13020

Laurentian-Acadian Northern Hardwoods Forest

BpS Model/Description Version: Aug. 2020

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| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
| Brendan Ward | bward@fs.fed.us | modeler was reviewer | None |
| None | None | None | None |
| None | None | None | None |

Vegetation Type

Forest and Woodland

Map Zones

40

Geographic Range

This system occurs in western Upper Peninsula of MI, northern WI, northern MN and Ontario. In MI, it occurs in ECOMAP subsections 212Tb, 212Ya, 212Jb, 212Sq, 212Jo, and 212Sn. In WI, this system occurs in all of the 212 subsections.

Biophysical Site Description

This type occurs principally on moraines of well drained soils that are coarse and fine textured, on lacustrine silts and clays, and on medium-textured till over bedrock -- areas of consistent moisture and nutrient availability that are protected from fire. Soils can frequently exhibit a thicker Bhs horizon and have a higher organic content, cation exchange capacity. Soil pH will range from 6-7.5. Typical sites are buffered from seasonal drought by fine-textured moisture-retaining soils or dense subsoil layers. Essential nutrients are mineralized from decaying organic matter at twice the rate of that in fire-dependent forest or wet forest communities.

Vegetation Description

This system is a mixture of mesophyllic hardwood species and is typified by Acer saccharum, Tilia americana, Fagus grandifolia (restricted to MZ51 and eastern MZ50), Betula allegheniensis and Ulmus americana. Populus tremuloides, Populus grandidentata and Betula papyrifera are early seral species in this system. Acer rubrum and Abies balsamea occasional species found in mid-seral stands, especially on less productive soils. Occasional Pinus strobus individuals were present in early and mid-seral stands that were in proximity to seed sources, but their presence in contemporary forests likely indicates a site that would have formerly been occupied more strongly by pine under the natural disturbance regime. Tsuga canadensis was an occasional late-seral species on more poor soils; however, its presence today likely suggests that the Laurentian-Acadian Pine-Hemlock-Hardwood Forest is a more appropriate BpS.

Structurally, these uneven-aged forests were characterized by large volumes of coarse, structurally complex woody debris arranged both vertically and horizontally beneath multi-storied canopies of different-aged cohorts, with super canopies composed of trees centuries old (Tyrell and Crow 1994). The dominant tree species are among the most moisture and nutrient-demanding species in the eastern US, and their distribution is confined to glacial landforms underlain by fertile soils (Woods 2000, Whitney 1986). Composition of the ground flora and understory varies along a moisture-nutrient gradient, and typically consists of high densities of shade-tolerant tree species and mesophilic herbaceous species including blue cohosh, yellow violet, sweet cicely, various ferns and ginseng. The shrub layer includes Canada yew, beaked hazel, moose wood and Amelanchier species.

In the mid-1800’s, there were 5.8 million acres of northern hardwood ecosystems in the Upper Peninsula of MI (Cleland et al. 2004a, ongoing R-9/SRS/MTU study). Sugar maple, hemlock, yellow birch, balsam fir, cedar in swales, spruce and beech were the dominant late-successional species recorded along section lines by GLO surveyors (figure 1). Early-successional aspen and white birch comprised only 2.0% of the GLO line trees. Large openings likely occurred on less than one percent of the landscape.

In the mid-1800’s, there were 8.4 million acres of northern hardwood ecosystems within the 17.8 million acres of forest lands in northern WI (ongoing R-9/SRS/MTU study). Yellow birch, sugar maple, hemlock, white pine, elm and basswood were the dominant late-successional species (figure 2). Early-successional aspen, white birch and oak species comprised 4.8% of the GLO corner trees. Large openings likely occurred on less than one percent of the landscape.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| ACSA3 | *Acer saccharum* | Sugar maple |
| TIAM | *Tilia americana* | American basswood |
| BEAL2 | *Betula alleghaniensis* | Yellow birch |
| ULAM | *Ulmus americana* | American elm |
| TSCA | *Tsuga canadensis* | Eastern hemlock |
| PRSE2 | *Prunus serotina* | Black cherry |
| FAGR | *Fagus grandifolia* | American beech |

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

Disturbance Description

These wind-driven ecosystems historically changed slowly over centuries due to fine-scale blowdowns, relatively rare broad-scale catastrophic storms, and even rarer fire events (Cleland et al. 2004, Woods 2000, Frelich and Lorimer 1991, Canham and Loucks 1984, Grimm 1984, Runkle 1982). Blowdowns affected conifers more than hardwoods, and older trees more than younger trees (Foster and Boose 1992, Webb 1989). These “asbestos” forests seldom burned (Grimm 1984, Stearns 1949), and exhibited a repeating and shifting steady state of fine-scaled mosaics of species whose overall proportions remained essentially constant (Borman and Likens 1979).

Fire Regime Description: Composed of fire-sensitive species, fires only occurred within this forest type following catastrophic wind events or during periods of extreme drought. This fire-resistance is due to high rates of organic matter decomposition and low rates of fuel accumulation, closed and multistoried canopy effects on microclimate, succulent ground-flora and herbaceous layers, high soil moisture storage capacity, and the dispersed canopies of volatile coniferous foliage within a fire-resistant deciduous hardwood matrix. The principal cause of fuel formation leading to fire in northern hardwood ecosystems is broad scale, storm-driven windthrow of catastrophic proportions (Canham and Loucks 1984, Dunn et al. 1983, Runkle 1982). Canham and Loucks (1984) estimated the return interval for catastrophic storms to be about 1200yrs in northern WI. Their comparisons of the presettlement disturbance regime with contemporary climatological records suggest that catastrophic thunderstorms were the principal mechanism for large-scale windthrow, followed by tornadoes that accounted for one-third of blowdown recorded by surveyors. Not only were these storms nearly stand-replacing events in themselves, but after the slash resulting from them cured, the probability of fire increased exponentially. However, fires within undisturbed, intact systems that did start or that moved into these stands from adjacent areas tended to smolder in the duff layer and move very slowly, eventually going out and causing little damage to the overstory (Frelich and Lorimer 1991, Stearns 1949).

Within the 5.8 million acres of northern hardwood ecosystems in the Upper Peninsula of MI, there were 146,028ac of blown down forests and 54,903ac of burned areas based on analyses of General Land Office survey notes recorded between 1840 and 1855 (Cleland et al. 2004a, Maclean and Cleland 2003). Assuming a 15yr recognition window, the historical fire rotation was 1568yrs. If surveyors recognized a blow-down 20yrs after the event, catastrophic wind rotations would have been 786yrs, with a 30yr recognition window estimate of 1179yrs. Because of the fire-resistance of undisturbed mesic deciduous forests, these estimates suggest that approximately 40% of the blown-down areas within this forest type in the Upper Peninsula subsequently burned.

Within the 8.4 million acres of northern hardwood ecosystems in northern WI, there were 396,485ac of blown-down forests and 61,800ac of burned areas based on analyses of General Land Office survey notes recorded between 1840 and 1855 (Cleland et al. 2004a). Assuming a 15yr recognition window, the historical fire rotation was 2039yrs. If surveyors recognized a blow-down 20yrs after the event, catastrophic wind rotations would have been 425yrs, with a 30yr recognition window estimate of 637yrs. Because of the fire-resistance of undisturbed mesic deciduous forests, these estimates suggest that approximately 16% of the blown-down areas in this forest type in WI subsequently burned. WI’s northern hardwood communities experienced more wind and less fire disturbance than those in MI’s Upper Peninsula. Although wind rotations differed across the two-state area, fire rotations for northern hardwoods were uniformly very long, ranging from 1400 to more than 2000yrs.

Fire Regime Group V is applicable to this system. Severe wind events were assumed to reset mature stands on an approximate 1100yr rotation in MI’s Upper Peninsula in the following VDDT models. Most replacement fire occurs in slash created by these wind events. Forty percent of the blowdown areas burn and revert to an open land or an early-seral aspen-birch stage that lasts 60yrs. Replacement fires without associated wind events are very rare.

Insects and disease are present but in a very minor way most likely affecting individual trees versus at a stand level. As an example root and stem rot cause individual tree mortality primarily in late development. These types of disturbances would likely contribute to higher fuel loads and structural complexity of stands.

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 2117 | 100 |  |  |
| Moderate (Mixed) |  |  |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 2117 | 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

This type is a large patch or small patch system within the dominant BpS, Northern Hardwood - Hemlock, across northern MN, northern WI and the western Upper Peninsula of MI.

Adjacency or Identification Concerns

This type is mostly embedded within the Northern Hardwood-Hemlock forest and occurs as small to large patches, associated with Sugar Maple - Hemlock and Sugar Maple - Yellow Birch cover types--the latter being primarily in Subsection 212Jc and 212Xc. The maple-basswood forest type is usually associated with more nutrient-rich and moisture-rich sites.

The BpS adjacent to this system include 1310 (North-Central Interior Dry-Mesic Oak Forest and Woodland), 1311 (North-Central Interior Dry Oak Forest and Woodland), 1344 (Boreal Jack Pine-Black Spruce Forest) and 1345 (Boreal White Spruce forest and Woodland).

This system can be easily confused with 1314 (North-Central Interior Maple Basswood Forest) and 1362 (Laurentian-Acadian Northern Pine-(Oak) Forest.

Exotics and invasives such as earthworms, garlic mustard, European buckthorn and honey suckle occur presently but would not have affected this system historically. Encroachment in the form of conversion, urban sprawl and management practices (forestry and fire suppression) are effects that would not have impacted this system historically but occur in the present day.

As a result of the forest management practices in the late 1800's the majority of today's forests are second growth. In terms of structure and composition, this system is much simpler in present day lacking shrub species such as Canada yew and the successional stages tend to be younger resulting in a second growth forest. The presence of exotics and invasives in the present day forest should also be noted.

It is possible that the replanting efforts by the Civilian Conservation Core (CCC) in the 1930's have converted some of this system to red pine monoculture.

Issues or Problems

In the coarse-scale assessment, this type was called Northern Hardwoods (#51). Kuchler (1964) typed the WI portion as Northern Hardwoods, but the UP portion as Northern Hardwood-Fir. We based this description on the FRCC Northern Hardwood-Fir description document.

Native Uncharacteristic Conditions

Comments

This model for MZs 39 and 40 was adapted from the model from MZ41 created by Peggy Burkman and reviewed by Dave Cleland and Brendan Ward. Quantitative changes to Burkman's model were made by Brendan Ward in order to better represent the system; these changes were suggested during Ward's review for Great Lakes but were incorporated for Great Plains, MZs 39 and 40. No further review for MZs 39 and 40 was obtained, as we were notified of this system's occurrence in these zones at a late date, and this system is just on the outskirts of these mapzones.

This model for MZ41 is adapted from Landfire Model 511302-3 Northern Sugar-Maple-Basswood Forest by Doug Pearsall (dpearsall@tnc.org) and Brad Slaughter (slaughterb@michigan.gov). Model 511302-3 was based on Rapid Assessment Model created by Cleland, Merzenich, and Parker for biophysical setting R6NHHEgl, "Northern Hardwood-Hemlock Forest (Great Lakes)". The Landfire Model 511302-3 also used Rapid Assessment Model R6MBMHW as a basis for much of its characterization. In the MZ51 assessment, we are considering this type to be a large-patch system within a matrix of hemlock-northern hardwoods.

Comments from Rapid Assessment: In the course-scale assessment, this type was called Northern Hardwoods (#51). Kuchler typed the Wisconsin portion as Northern Hardwoods, but the UP portion as Northern Hardwood-Fir. We based this description on the FRCC Northern Hardwood-Fir description document. At the Great Lakes Rapid Assessment workshop it was agreed to rename as Northern Hardwood-Hemlock Forest (Great Lakes). Suggested reviewers: Eric Epstein (WDNR Natural Heritage Ecologist, Randy Hoffman (WDNR Natural Areas program), Eunice Padley (WDNR Div of Forestry), Mike Kost (Mich NFI), John Almendinger (MN DNR).

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 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Herb | 0.5-1.0 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Herb | >1.0 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Shrub | 0-0.5 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Shrub | 0.5-1.0 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Shrub | 1.0-3.0 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Shrub | >3.0 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Tree | 0-5 | A | A | A | A | A | A | A | A | A | A |
| Tree | 5-10 | B | B | B | B | B | B | B | B | B | B |
| Tree | 10-25 | UN | UN | UN | UN | UN | UN | E | E | C | C |
| Tree | 25-50 | UN | UN | UN | UN | UN | UN | UN | D | D | D |
| Tree | >50 | UN | UN | UN | UN | UN | UN | UN | 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 2 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| POTR5 | Populus tremuloides | Quaking aspen | Upper |
| BEPA | Betula papyrifera | Paper birch | Upper |
| POGR4 | Populus grandidentata | Bigtooth aspen | None |

Description

Class A contains early-seral stands characterized by aspen and paper birch 0-39yrs of age. It occurs due to the combination of blowdown followed by fire. Forty percent of blowdown areas burn and revert to this class.

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

Class B 4 Early Development 2 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| ACSA3 | Acer saccharum | Sugar maple | Upper |
| TIAM | Tilia americana | American basswood | Upper |
| BEAL2 | Betula alleghaniensis | Yellow birch | Upper |
| BEPA | Betula papyrifera | Paper birch | Upper |

Description

Class B contains regenerating stands 0-39yrs of age dominated by mid-tolerant northern hardwood species. Windthrow of mature stands (without subsequent fire) generally results in this class. Includes a combination of new recruits and sprouts.

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

Class C 14 Mid Development 1 - Closed

Upper Layer Lifeform is not the dominant lifeform

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| ACSA3 | Acer saccharum | Sugar maple | Upper |
| TIAM | Tilia americana | American basswood | Upper |
| BEAL2 | Betula alleghaniensis | Yellow birch | Upper |

Description

Class C contains mid-aged stands 40-150yrs of age dominated by sugar maple and basswood.

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

Class D 78 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| ACSA3 | Acer saccharum | Sugar maple | Upper |
| TIAM | Tilia americana | American basswood | Upper |
| BEAL2 | Betula alleghaniensis | Yellow birch | Upper |
| TSUGA | Tsuga | Hemlock | Upper |

Description

Class D represents old late-seral forests and the end point of succession. These stands are greater than 150yrs old. Sugar maple and basswood are co-dominants, with yellow birch, American elm, white ash and hemlock occasional.

*Maximum Tree Size Class*  
Very Large >33"DBH

Class E 2 Mid Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| POTR5 | Populus tremuloides | Quaking aspen | Upper |
| ACSA3 | Acer saccharum | Sugar maple | Mid-Upper |
| TIAM | Tilia americana | American basswood | Mid-Upper |
| BEPA | Betula papyrifera | Paper birch | Upper |

Description

Class E represents transition from fire response, early successional stands (class A) to mid-successional maple-basswood stands (class C). Stand age is from 40-89yrs.

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

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Mid2:CLS | 39 |
| Early2:ALL | 1 | Mid1:CLS | 39 |
| Mid1:CLS | 40 | Late1:CLS | 150 |
| Mid2:CLS | 40 | Mid1:CLS | 89 |
| Late1:CLS | 151 | 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 | Early1:ALL | Early1:ALL | 0.0003 | 3333 | Yes | 0 |
| Wind or Weather or Stress | Early1:ALL | Early2:ALL | 0.0004 | 2500 | Yes | 0 |
| Replacement Fire | Early2:ALL | Early1:ALL | 0.0003 | 3333 | Yes | 0 |
| Wind or Weather or Stress | Early2:ALL | Early2:ALL | 0.0004 | 2500 | No | 0 |
| Replacement Fire | Mid1:CLS | Early1:ALL | 0.0004 | 2500 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Early2:ALL | 0.001 | 1000 | Yes | 0 |
| Replacement Fire | Mid2:CLS | Early1:ALL | 0.0004 | 2500 | Yes | 0 |
| Wind or Weather or Stress | Mid2:CLS | Early2:ALL | 0.001 | 1000 | Yes | 0 |
| Alternative Succession | Mid2:CLS | Mid1:CLS | 0.01 | 100 | Yes | 0 |
| Replacement Fire | Late1:CLS | Early1:ALL | 0.0005 | 2000 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Early2:ALL | 0.001 | 1000 | Yes | 0 |

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