire disturbance (Curtis 1959, Comer et al. 1995). *Acer spicatum, A. pennsylvanicum, Sorbus Americana*, and *S. decorus* are characteristic of the subcanopy and understory. Where *Populus* and/or *Betula* dominate the canopy, conifers are prevalent in the subcanopy and understory. Additional understory or tall shrub species include *Cornus rugosa, Alnus rugosa,* and *Sheperdia canadensis*. Characteristic low shrubs include *Lonicera canadensis, Arctostaphylos uva-ursi, Ribes cynosbati, Vaccinium myrtilloides, Diervilla lonicera, Juniperus communis,* and *Rubus pubescens*. In some cases, *Taxus canadensis* would have been quite dense in localized areas reducing diversity and occurrence of other groundlayer species. Groundlayer species are a mix of species found in mesic northern forest and northern swamp types, but prominent among them are *Actaea rubra, Aralia nudicaulis, Aster macrophyllus, Carex eburnea, C. deweyana, Clintonia borealis, Coptis trifolia, Cornus candensis, Drypoteris* spp., *Galium triflorum, Goodyera* spp. (i.e., *G. oblongifolia* and *G. repens), Linnaea borealis, Mainthemum canadense, Mitella nuda, Mitchella repens, Pteridium aquilinum, Polygala paucifolia, Smilacina stellata, Streptopus roseus, Trientalis borealis*, and *Viola* spp. *Cypripedium arietinum* and *Iris lacustris* are uncommon, but characteristic. Sphagnum species are common and can often form thick mats. Mosses and Usnea lichens often are abundant due to favorable, moist conditions. (Grant 1934, Darlington 1940, Potzger 1941, Buell and Niering 1957, Curtis 1959, Maycock and Curtis 1960, Buell and Martin 1961, Stearns et al. 1982, Harman and Plough 1986, Rutkowski and Stottlemyer 1993).

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| THOC2 | *Thuja occidentalis* | Arborvitae |
| PIGL | *Picea glauca* | White spruce |
| ABBA | *Abies balsamea* | Balsam fir |
| BEPA | *Betula papyrifera* | Paper birch |
| POTR5 | *Populus tremuloides* | Quaking aspen |

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

Disturbance Description

Proximity to the Great Lakes results in the moderation of the microclimate of coastal boreal forests with higher humidity, greater snowfall, lower summer temperatures, warmer winter temperatures, and greater summer fog and mist compared to the adjacent inland areas (Curtis 1959, Potzger 1941). Natural disturbance regime characterized by frequent windthrow and insect epidemics, which are typically small-scale events. Because many sites lie next to the Great Lakes and trees are shallowly rooted, windthrow and snap-off rates are high (Comer et al. 1995, Curtis 1959, Grant 1934); balsam fir is especially susceptible to windthrow and breakage (Buell and Martin 1961). *Choristoneura fumiferana* (Spruce budworm) defoliates both spruce and balsam fir but tends to be more detrimental to the latter (Curtis 1959). Outbreaks were typically localized resulting in patch scale disturbance effects. Interactions of blowdowns, insects and climate (i.e., droughts) influence fire regimes of boreal forests. Infrequent catastrophic fires are an important disturbance factor (Curtis 1959), especially in inland boreal forests. Estimations for fire return interval for Canadian boreal forests range from 74-142yrs (Larsen and MacDonald 1998). During drought years the large quantities of Sphagnum moss and Usnea lichens can dry out and contribute significantly to fuel loadings. Given the prevailing landscape position of most Great Lakes boreal forests (along the shoreline), the fire return interval for these systems was probably >300yrs with fire return intervals more similar to Canadian forests for inland Great Lakes systems. Large-scale disturbance events in boreal forests can lead to the development of even-aged stands while small-scale disturbance factors can lead to uneven-aged systems (Comer et al. 1995, Stearns et al. 1982, Maycock and Curtis 1960, Curtis 1959).

Selective browsing by moose in the Upper Peninsula of MI (Isle Royale) can result in the alteration of species composition, community structure, and ultimately forest successional patterns of boreal forests. On sites with spruce and balsam fir, moose preferentially browse on balsam fir retarding fir vertical growth, limiting fir abundance and imparting a competitive advantage to spruce (Risenhoover and Maass 1987).

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 937 | 55 | 300 | 1500 |
| Moderate (Mixed) | 1143 | 45 | 300 | 1500 |
| Low (Surface) |  |  |  |  |
| All Fires | 515 | 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

Infrequent fires burned large areas (hundreds of acres), killing all or most overstory species. Small-scale outbreaks of spruce budworm likely occurred every 30-60yrs, killing primarily balsam fir over small scale (10s of acres); occasional wind storms blew down trees over small scale (ten or more acres).

Adjacency or Identification Concerns

BpS adjacent to this system are 1302 (Laurentian-Acadian Northern Hardwoods Forest), 1344 (Boreal Jack Pine-Black Spruce Forest) and 1345 (Boreal White Spruce forest and Woodland).

This system can be confused with BpS 1345 (Boreal White Spruce Forest and Woodland).

Landscape scale spruce budworm (*Choristoneura fumiferana*) outbreaks that are a result of fire suppression and forest management practices would not have occurred under historical range of variability. Encroachment in the form of conversion, urban sprawl and management practices such as forestry and fire suppression are effects that would not have impacted this system historically but occur in the present day. High levels of deer herbivory can result in regeneration failure of cedar.

With turn of the century forest management practices a second growth forest type is more dominant. Today this system is structurally less complex with less Canada Yew and more abundance of balsam fir and white birch.

It is possible that the replanting efforts by the Civilian Conservation Core in the 1930s have converted some of this system.

Along shorelines, boreal forest often shares an abrupt boundary with coastal communities such as cobble beach, sand/gravel beach, open dunes, limestone bedrock lakeshore, Great Lakes marsh, and Great Lakes barrens and gradually grades to mesic northern forest or less frequently rich conifer swamp, limestone bedrock glade, or alvar inland from the lakeshore. Mapped as Spruce-Fir-Cedar Forest on Comer et al.'s (1995) circa 1800 vegetation map. Coastal boreal forests are typically within 1000m of the shoreline and correspond to conifer dominated current land cover.

Issues or Problems

Need more research on spruce budworm impacts (what is scale and intensity of disturbance?). Disturbance return intervals (i.e., fire, wind and insect) for boreal forests are derived from Canadian systems and from research from Minnesota. Estimations of fire size are based on polygon size of spruce-fir-cedar forest from circa 1800 vegetation map (Comer et al. 1995).

Native Uncharacteristic Conditions

Comments

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

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 3 Early Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| BEPA | Betula papyrifera | Paper birch | Upper |
| POTR5 | Populus tremuloides | Quaking aspen | Upper |

Description

High density seedling-sapling-pole aspen-birch stand following stand-replacement fire event. Class A occurs following catastrophic fire which is assumed to occur at low fire frequency (500-1000yrs) compared to inland boreal forest systems. Low levels of conifer regeneration, which increase over time through seeding in. Catastrophic fire exposes mineral soil. Due to differences in growth rates birch and aspen initially dominate over spruce and fir.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class B 6 Early Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| ABBA | Abies balsamea | Balsam fir | Upper |
| PIGL | Picea glauca | White spruce | Upper |
| THOC2 | Thuja occidentalis | Arborvitae | Upper |

Description

High density seedling-sapling-pole fir-spruce-cedar stand following catastrophic windthrow and moderate severity fire which leave adequate seed source to impart competitive advantage to conifers over early successional hardwoods.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class C 4 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| BEPA | Betula papyrifera | Paper birch | Upper |
| POTR5 | Populus tremuloides | Quaking aspen | Upper |
| ABBA | Abies balsamea | Balsam fir | Low-Mid |
| PIGL | Picea glauca | White spruce | Low-Mid |

Description

Mature aspen-birch with spruce-fir-cedar understory development.

*Maximum Tree Size Class*  
Medium 9-21"DBH

Class D 87 Late Development 1 - Closed

Upper Layer Lifeform: Tree

Upper Layer Canopy Cover: 71 - 100%

Upper Layer Canopy Height: Tree 10.1m - Tree 25m

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| THOC2 | Thuja occidentalis | Arborvitae | Upper |
| PIGL | Picea glauca | White spruce | Upper |
| ABBA | Abies balsamea | Balsam fir | Upper |

Description

Spruce-fir-cedar forest.

*Maximum Tree Size Class*  
Large 21-33"DBH

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:CLS | 0 | Mid1:CLS | 30 |
| Early2:CLS | 1 | Early2:CLS | 70 |
| Mid1:CLS | 31 | Late1:CLS | 70 |
| Late1:CLS | 71 | 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 | Early2:CLS | Late1:CLS | 1 | 1 | Yes | 68 |
| Replacement Fire | Early2:CLS | Early1:CLS | 0.002 | 500 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Early2:CLS | 0.001 | 1000 | Yes | 0 |
| Replacement Fire | Mid1:CLS | Early1:CLS | 0.002 | 500 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Early2:CLS | 0.001 | 1000 | Yes | 0 |
| Mixed Fire | Late1:CLS | Early2:CLS | 0.001 | 1000 | Yes | 0 |
| Replacement Fire | Late1:CLS | Early1:CLS | 0.001 | 1000 | Yes | 0 |
| Insects or Disease | Late1:CLS | Late1:CLS | 0.017 | 59 | No | 0 |

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