

Fire Regime Condition Class (FRCC) Interagency Handbook Reference Conditions

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PNVG Code: JPBS

Potential Natural Vegetation Group: Great Lakes pine forests: Jack pine /Black spruce

Geographic Area: Northern Minnesota.

Description: Near-Boreal Jack pine / Black spruce forests. Forests on poor-quality sandy or rocky soils. These sites also include white spruce, aspen, paper birch, balsam fir, white spruce, and red maple.

Jack pine is a fast growing, short-lived fire-dependent species that grows farther north than any other American pine and is the most widely distributed pine species in Canada. Black spruce is a slower-growing, long-lived species that ranges from northern Massachusetts to northern Labrador on the Atlantic coast, extending west across Canada to Alaska. The southern limit for both species extends to northern lower Michigan, northern Wisconsin, and Minnesota. Jack pine is confined to regions having a short fire cycle, while black spruce can maintain itself with or without fire.

Once established, jack pine and black spruce are both adapted to growing across a wide range of site conditions and soils. However, competition by faster growing or more shade tolerant species limits their dominance to droughty infertile soils, as well as poorly drained organic soils. Black spruce is also adapted to survival in acid organic soils. This description and model applies to jack pine and black spruce on upland, primarily sandy or shallow soils of northern Minnesota.

Black spruce and jack pine are capable of self-replacement following stand-replacing fires. Jack pine's adaptation to catastrophic fire is largely due to its ability to produce viable seed within a decade or so of establishment, aerial seed protection 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).

Black spruce exhibits similar adaptations to fire as jack pine, although it requires a longer period to produce viable seed, which is released from semi-serotinous cones in large amounts following fire. Resulting high densities of seedlings exhibit slower rates of growth than jack pine (Vasiliauskas and Chen 2002). In contrast to jack pine, black spruce is a long-lived species capable of reproducing in the absence of fire due to its shade-tolerance and its ability to reproduce vegetatively through layering. It is therefore adapted to both short and long fire-free periods, being able to persist with or without fire for centuries (Le Goff and Sirois 2004), and exists in an old growth state over extensive areas within its range (Harper et al. 2003).

Successional dynamics are influenced by complex interactions between fire history, topographic position, climate, the prefire vegetation, and fire behavior (Arseneault 2001). Jack pine effectively self-replaces following fire, with the even-aged cohort eventually dying during long fire-free periods, leading to succession to black spruce, white spruce, balsam fir, and paper birch (Frelich and Reich 1995). Following stand-replacing fire, black spruce replaces itself beneath pure stands, but in mixed jack pine stands, black spruce forms a subcanopy that persists in low light conditions (Lesieur et al. 2002). Under these conditions, black spruce eventually replaces jack pine during secondary succession as senescent jack pine stands break up (Larsen and Macdonald 1998).

Le Goff and Sirois (2004) describe how fire interval can influence the dynamics of black spruce and jack pine in upland and lowland boreal forests of Canada. They concluded that fire intervals less than 60 years lead to the local extinction of black spruce, and those over 220 years lead to that of jack pine (Figure 1).

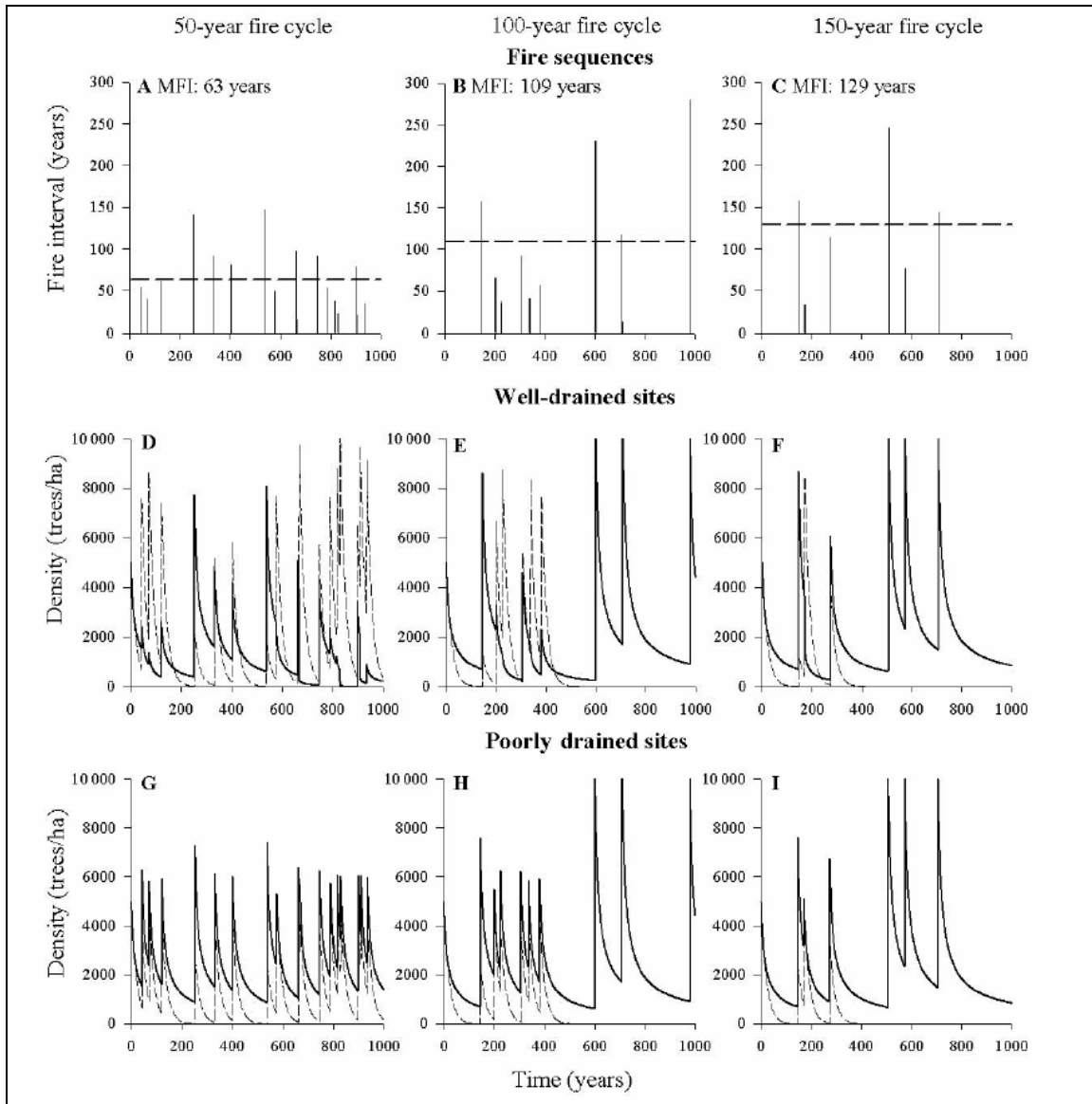


Figure 1. From H elo ise Le Goff and Luc Sirois 2004. "Fire sequences and simulated densities of jack pine and black spruce in well-drained and poorly drained sites for 50, 100, and 150 year fire cycles. The mean fire interval (MFI) is indicated by a horizontal dashed line on the upper graphs representing the fire sequences. Black spruce is represented by a bold line, and jack pine is represented by a broken line."

Fire Regime Description: Fire regime group IV with fires occurring every 50 to 100 years and high stand replacement severity. Severe stand-replacing wind events affect mature stands on an approximate 1,000-year interval.

Stand-replacing fire rotations reported in the literature for the jack pine-black spruce community were 50 years in Minnesota (Heinselman 1981), 60 years in Ontario (Chandler et al. 1983), and 100 years in Quebec (Chandler et al. 1983). Larsen (1997) reported fire rotations of 39, 78, and 96 years for jack pine, black spruce, and white spruce, respectively, in boreal forests of northern Alberta.

Following ignition, jack pine and black spruce promote crown fires due to 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- black spruce communities.

Fires recurring in less than 10 to 15 year intervals prevent jack pine and black spruce from surviving long enough to produce viable seed, favoring maintenance or establishment of associated barrens and openlands that historically comprised 10-20% of the landscape and provide germination niches for invading light-seeded white birch and aspen. Fires occurring in rotations greater than 60- 100 years lead to replacement of jack pine by black spruce, as well as white spruce, cedar, balsam fir, and paper birch (Frelich and Reich 1995).

Vegetation Type and Structure

Class*	Percent of Landscape	Description
A: early-seral open (aspen/birch)	30	Early seral aspen/birch stands (0-60 yrs)
B: mid seral open (young jpine/bspruce)	20	Young jack pine and black spruce stands less than 15 years of age. Fires normally result in aspen/birch (class A)
C: mid-seral closed (mid pine/bspruce)	40	Jack pine / black spruce dominated stands 15 to 100 years
D: late-seral closed (mature mixed conifer)	10	Mixed conifer stands > 100 years. Dominant species are black spruce, balsam fir, and white spruce. Birch and other early seral species occur in canopy gaps.
Total	100	

*Formal codes for classes A-E are: AE10, BM10, CM1C, and DL1C, respectively.

All fires are stand replacing. Conifer stands (classes B, C, and D) burn at a rate of 2 % per year (50 year fire rotation). Aspen/birch stands (class A) are assumed to burn on a 150-year rotation (0.67% per year). Jack pine and black spruce cones are serotinous, and areas quickly regenerate to jack pine/black spruce. Areas that burn twice within a 15-year period (class B) revert to early seral aspen/birch stands. Mixed conifer stands may revert to young jack pine/black spruce or aspen/birch, dependent upon availability of seed source.

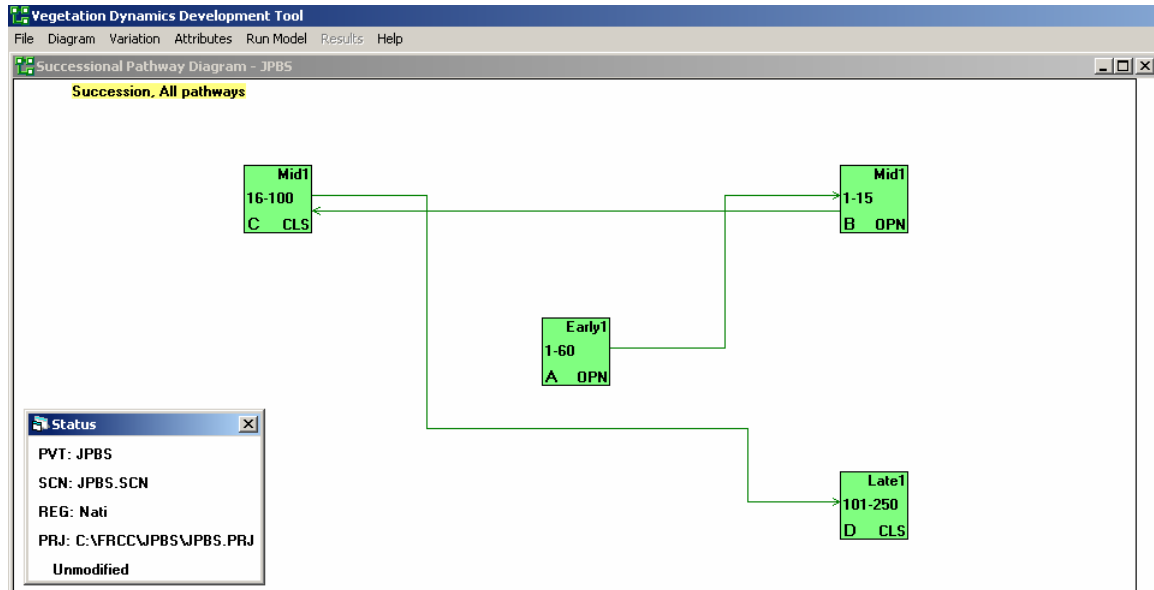
Fire Severity	Fire Frequency (yrs)	Probability	Percent, All Fires	Description
Replacement Fire	62	.016	100	Conifer stands burn on a 50 year and aspen/birch on a 150 year rotation
Non-Replacement Fire	NA	NA	NA	
All Fire Frequency*	62	.016	100	

*All Fire Probability = sum of replacement fire and non-replacement fire probabilities. All Fire Frequency = inverse of all fire probability (previous calculation).

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VDDT file documentation: Model is located in C:\FRCC\JPBS. Text files must be located in C:\FRCC for project file to work. Diagram shows succession only.



Disturbance probabilities by class: VDDT model JPBS

Class	To	Agent	Prob	TSD	Freq/ FRI	Rel Age
A	A	Replacement fire	.0067	0	150	-60
A	A	Wind/weather/stress	.0005	0	2000	-60
B	A	Replacement fire	.02	0	50	0
C	B	Replacement fire	.02	0	50	0
C	B	Wind/weather/stress	.001	0	1000	0
D	A	Replacement fire	.005	0	200	0
D	B	Replacement fire	.015	0	67	0
D	B	Wind/weather/stress	.001	0	1000	0

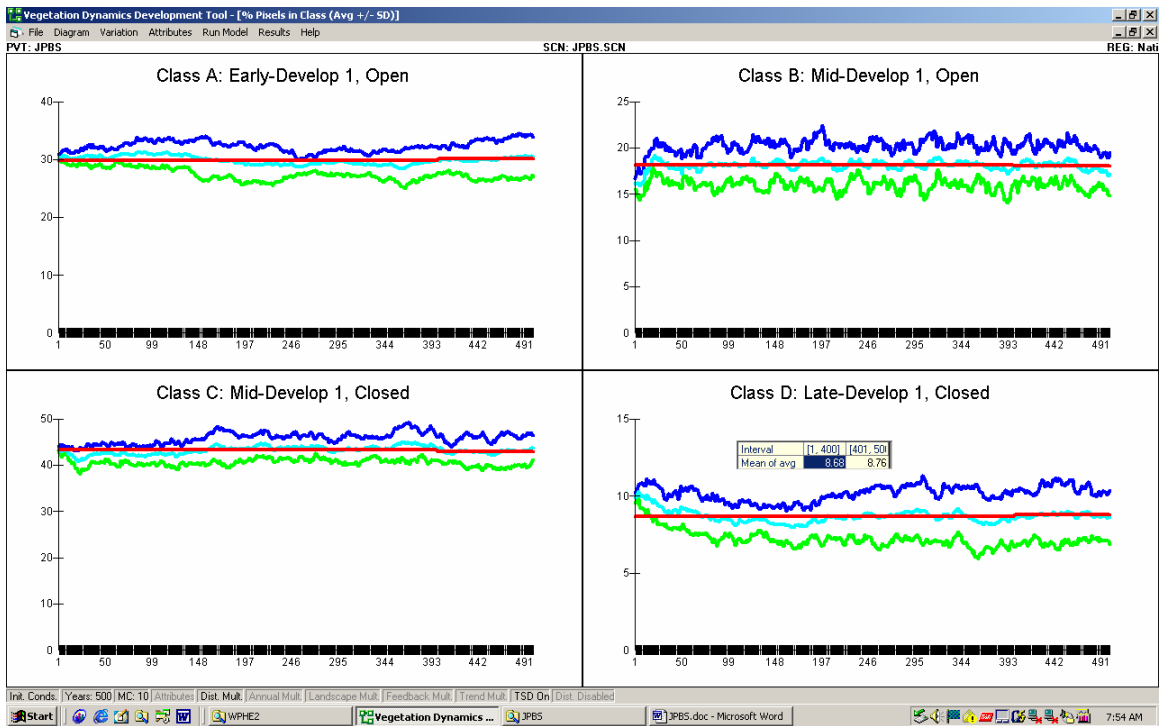
Class A – early seral aspen/birch < 60 yrs: Succeeds to class B. This class results when 2 fires occur in rapid succession (15 years or less) eliminating a conifer seed source; may also result from fire in class D. Stands < 30 years are not susceptible to windthrow.

Class B – young jack pine/black spruce < 15 yrs: Succeeds to class C. Replacement fires result in aspen/birch.

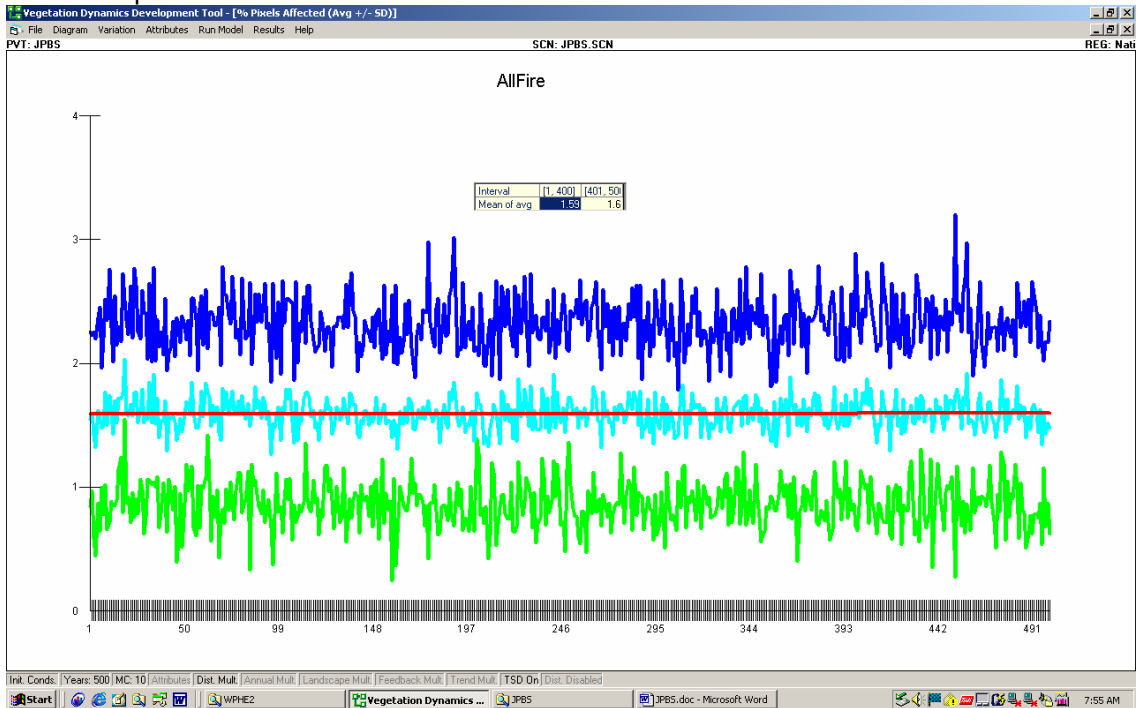
Class C – jack pine/black spruce dominated stands 16-100 yrs): Succeeds to class D. Replacement fire results in young jack pine/black spruce stand (class B).

Class D – mixed conifer stands > 100 yrs : End point of succession. One-fourth of replacement fires result in aspen/birch (class A) due to lack of jp/bs seed source.

Results: Percent of area by class for 500 years. Average + or - 2 standard deviations.



All fire frequency: 1.6 % of the area burns/year for a fire return interval (FRI) of 62 years. All fires are replacement.



Windthrow frequency (no graph): 0.07 % of mature stands are windthrown per year for an average windthrow rotation of about 1400 years.