

13620

Laurentian-Acadian Northern Pine(-Oak) Forest

BpS Model/Description Version: Aug. 2020

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Vegetation Type

Forest and Woodland

Map Zones

51, 63, 64, 65, 66

Geographic Range

Laurentian-Acadian Northern Pine Oak Forest is a wide-ranging system occurring in Canada from Quebec west to Ontario and south in the United States in the northern Great Lakes states (Minnesota, Wisconsin, Michigan), New York, and New England (Menard and Gawler 2010).

Northern pine-oak forests occur principally on sandy glacial outwash, sandy glacial lake plains, and less often on thin glacial drift over bedrock, inland dune ridges, and coarse-textured end moraines and ice-contact ridges. Soils are typically coarse- to medium- textured sand or loamy sand and are moderately to extremely acidic with a surface layer of mor humus from accumulated pine needles (Cohen 2002). The system occurred in proximity to other pyrogenic systems such as red pine -- jack pine forest and jack pine barrens -- but had a greater tendency to occur in areas with greater topographic relief and presence of wetlands and lakes that likely combined to reduce fire severity (Albert and Comer 2008).

Vegetation Description

Typically *Pinus strobus* (white pine) and/or *P. resinosa* (red pine) form a supercanopy over a canopy of co-dominant or subcanopy trees such as *Acer rubrum* (red maple), *Betula papyrifera* (paper birch), *Populus grandidentata* (bigtooth aspen), *P. tremuloides* (trembling aspen), *Quercus alba* (white oak), *Q. rubra* (red oak), *Q. velutina* (black oak), *Q. ellipsoidalis* (northern pin oak), *Q. macrocarpa* (bur oak), *Pinus banksiana* (jack pine), *Tsuga canadensis* (eastern hemlock), *Abies balsamea* (balsam fir), *Picea glauca* (white spruce), and *P. rubens* (red spruce) (Epstein et al. 2002; MNDNR 2003; Cohen et al. 2015; NatureServe 2016). Where the system occurs adjacent to or within large peatland complexes, additional canopy species may include *Picea mariana* (black spruce) and *Thuja occidentalis* (northern white cedar) (MNFI 2016). Portions of this type that occur on more mesic portions of the landscape may include *Acer saccharum* (sugar maple), *Betula alleghaniensis* (yellow birch), and *Fagus grandifolia* (American beech), although systems where these species are prevalent should be referred to Biophysical Setting (BpS) 5113022 (Laurentian-Acadian Northern Hardwoods Forest -- Hemlock).

Small trees and shrubs are patchy to occasionally continuous. Prevalent species include balsam fir, *Prunus virginiana* (choke cherry), *Hamamelis virginiana* (witch-hazel), *Corylus cornuta* (beaked hazelnut), *Amelanchier* spp. (serviceberries), *Gaylussacia baccata* (huckleberry), *Vaccinium angustifolium* (low sweet blueberry), *V. myrtilloides* (Canada blueberry), and *Lonicera canadensis* (Canadian fly honeysuckle). On sand ridges within peatlands, species such as *Ilex mucronata* (mountain holly) and *Viburnum cassinoides* (wild raisin) may be present (MNFI 2016). Common dwarf shrubs include *Epigaea repens* (trailing arbutus), *Gaultheria procumbens* (wintergreen), *Cornus canadensis* (bunchberry), and *Chimaphila umbellata* (pipsissewa) (MNDNR 2003; Cohen et al. 2015).

The herbaceous layer in northern pine-oak forests is also patchy to continuous. Characteristic species include *Eurybia macrophylla* (large-leaved aster), *Maianthemum canadense* (Canada mayflower), *Aralia nudicaulis* (sarsaparilla), *Mitchella repens* (partridge-berry), *Pyrola elliptica* (large-leaved shinleaf), *Trientalis borealis* (starflower), *Melampyrum lineare* (cow-wheat), *Pteridium aquilinum* (bracken fern), *Dendrolycopodium obscurum* (ground-pine), *Avenella flexuosa* (wiry hair-grass), *Oryzopsis asperifolia* (rough-leaved rice-grass), *Danthonia spicata* (poverty grass), *Brachyelytrum aristosum* (long-awned wood grass), and *Carex pensylvanica* (Pennsylvania sedge) (Epstein et al. 2002; MNDNR 2003; Cohen et al. 2015). Lichens and mosses may also be prevalent in the ground layer (Menard and Gawler 2010).

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
PIRE	<i>Pinus resinosa</i>	Red pine
PIST	<i>Pinus strobus</i>	Eastern white pine
QURU	<i>Quercus rubra</i>	Northern red oak

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

Disturbance Description

The natural disturbance regime in northern pine-oak forests is characterized by both infrequent catastrophic fire and frequent stand-perpetuating surface fires. This system fits into Fire Regime Group I, with fires occurring every 10-30yrs and low- to moderate-intensity (surface) fires most common. Severe wind events affect mature stands as infrequently as >1000yrs (MNDNR 2003). Replacement fires occurred more frequently in barrens, young stands of mixed conifers, and mature closed conifers, whereas stands of mature, open conifers were primarily affected by surface fires.

Young white and red pines are killed by surface fires, becoming more resistant to fire disturbance when mature (age 50-100yrs). Once mature (~50yrs), both red pine and white pine are fire-adapted species and can withstand surface fire quite well. Mature stands are less susceptible to stand-replacing fires, due to tall crowns and the wide spacing of dominant trees, which is maintained by surface fires. However, when catastrophic crown fires do occur, mortality is high in all structural layers, and survivorship depends on random variations in fire patterns resulting in unburned areas.

Fifty to 100yrs is required for red and white pine to produce adequate amounts of viable seed for self-replacement; thus crown-fire rotations of <50-100yrs favor early successional species capable of sprouting or invasion (e.g., aspen and birch), as well as species capable of producing

seed in short periods (e.g., jack pine and black spruce). White pine is a mid-tolerant species capable of regenerating under full light to shaded conditions. Red pine is less tolerant than white pine, and seedlings can only survive in ~35% or more full sunlight. This red pine-white pine community was predominantly even-aged due to frequent stand-replacing fires, with a relatively uniform structure in terms of tree height and diameter. During fire-free periods or periods with long surface fire rotation, mid-tolerant white pine gained dominance through gap-phase regeneration. During periods of repeated surface fires, red pine was favored over white pine.

Successional dynamics within this community were driven by interactions of disturbance regimes and neighborhood effects of nearby seed sources. Areas burning twice within short periods became temporary open lands and barrens or early-successional aspen-birch.

Heinselman (1981) suggested there are two types of red-white pine systems -- those maintained by frequent surface fires and a crown-fire rotation <150yrs and those maintained by infrequent surface fires and crown-fire rotations between 150-300yrs. In the former, even-aged stands dominated, whereas in the latter systems, multi-aged white pine systems eventually developed. This description applies to red-white pine that occurred within landscape ecosystems where stand-replacing fires burned with 150yr rotations. Surface and crown fire regimes interacted to regulate age, landscape, within-stand structure, and succession within this community. Fire probability often increased with stand age due to the general increase in fuel (Clark 1990; Heinselman 1973), but individual tree susceptibility to damage or mortality from fire often declined with tree size due to increasing bark thickness and a separation of foliage from the ground, which reduces crown-fire occurrence. Red-white pine forests were disturbed by large-scale, stand-replacing, crown fires in northern Lower Michigan within rotations of 130-260yrs (Whitney 1986) and relatively frequent surface fires. In Michigan's Upper Peninsula, Zhang et al. (1999) estimated that mixed red-jack-white pine communities burned on 160yr rotations and that red-white pine communities burned on 320yr rotations. Clark (1990), Heinselman (1981), and Frissel (1973) reported rotations of 135, 180, and 150yrs, respectively, for red-white pine communities in Minnesota. Cleland et al. (2004a) estimated crown-fire rotations for the red-white pine community to be 164, 174, and 207yrs in northern Lower Michigan, Michigan's Upper Peninsula, and northern Wisconsin, respectively. Longer rotations in Wisconsin are believed to be due to a higher density of lakes and wetlands, resulting in a smaller surface area of upland landforms.

This community may have promoted surface fires by forming a deep, well-aerated litter layer of pine needles (McCune 1988). Relatively frequent surface fires (10-30yr cycles) reduced fuel loadings, eliminated living fuel ladders, and promoted widely spaced trees that became increasingly resistant to crown fires over time (Frissell 1973). Surface fire regimes favored species with survival adaptations including thick bark and tall crowns and maintained a landscape with a large proportion composed of widely spaced, large pine. Surface fires also reduced competition and limited succession of more shade-tolerant species. Area maintained by surface fire was likely inversely related to area burned by crown fire, due to reduced fuel loadings and removal of shade-tolerant, coniferous fuel ladders. Fires burning in closed forests could be quite variable in intensity -- from light surface fires to intense crown fires. Thus, each fire event represented a complex of fire types, with forest maintenance surface fires and forest-replacement crown fires interacting to form a single overall regime. Increased frequency of

maintenance fires lengthened crown-fire rotations by reducing fuel loadings and eliminating the fuel ladders that promote crown fires.

Notes from 2017 BpS review:

- Drobyshev et al. (2009) reported wide variation in fire rotation intervals for Seney National Wildlife Refuge, 30-144yrs historically, with most fires being non-replacement. Some areas had fire much more frequently. Fire frequency related to landform (also see White and Host 2008, report landform-fire relationship in Minnesota).
- Seedling establishment of red and white pines positively correlated with number of fires. See Nyamai et al. (2014) for more information.
- Magruder et al. (2013) report that thinning increases climatic resilience of red pine.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	309	16		
Moderate (Mixed)	448	11		
Low (Surface)	65	73		
All Fires	48	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

Landscape must be adequate in size to contain natural variation in vegetation and disturbance regime. Though the virgin stands of red and white pine are greatly reduced from pre-settlement conditions, scattered stands and ecosystems still exist to represent this type. The Boundary Waters Canoe Area Wilderness (BWCAW) is an example, along with the national forests in Minnesota (Chippewa, Superior), Michigan (Ottawa, Hiawatha), and Wisconsin (Chequamegon, Nicolet) and the Menominee Reservation in Wisconsin.

Adjacency or Identification Concerns

The natural range of red pine and white pine largely coincides with the extent of the Canadian shield. These pine forests were widespread in the past and included a diverse mixture of hardwood and conifer species including trembling aspen, bigtooth aspen, paper birch, white spruce, black spruce, balsam fir, red maple, sugar maple, and northern red oak. BpS 1301 -- Boreal Aspen Birch Forest has been eliminated and lumped into several other BpSs in the Great Lakes. Trembling aspen-paper birch may have been a significant component of the early successional stages of this and other BpSs.

Sites supporting dominance of *Tsuga canadensis* (>25%), with varying mixtures of *Pinus strobus*, *Thuja occidentalis*, and other northern hardwood species, such as *Betula alleghaniensis*, *Acer saccharum*, *Fagus grandifolia*, and *Quercus rubra*, and the absence of any of the Appalachian species, including *Aesculus flava*, *Betula lenta*, *Liriodendron tulipifera*, and *Quercus prinus*. *Picea glauca*, *Picea rubens*, and *Abies balsamea* <25%, are placed in Eastern Hemlock -- Eastern White Pine -- Yellow Birch Forest Group (Gawler and Faber-Langendoen 2015). Hemlock and white pine can be co-dominant at the margins of dune ridges that are otherwise characterized by more xeric red pine-white pine communities in Upper Michigan.

Other classifications (as of 2008): Michigan Natural Features Inventory: Dry-mesic Northern Forest. Minnesota: Central Dry Pine Woodland; Central Dry Oak-Aspen (Pine) Woodland; Central Dry-mesic Pine-Hardwood Forest (MNDNR 2003). Wisconsin: Northern Dry-mesic Forest (Epstein et al. 2002). National Vegetation Classification (NVC): Laurentian-Acadian Pine -- Oak Forest and Woodland Group; Associations CEG002443 *Pinus resinosa* -- *Pinus strobus*/*Corylus cornuta*/*Vaccinium angustifolium* Forest; CEG002445 *Pinus strobus*/*Acer spicatum* -- *Corylus cornuta* Forest; CEG002480 *Pinus strobus* -- (*Pinus resinosa*) -- *Quercus rubra* Forest; CEG005399 *Pinus resinosa* -- *Pinus strobus* -- (*Quercus rubra*)/*Corylus cornuta* Forest; CEG006253 *Pinus strobus* -- *Pinus resinosa*/*Cornus canadensis* Forest; CEG006506 *Quercus rubra* -- *Acer rubrum* -- *Betula* spp. -- *Pinus strobus* Ruderal Forest.

At the suggestion of the Rapid Assessment model (R6RPWff): The VDDT model was modified to increase the probability of wind storm events. Frelich has documented wind disturbance of catastrophic proportions as occurring on a 1,000-2,000yr interval. Granted that this may possibly be the landscape-level mean, wind events are far more prevalent and occur randomly and with widespread regularity throughout the range of the red and white pine cover type. Thus, using local data, the wind event probability was increased to occur on an ~250yr average.

Laurentian-Acadian Pine -- Oak Forest and Woodland Group per NVC (Menard and Gawler 2010; = Eastern White Pine -- Jack Pine -- Northern Red Oak Forest and Woodland Group). Described and modeled here is the Eastern White Pine -- Red Pine -- Northern Red Oak Forest and Woodland Alliance. The other Alliance under this Group is *Pinus banksiana* -- *Pinus resinosa* -- *Quercus ellipsoidalis* Forest and Woodland Alliance, which is described and modeled in the Great Lakes Pine Barrens BpS; 13620 may instead be the appropriate place for these jack pine forests.

[illegible]

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	A	A	A	A	A	A	A	A	A
Tree	5-10	C	C	C	C	B	B	B	B	B	B
Tree	10-25	C	C	C	C	B	B	B	B	B	B
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 13 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIRE	<i>Pinus resinosa</i>	Red pine	Upper
PIST	<i>Pinus strobus</i>	Eastern white pine	Upper
PIBA2	<i>Pinus banksiana</i>	Jack pine	Low-Mid
POTR5	<i>Populus tremuloides</i>	Quaking aspen	Mid-Upper
BEPA	<i>Betula papyrifera</i>	Paper birch	Mid-Upper
POGR4	<i>Populus grandidentata</i>	Bigtooth aspen	Mid-Upper

Description

This class is typified by barrens and open lands dominated by shrubs, sweet fern, bracken fern, blueberry, sedges, grasses, and other herbaceous plants. This stage represents 0-30yrs in time. At the start of this class, trees comprise <10% canopy cover, including those that survived a catastrophic fire event. After 5-10yrs, pine and oak seedlings and saplings will establish. If a replacement fire occurs in Early1:All, this stage will consist of scrubby oak grubs and young jack pines.

Upper-layer lifeform is not the dominant lifeform: dominant lifeform consists of low shrubs, ferns, and herbaceous species, although any existing scattered trees would be the upper-level lifeform.

Maximum Tree Size Class

Pole 5-9" DBH

Class B 13 Mid Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIRE	Pinus resinosa	Red pine	Upper
PIBA2	Pinus banksiana	Jack pine	Upper
POTR5	Populus tremuloides	Quaking aspen	Mid-Upper
BEPA	Betula papyrifera	Paper birch	Mid-Upper

Description

This class is comprised of mixed red pine-jack pine-oak stands with a bigtooth and trembling aspen-birch component that has established following a major disturbance event. This stage could establish in the absence of a nearby pine and oak seed source. This stage may include a significant component of aspens and paper birch with young pines and oaks in the understory of these pioneer species. After 30-50yrs, pine and hardwoods may begin to compete with pioneer aspens and birch and obtain canopy dominance. By 75-100yrs, aspens and birch will begin to senesce and pine and oak species will reach canopy dominance.

Maximum Tree Size Class

Medium 9-21" DBH

Class C 48 Mid Development 2 - Open

Upper Layer Lifeform: Tree

Upper Layer Canopy Cover: 0 - 40%

Upper Layer Canopy Height: Tree 5.1m - Tree 25m

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIRE	Pinus resinosa	Red pine	Upper
PIST	Pinus strobus	Eastern white pine	Upper
PIBA2	Pinus banksiana	Jack pine	Upper

Description

This class is a mid-seral stage comprised of young red pine-white pine stands 30-150yrs old. Jack pine could be a significant component of this mid-seral stages, especially following replacement or frequent fire events. This stage would occur on drier, more barren sites where aspen and birch are not a major component or where seed-producing pines seeded in after a fire event. Also, these drier sites would be more fire-prone, and therefore frequent surface fires would help maintain the open conditions of this class.

Maximum Tree Size Class

Medium 9-21" DBH

Class D 26 Late Development 1 - Closed

Upper Layer Lifeform: Tree

Upper Layer Canopy Cover: 51 - 90%

Upper Layer Canopy Height: Tree 25.1m - Tree 50m

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIRE	Pinus resinosa	Red pine	Upper
PIST	Pinus strobus	Eastern white pine	Upper
	Vaccinium spp.		Lower
COCO6	Corylus cornuta Marshall	Beaked hazelnut	

Description

Class D is comprised of mature red pine-white pine stands (>151yrs). There may be a subcanopy of hardwood species such as oaks and red maple. There may also be a low to mid-shrub layer of shrubs such as witch hazel and maple-leaved viburnum. Ground-layer species may include wintergreen and wild sarsaparilla.

Maximum Tree Size Class

Very Large >33" DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid2:OPN	30
Mid1:CLS	31	Mid1:CLS	150
Mid2:OPN	31	Late1:CLS	150
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
Alternative Succession	Early1:ALL	Mid1:CLS	0.001	1000	Yes	0
Replacement Fire	Early1:ALL	Early1:ALL	0.01	100	Yes	0
Alternative Succession	Mid1:CLS	Late1:CLS	1	1	Yes	100
Wind or Weather or Stress	Mid1:CLS	Mid1:CLS	0.002	500	No	0
Wind or Weather or Stress	Mid1:CLS	Early1:ALL	0.002	500	Yes	0
Replacement Fire	Mid1:CLS	Early1:ALL	0.002	500	Yes	0
Competition or Maintenance	Mid1:CLS	Mid2:OPN	0.02	50	Yes	0
Wind or Weather or Stress	Mid2:OPN	Mid1:CLS	0.002	500	Yes	0

Mixed Fire	Mid2:OPN	Mid1:CLS	0.002	500	Yes	0
Wind or Weather or Stress	Mid2:OPN	Early1:ALL	0.002	500	Yes	0
Replacement Fire	Mid2:OPN	Early1:ALL	0.002	500	Yes	0
Surface Fire	Mid2:OPN	Mid2:OPN	0.025	40	No	0
Wind or Weather or Stress	Late1:CLS	Mid1:CLS	0.002	500	Yes	0
Wind or Weather or Stress	Late1:CLS	Early1:ALL	0.002	500	Yes	0
Replacement Fire	Late1:CLS	Early1:ALL	0.003	333	Yes	0
Mixed Fire	Late1:CLS	Mid1:CLS	0.005	200	Yes	0
Surface Fire	Late1:CLS	Late1:CLS	0.013	77	No	0

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