13651

Boreal White Spruce-Fir-Hardwood Forest - Inland

BpS Model/Description Version: Aug. 2020

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|  |  |  |  |

Vegetation Type

Forest and Woodland

Map Zones

51

Model Splits or Lumps

This BpS is lumped with 1301

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 ~10,000yrs, following the retreat of the glaciers. Within North American, 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. Within Michigan, this forest type is predominantly found on Great Lakes islands and 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 Michigan. 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, Ontonogan, Delta and Mackinac Counties. Inland boreal forest occurs in the northern Lower Peninsula in section 212H and subsubsections 212HI and 212Hj and throughout the Upper Peninsula in all sections and subsections (Cleland et al. 2007). (Flakne 2003, Comer et al. 1995, Stearns et al. 1982, Maycock and Curtis 1960, Curtis 1959, Nichols 1935). System occurs in north central MN and the arrowhead region with deep, nutrient-rich, fine-textured soils.

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, Drummond Island, Beaver Island) and locally inland (e.g. restricted areas in the Negaunee Michigamme Highlands). 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). Inland boreal forest of MI are typically found on moderately drained lakeplain and outwash deposits. Within lakeplain, boreal forest is often found in areas with poorly expressed dune and swale topography. Topography of these systems is typically flat to gently sloping.

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 (Comer et al. 1995, Stearns et al. 1982, Curtis 1959).

In Minnesota, boreal forest occurs on soils that are deeper or finer-textured than soils in the jack pine forest that allowed development of dense forests of mixed aspen, birch, balsam fir, white spruce and red maple (Frelich and Reich 1998). This community occurs in upland positions, often with loamy shallow soils within bedrock-controlled landforms (Heinselman 1996).

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 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 (Comer et al. 1995, Curtis 1959). *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, Taxus canadensis, Ribes cynosbati, Vaccinium myrtilloides, Diervilla lonicera, Juniperus communis,* and *Rubus pubescens*. 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. Mosses and Usnea lichens often are abundant due to favorable, moist conditions (MNFI Database 2007, Rutkowski and Stottlemyer 1993, Harman and Plough 1986, Stearns et al. 1982, Buell and Martin 1961, Maycock and Curtis 1960, Curtis 1959, Buell and Niering 1957, Potzger 1941, Darlington 1940, Grant 1934).

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| ABBA | *Abies balsamea* | Balsam fir |
| PIGL | *Picea glauca* | White spruce |
| THOC2 | *Thuja occidentalis* | Arborvitae |
| BEPA | *Betula papyrifera* | Paper birch |
| POTR5 | *Populus tremuloides* | Quaking aspen |
| PIST | *Pinus strobus* | Eastern white pine |
| TSCA | *Tsuga canadensis* | Eastern hemlock |

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

Disturbance Description

Natural disturbance regime characterized by frequent windthrow and insect epidemics, which are typically small-scale events. *Choristoneura fumiferana* (Spruce budworm) defoliates both spruce and balsam fir but tends to be more detrimental to the later (Curtis 1959). 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). We estimate that the fire return interval for the inland boreal forests of Michigan probably ranged from 200-300yrs given that these systems occurred as patches in a matrix of a range of community types with varying fire regimes compared to the extensive, homogenous, flammable Canadian boreal forest. We also estimate that wind disturbance was more prevalent along the Great Lakes shoreline compared to inland 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 Michigan (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 | 496 | 52 | 100 | 500 |
| Moderate (Mixed) | 531 | 48 |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 256 | 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 (100s-1000s 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 (tens to hundreds of acres); occasional wind storms blew down trees over small scale (10 or more acres).

Adjacency or Identification Concerns

This system was mapped separately from 5113442 (Great Lakes Spruce Fir), though there are significant similarities, especially in the description.

The inland variant of the boreal white spruce-fir hardwood forest is located more than one km inland within the main portions of the Lower and Upper Peninsulas. The coastal variant of the boreal white spruce-fir hardwood forest (511365-1) would be found within approx. one km of the Great Lakes shoreline and across any island or Peninsula within the Great Lakes such as Beaver Island, Bois Blanc Island, Drummond island and the Garden Peninsula.

Mapped as Spruce-Fir-Cedar Forest on Comer et al.'s (1995) circa 1800 vegetation map. Corresponds to upland spruce-fir 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

High levels of deer herbivory can result in regeneration failure of cedar.

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 7 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 moderate fire frequency (200-300yrs) compared to coastal boreal forest systems. Low levels of conifer regeneration, which increase over time through seeding in. Catastrophic fire exposes mineral soil and reduces conifer competition, imparting competitive advantage to birch and aspen.

Class A consists of deciduous tree species while class B consists of coniferous tree species.

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

Class B 22 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 7 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 64 Late Development 1 - Closed

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 |
| PIST | Pinus strobus | Eastern white pine | None |

Description

Spruce-fir-cedar forest with canopy associates *including Populus tremuloides, Betula papyrifera, Pinus strobus, Populus grandidentata, Pinus resinosa, Pinus banksiana, Picea mariana*, and *Tsuga canadensis*. Populus tremuloides

,

Betula papyrifera

,

Pinus strobus

,

Populus grandidentata

,

Pinus resinosa

,

Pinus banksiana

,

Picea mariana

,

and

Tsuga

canadensis

.

Populus tremuloides

,

Betula papyrifera

,

Pinus strobus

,

Populus grandidentata

,

Pinus resinosa

,

Pinus banksiana

,

Picea mariana

,

and

Tsuga

canadensis

.

Spruce budworm and small-scale windthrow events create small canopy gaps which maintain uneven-aged structure. Frequency of large-scale insect events needs further research.

*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** |
| Replacement Fire | Early2:CLS | Early1:CLS | 0.002 | 500 | Yes | 0 |
| Alternative Succession | Early2:CLS | Late1:CLS | 0.01 | 100 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Early2:CLS | 0.001 | 1000 | Yes | 0 |
| Replacement Fire | Mid1:CLS | Early1:CLS | 0.004 | 250 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Early2:CLS | 0.001 | 1000 | Yes | 0 |
| Replacement Fire | Late1:CLS | Early1:CLS | 0.002 | 500 | Yes | 0 |
| Mixed Fire | Late1:CLS | Early2:CLS | 0.003 | 333 | Yes | 0 |
| Insects or Disease | Late1:CLS | Late1:CLS | 0.017 | 59 | No | 0 |
| Wind or Weather or Stress | Late1:CLS | Late1:CLS | 0.1 | 10 | No | 0 |

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