Rapid Assessment Reference Condition Model

The Rapid Assessment is a component of the LANDFIRE project. Reference condition models for the Rapid Assessment were created through a series of expert workshops and a peer-review process in 2004 and 2005. For more information, please visit www.landfire.gov. Please direct questions to helpdesk@landfire.gov.

Potential Natural Vegetation Group (PNVG)

R6RPWPff **Red Pine-White Pine with Frequent Fire**

General Information

Contributors *(additional contributors may be listed under "Model Evolution and Comments")*

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Vegetation Type

Forested

Dominant Species*

PIRE, BEPA, PIST, POTR5, ABBA

General Model Sources

- ☑ Literature
- ☑ Local Data
- ☑ Expert Estimate

LANDFIRE Mapping Zones

41, 62, 50, 51

Rapid AssessmentModel Zones

☐ California	☐ Pacific Northwest
☐ Great Basin	☐ South Central
☑ Great Lakes	☐ Southeast
☐ Northeast	☐ S. Appalachians
☐ Northern Plains	☐ Southwest
☐ N-Cent.Rockies	

Geographic Range

The red pine (Pinus resinosa) and white pine (Pinus strobus) cover type is found primarily throughout northern Minnesota, Wisconsin and Michigan. It has historically been the most economically important species group in the lake states region. Red pine does not naturally extend too far into the eastern United States, though it has been established in plantations as far as Pennsylvania, New York, and into the Northeast. White pine has an extensive natural range much larger than red pine. It is also economically and biologically significant throughout the northeastern United States and in areas extending southward at the higher elevations of the Appalachian Mountains into northeast Georgia.

Biophysical Site Description

This red–white pine community historically occurred in ice-contact and glaciofluvial landforms underlain by sandy soils. The relative lack of fire protection due to homogeneous landscape patterns and absence of natural fuel breaks (Bergeron and Brisson 1990), as well as localized edaphic conditions, resulted in relatively short fire rotations, low species diversity, and short species longevity. Within these xeric, sandy landforms, red pine likely has a maximum life expectancy of 150 years and white pine around 250 years. Within forests owned by the Menominee Nation in northern Wisconsin, white pine stands less than 200 years old exhibit signs of breakup and mortality on sandy sites, whereas stands 300 to 400 years old remain intact on more mesic sites. In northern Minnesota, on mesic sites, red pine has been found to reach ages as old as 300 years and white pine has attained even longer life spans exceeding 400 years of age (Heinselman, 1981, Frelich, 2003).

Vegetation Description

Both red pine and white pine are fire-resistant and fire-adapted species. From approximately 50 years of age and older they can withstand surface fire quite well, and the mature overstory dominants are extremely fire-resistant due to their thick bark (3-4 inches).

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.

Disturbance Description

Young white and red pines are killed by surface fires, becoming more resistant to fire disturbance when mature (age 50 to 100 years) due to development of thick bark that protects the cambium. Red pine develops thicker bark than white pine, and is considered more resistant to surface fire.

Forests of both species are less susceptible to stand-replacing fires when trees are mature, due to tall crowns and the wide spacing of dominant trees that 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 100 years is required for these species to produce adequate amounts of viable seed for self-replacement; thus crown-fire rotations of less than 50 to 100 years 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 approximately 35 percent 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 due to the species' thicker bark and its resultant higher tolerance of fire.

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 openlands and barrens, or early-successional aspen-birch. This system fits into Fire Regime Group I, with fires occurring every 10 to 30 years and low to moderate intensity (surface fires) most common. Severe wind events affect mature stands on an approximate 500-year interval. 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.

Heinselman (1981) suggested there are two types of red-white pine systems, those maintained by frequent surface fires and a crown-fire rotation less than 150 years, and those maintained by infrequent surface fires and crown-fire rotations between 150-300 years. 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 150-year rotations. Surface and crown fire regimes interacted to regulate age, landscape and within-stand structure,

and succession within this community. Fire probability often increased with stand age due to the general increase in fuel (Clark 1989, 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 to 260 years (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 160-year rotations, and red–white pine communities burned on 320-year rotations. Clark (1990), Heinselman (1981) and Frissel (1973) reported rotations of 135, 180, and 150 years, 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 207 years 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 to 30-year 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.

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.

Scale Description

Sources of Scale Data ☑ Literature ☑ Local Data ☑ Expert Estimate

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).

Issues/Problems

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 1000 to 2000-year 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 approximately 250-year average.

Model Evolution and Comments

Historical fire size ranged from small acreages (<1000 acres) to extremely large events (>100,000 acres or 40,000 ha) (Heinselman, 1978). To capture a range of ecologically significant fire events, the following values were used: Minimum = 1000 ac, maximum = 100,000 ac, with an average of 10,000 ac.

*Succession Classes***

Succession classes are the equivalent of "Vegetation Fuel Classes" as defined in the Interagency FRCC Guidebook (www.frcc.gov).

Class A 5%

Early1 All Struct

Description

Class A is typified by barrens and open lands dominated by Carex, grasses, and herbaceous plants. Trees comprise less than 10% canopy cover.

Dominant Species* and Canopy Position

PIRE
PIST

Upper Layer Lifeform

☑ Herbaceous
☐ Shrub
☐ Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	no data	no data
Tree Size Class	Seedling <4.5ft	

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.

Class B 25 %

Early2 Closed

Description

Class B is comprised of mixed red pine-jack pine-oak stands. May include a significant component of aspen, paper birch, red maple, northern red oak and pin oak.

Dominant Species* and Canopy Position

PIRE	Upper
PIBA2	Upper
POTR5	Mid-Upper
QURU	Mid-Upper

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	40 %	100 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Class C 30 %

Early3 Open

Description

Class C is comprised of young red pine-white pine stands < 50 years old.

Dominant Species* and Canopy Position

PIRE	Upper
PIST	Upper

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	0 %	40 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Class D 30 %

Late1 Open

Description

Class D is comprised of mature red pine-white pine stands (>50 yrs) maintained by frequent surface fires.

Dominant Species* and Canopy Position

PIRE	Upper
PIST	Upper

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	0 %	40 %
Height	Tree Medium 10-24m	Tree Giant >50m
Tree Size Class	Very Large >33"DBH	

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Class E 10 %

Late1 Closed

Description

Class E is comprised of mature red pine-white pine stands (>50 yrs) with significant ladder fuels that result from lack of surface fires for >30 yrs.

Dominant Species* and Canopy Position

PIRE	Upper
PIST	Upper
POTR5	Middle
ABBA	Middle

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	40 %	100 %
Height	Tree Short 5-9m	Tree Giant >50m
Tree Size Class	Very Large >33"DBH	

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

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Disturbances

Disturbances Modeled

- ☑ Fire
- ☐ Insects/Disease
- ☑ Wind/Weather/Stress
- ☐ Native Grazing
- ☐ Competition
- ☐ Other:
- ☐ Other:

Historical Fire Size (acres)

Avg: 10000
Min: 1000
Max: 100000

Sources of Fire Regime Data

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Regime Group: 1

I: 0-35 year frequency, low and mixed severity
II: 0-35 year frequency, replacement severity
III: 35-200 year frequency, low and mixed severity
IV: 35-200 year frequency, replacement severity
V: 200+ year frequency, replacement severity

Fire Intervals (FI)

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class. All values are estimates and not precise.

	Avg FI	*Min FI*	*Max FI*	*Probability*	*Percent of All Fires*
Replacement	56			0.01786	38
Mixed	60			0.01667	36
Surface	84			0.01190	26
All Fires	22			0.04643	

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