

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)

R6JAPI Great Lakes Pine Forest: Jack Pine

General Information

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

Modelers

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Vegetation Type

Forested

General Model Sources

- Literature
 Local Data
 Expert Estimate

Rapid Assessment Model Zones

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

Dominant Species*

PIBA2 BETU
PIRE POTR5
PIST
PIMA

LANDFIRE Mapping Zones

41
50
51

Geographic Range

System occurs in Michigan, Minnesota, and Wisconsin.

Biophysical Site Description

The jack pine community is endemic to very dry, nutrient-impoverished landscape ecosystems. These ecosystems occur in landforms deposited by high-energy glacial melt waters, principally outwash plains and glacial lakebeds, underlain by well-sorted coarse-textured sandy soils. In Minnesota, jack pine also occurs on bedrock-controlled shallow soils with limited moisture storage capacity. It is commonly associated with barrens. Jack pine often occurs with red pine, and the community includes a spruce associate in Minnesota. Oak species and white pine may be present in low densities, and aspen and birch also occur within areas of less xeric soils. Jack pine also occurs within wetlands.

Vegetation Description

This type is characterized mainly by jack pine in early stages with a mix of oak, red pine, white pine, aspen, and birch.

Jack pine is a fast-growing, short-lived, fire-dependent species that grows farther north than any other North American pine and is the most widely-distributed pine species in Canada. It is generally regarded as a pioneer species or "fire-disclimax", and is capable of self-replacement. In the absence of fire or other catastrophes, jack pine is succeeded by more tolerant or longer-lived species, but on the poorest, driest sites it may persist as an edaphic climax (Brubaker 1975).

Jack pine is one of the most shade-intolerant trees in its native range, requiring full light for growth and survival. It usually grows in even-aged pure stands, although mixed stands also occur. Jack pine's adaptation to catastrophic fire is largely due to its capacity to produce viable seed within a decade or so of establishment, aerial seed protection and storage in serotinous cones, delayed seed release following fire, and prolific germination of released seed. High seedling densities (2,000 to 5,000 per acre) effectively compete with other re-establishing or invading species and self-thin over time. In the southern part of its range, cones are both serotinous and nonserotinous (Zasada et al. 1992).

Following ignition, jack pine promotes crown fires due to

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high concentrations of volatile foliar substances, dense foliage, and retention of lower branches that form fuel ladders. Thus surface fires are not common within well-stocked jack pine communities. Fires recurring in less than 10 to 15 year intervals prevent jack pine from surviving long enough to produce viable seed, maintaining associated barrens and openlands that comprise 10-20% of the landscape.

Jack pine regenerates successfully after high-intensity crown fires, although a relatively low temperature of 120°F is required to open jack pine cones, so even low-intensity fires are capable of releasing seed. Jack pine trees are susceptible to mortality during or following a fire, and populations of jack pine tend to survive as seeds (McCune 1988).

Jack pine stands become susceptible to mortality through natural senescence, as well as insects and disease, after 60 to 80 years. However, vigorous trees 185 years old have been found in northwestern Minnesota. Dead stands pose a severe crown fire risk throughout the year, until snags blow down and decompose. In the northern half of the Lower Peninsula of Michigan, 91% of all line trees recorded by General Land Office surveyors within xeric outwash plains were pine species (Figure 1). Jack pine represented 54% and “pine” recorded only to the genus level 17% of the total; it is likely that a large proportion of the undifferentiated pine were jack or red pine. Red and white pine represented 31%, and early successional oak, aspen, and birch represented 4.4% of the total count of GLO line trees. In the Upper Peninsula of Michigan, 81% of all line trees recorded by General Land Office surveyors within xeric outwash plains were pine species and 90% were upland conifers. Jack pine represented 55%, red and white pine 24%, spruce-fir 9%, and early successional aspen and birch 4.4% of the total count of GLO line trees. In Wisconsin, 84% of all corner and quarter-corner trees recorded by General Land Office surveyors within xeric outwash plains were pine species (Figure 3). Jack pine represented 54%, red and white pine 30%, and early successional oak, aspen and birch 13% of the total count of GLO corner and quarter-corner trees. The higher proportion of aspen and birch in Wisconsin is due to less xeric soils. The proportion of jack pine, red pine, and white pine in the GLO records is consistent with expected fire return intervals for a 50-year fire rotation based on a negative exponential curve. Roughly 80% of the total area would have escaped fire long enough for jack pine to produce viable seed (10 years) and then burn sometime within the next 50 years. Another 30% of the area would not have burned for at least 60 years, long enough for red and white pine to mature, reproduce, and develop the bark thickness and canopy height necessary to survive the relatively infrequent surface fires that maintained wide tree spacing and thereby reduced crown fire occurrence.

Disturbance Description

Fires occur every 30 to 40 years and replacement fires occur every 50 years. Severe wind events affect mature stands on an approximate 250-year interval. This results in an overall wind rotation of 500 years.

Fire behavior in jack pine stands is usually of the highest intensity observed in the boreal forest (de Groot et al. 2004). Jack pine is not only highly adapted to frequent crown fire regimes, it usually requires catastrophic fire to regenerate successfully or to compete with longer-lived or more shade-tolerant species.

Cleland et al. (2004) reported a 59-year historical fire rotation for jack pine in northern Lower Michigan. Whitney (1986) reported an 80-year fire rotation, and Leahy and Pregitzer (2003) a 100-year fire rotation for jack pine in northeastern Lower Michigan. Zhang et al. (1999) reported a 130-year rotation for jack pine in Michigan's Upper Peninsula. Heinselman (1981) reported a 50-year rotation for jack pine in Minnesota. Ongoing research (Cleland et al. 2004a) indicates jack pine ecosystems in Michigan's Upper and Lower Peninsula and Wisconsin had comparable historical stand-replacing fire rotations of 50-60 years, and much shorter rotations within the openland component of this landscape ecosystem.

Jack pine ecosystems embedded within a wetland matrix, principally in the eastern Upper Peninsula of Michigan and in Minnesota, are believed to have naturally longer fire rotations due to low contagion of fire from nearby communities.

Adjacency or Identification Concerns

May include PNV types R6JAP1op, R6JPRP, R6JPOK.

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

Scale Description

Sources of Scale Data Literature Local Data Expert Estimate

Fires which burned over 1,000 to 100,000 acres created large landscapes with this vegetation type. Lowlands, shorelines, and wetlands embedded in this type burned during dry years and were skipped in wetter years, creating mosaics across the landscape.

Issues/Problems

Model Evolution and Comments

Succession Classes**

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

Class A 20%

Early1 All Struct

Description

Barrens dominated by Carex spp., grasses, and herbaceous plants. Trees comprise less than 10 percent canopy coverage. All fires are replacement and set this class back to barrens. Without fire, barrens persist for 25 years before they usually regenerate to jack pine. Depending upon available seed source, approximately 15 percent of barrens are regenerated to red pine using the AltSuccession disturbance.

Dominant Species* and Canopy Position

PIBA2 Upper

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model 2

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	100 %
Height	Herb Short <0.5m	no data
Tree Size Class	no data	

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

Class B 20%

Early2 Open

Description

Young jack pine stands less than 15 years of age. Non-seed bearing. Fires are 60% replacement and 40% mixed. Since jack pine does not produce viable seed until about age 15, replacement fires result in a barren.

Dominant Species* and Canopy Position

PIBA2 Upper
NVEG

Upper Layer Lifeform

- Herbaceous
 Shrub
 Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	30 %
Height	Tree Regen <5m	Tree Short 5-9m
Tree Size Class	Seedling <4.5ft	

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

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Class C 40%

Late2 Closed

Description

Jack pine-dominated stands aged 15 to 100 years. Fires in this class are 80% replacement and 20% mixed. Fire severity increases with age. Replacement fires result in a young jack pine stand. In stands that escape replacement fire for 100 years, the jack pine die. These stands then succeed to young red pine.

Dominant Species* and Canopy Position

PIBA2 Upper
PIRE Upper
QURU Middle

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	Max
Cover	30 %	60 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Medium 9-21"DBH	

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

Class D 10%

Early3 Open

Description

Open red pine/jack pine stands less than 50 years of age. Fires are 50% replacement and 50% mixed. Since red pine on these sites doesn't produce sufficient viable seed until age 50, replacement burns result in a barren.

Dominant Species* and Canopy Position

PIRE Upper
PIBA2 Upper
QURU Middle
PIST Upper

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 9

Structure Data (for upper layer lifeform)

	Min	Max
Cover	0 %	30 %
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 E 10%

Late3 All Structu

Description

Open and closed red pine stands greater than 50 years of age. Larger red pine are more resistant to wildfire. Assumed fire severities are 90% non-lethal surface fires and 10% replacement fires. Red pine stands die after age 150 and revert to young red pine stands. Surface fires maintain stands at a lower stocking level resulting in less moisture competition for individual trees. Repeated surface fires prolong the life of the large trees.

Dominant Species* and Canopy Position

PIRE Upper
PIST Upper
PIMA Upper
QURU Middle

Upper Layer Lifeform

- Herbaceous
- Shrub
- Tree

Fuel Model 10

Structure Data (for upper layer lifeform)

	Min	Max
Cover	30 %	90 %
Height	Tree Short 5-9m	Tree Tall 25-49m
Tree Size Class	Large 21-33"DBH	

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

Disturbances

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Disturbances Modeled

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

Historical Fire Size (acres)

Avg: 1000
 Min: 100
 Max: 100000

Sources of Fire Regime Data

- Literature
- Local Data
- Expert Estimate

Fire Regime Group: 2

- 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.

	<i>Avg FI</i>	<i>Min FI</i>	<i>Max FI</i>	<i>Probability</i>	<i>Percent of All Fires</i>
<i>Replacement</i>	50			0.02	67
<i>Mixed</i>	143			0.00699	23
<i>Surface</i>	333			0.00300	10
<i>All Fires</i>	33			0.03	

References

Needed from Cleland, Merznick and Johnson!