13652

Boreal White Spruce-Fir-Hardwood Forest - Coastal

BpS Model/Description Version: Aug. 2020

Update: 4/17/2018

|  |  |  |  |
| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
| Joshua Cohen | cohenjo@michigan.gov | Randy Swaty | rswaty@tnc.org |
| Kimberly Hall | hallkim@msu.edu | None | None |
| None | None | None | None |

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 US and Canada for approximately10,000yrs, 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.

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 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, Ontonogan, 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, Drummond Island, 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 (Harman and Plough 1986, Curtis 1959 and Potzger 1941). 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).

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, 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** |
| 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 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). 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 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 | 877 | 60 | 300 | 1500 |
| Moderate (Mixed) | 1311 | 40 | 300 | 1500 |
| Low (Surface) |  |  |  |  |
| All Fires | 526 | 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

The coastal variant of the boreal white spruce-fir hardwood forest (511365-1) would be found within 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. The inland variant is located approximately more than one km inland within the main portions of the Lower and Upper Peninsulas.

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

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 4 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. This class occurs following catastrophic fire which is assumed to occur at low fire frequency (300-500yrs) compared to inland 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.

Upper Layer Lifeform is not the dominant lifeform. Ecologically, class A and B overlap in structural data (canopy closure and tree height/size) as these are both early seral stages that result from different replacement events (i.e. fire vs. wind). 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 13 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 79 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 |

Description

Spruce-fir-cedar forest. 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 | 0.002 | 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 |

References

Buell, M.F., and W.A. Niering. 1957. Fir-spruce-birch forest in northern Minnesota.

Ecology 38(4): 602-610.

Buell, M.F., and W.E. Gordon. 1945. Hardwood-conifer forest contact zone in Itasca

Park, Minnesota. American Midland Naturalist 34(2): 433-439.

Buell, M.F., and W.E. Martin. 1961. Competition between maple-basswood and fir-

spruce communities in Itasca Park, Minnesota. Ecology 42(2): 428-429.

Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A.

Corner, and D.W. Schuen. 1995. Michigan’s presettlement vegetation, as interpreted from the General Land Office Surveys 1816-1856. Michigan Natural Features Inventory, Lansing, MI. Digital map.

Curtis, J.T. 1959. Vegetation of Wisconsin: An Ordination of Plant Communities. University of Wisconsin Press, Madison, WI. 657 pp.

Darlington, H.T. 1940. Some vegetational aspects of Beaver Island, Lake Michigan.

Papers of the Michigan Academy of Science, Arts, and Letters 25: 31-37.

Flakne, R. 2003. The Holocene vegetation history of Isle Royale National Park, Michigan, USA. Canadian Journal of Forest Research 33: 1144-1166.

Grant, M.L. 1934. The climax forest community in Itasca County, Minnesota, and its

bearing upon the successional status of the pine community. Ecology 15(3): 243-257.

Harman, J.R., and J. Plough. 1986. Asymmetric distribution of coniferous trees on

northern Lake Michigan Islands. The East Lakes Geographer 21: 24-33.

Heinselman, M.L. 1973. Fire in the virgin forests of the Boundary Waters Canoe Area, Minnesota. Journal of Quarternary Research 3: 329-382.

Larsen, C.P.S. and MacDonald, G.M. 1998. An 840-year record of fire and vegetation in a boreal white spruce forest. Ecology 79: 106-118.

Maycock, P.F., and J.T. Curtis. 1960. The phytosociology of boreal conifers – Hardwood forests of the Great Lakes Region. Ecological Monographs 30: 1-35.

Michigan Natural Features Inventory. Natural History Database-BIOTICS. 2007.

Nichols, G.E. 1935. The hemlock-white pine-northern hardwood region of eastern North

America. Ecology 16: 403-422.

Potzger, J.E. 1941. The vegetation of Mackinac Island, Michigan: An ecological survey.

American Midland Naturalist 25(2): 298-323.

Risenhoover, K.L., and S.A. Maass. 1987. The influence of moose on composition and

structure of Isle Royale forests. Canadian Journal of Forest Research 17: 357-364.

Rutkowski, D.R., and R. Stottlemyer. 1993. Composition, biomass, and nutrient distribution in mature northern hardwood and boreal forest stands, Michigan. American Midland Naturalist 130(1): 13-30.

Stearns et al. 1982. Ecology and geology of the Superior Upland Region: A theme study

for the National Park Service.