

Fire Regime Condition Class (FRCC) Interagency Handbook Reference Conditions

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PNVG Code: RPWP2

Potential Natural Vegetation Group: Great Lakes pine forests: Red pine/White pine #2

Geographic Area: Michigan, Minnesota, and Wisconsin

Description: Red pine and white pine in areas interspersed with lakes or other fire barriers, located primarily in northern Wisconsin, the upper peninsula of Michigan, and northern Minnesota.

This red – white pine community occurred within ice-contact and glaciofluvial glacial deposits with high densities of lakes, streams, and wetlands. Pitted or heavily dissected landforms formed a complex of uplands and lowlands, and natural fuel breaks reduced the propagation of wildfire across heterogeneous landscapes (Turner et al. 1989, Motzkin et al.1999).

Fire regimes were associated not only with degree of fire protection afforded by landscape patterns (Bergeron and Brisson 1990), but also with localized edaphic conditions that affected community composition, species longevity, age at which viable seed is produced, and other physiological responses. The soils underlying this community were generally loamier and more fertile than those within the more xeric sandy soils of lower Michigan.

Within these landforms and soils, species longevity was relatively high; red pine likely had a maximum life expectancy of 250 to 300 years, white pine 300 to 400 years. Within the Menominee Nation's forest in northern Wisconsin, white pine stands less than 200 years old exhibit signs of stand breakup and mortality on sandy sites, whereas stands 300 to 400 years old remain intact on more mesic sites. These more fertile soils also supported a denser understory of fire-resistant deciduous shrubs and herbaceous plants along the forest floor.

Young white and red pines are killed by surface fires, becoming resistant to surface fire 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. Both species are somewhat adapted to avoiding stand-replacing fires when mature due to development of tall crowns, as well as the wide spacing of dominant trees 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.

A large proportion of this red pine - white pine community was historically in an old growth state, with a predominantly multi-aged (Holla and Knowles 1988) or uneven-aged distribution due to continuous recruitment caused by local disturbances (Quinby 1991). Structurally, these forests were uniform with respect to tree height and diameter. During fire-free or long surface fire rotation periods, mid-tolerant white pine gained dominance through gap phase regeneration dynamics. During periods of repeated surface fires, red pine was favored due to the species' thicker bark, hence higher tolerance of fire.

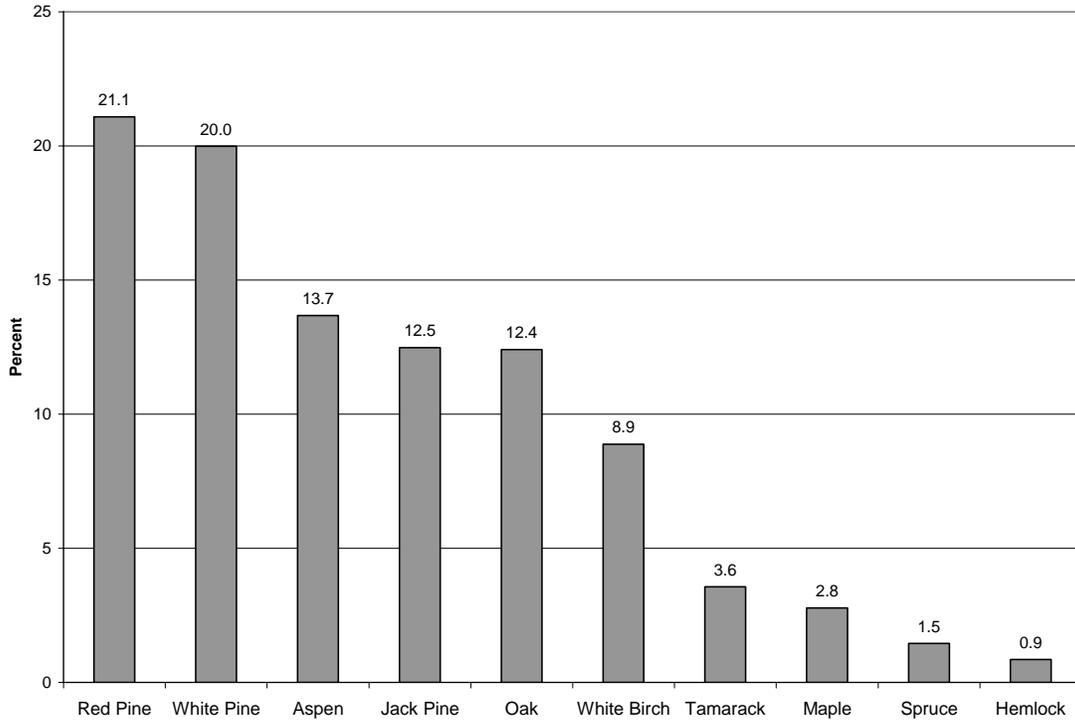


Figure 1. Percentage of trees in each species recorded within GLO line notes for the “red pine - white pine” potential natural vegetation group of northern Wisconsin.

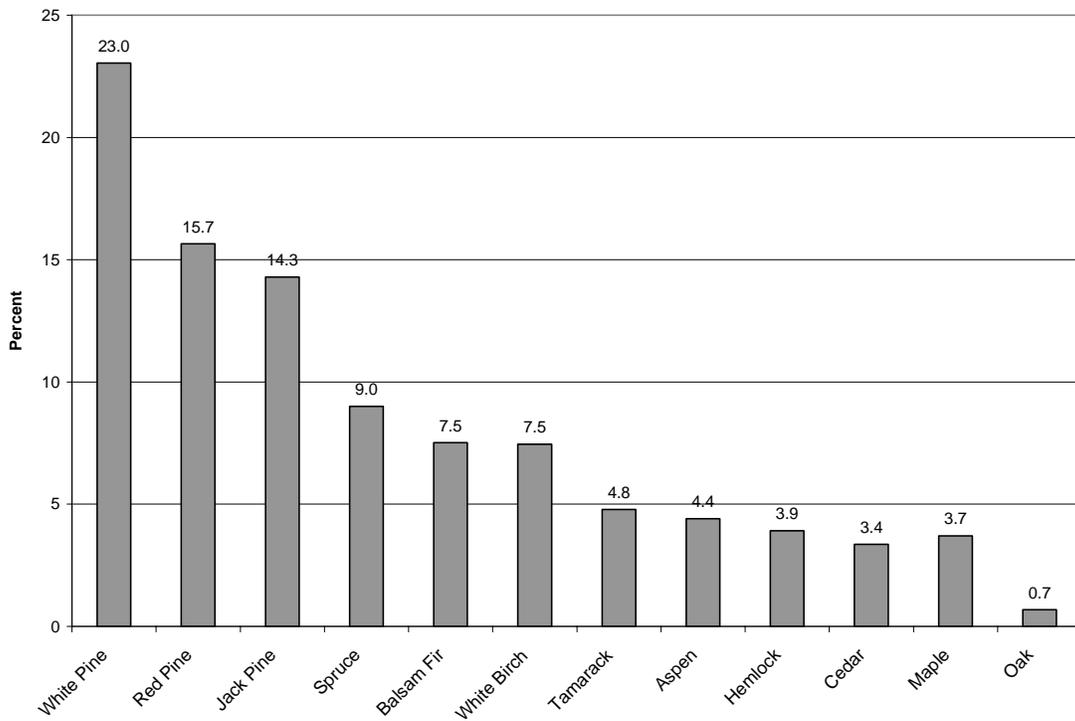


Figure 2. Percentage of trees in each species recorded within GLO line notes for the “red pine - white pine” potential natural vegetation group of Michigan’s Upper Peninsula.

Percentage of trees in each species recorded by General Land Office surveyors as line trees in the mid-1800's for northern Wisconsin and the upper peninsula of Michigan and are displayed in Figures 1 and 2. In the northern Wisconsin, white, red, and jack pine comprised 54% of corner-quarter trees, and early successional aspen, birch, and oak comprised 35%. In the upper peninsula, white, red, and jack pine comprised 53% of line trees, spruce-fir 16%, and early successional aspen, birch, and oak 13%. Subregional differences include more aspen, birch, and oak in Wisconsin, and more spruce and fir in the upper peninsula.

The prevalence of aspen, birch, and oak within Wisconsin may be due to the high density of lakes, riparian zones, and wetlands interspersed within upland landscape ecosystems that not only affected degree of protection, but also provided a complex of wet and dry niches. Aspen and white birch are adapted to establishing in both environments, and therefore might have a competitive advantage in this type of landscape ecosystem. Oak was uncommon in Michigan's upper peninsula.

Fire Regime Description: Fire regime group III, with fires occurring every 50 years and low to moderate intensity surface fires most common. High intensity crown fires occur on 290-year rotations. Severe wind events affect mature stands on an approximate 500-year interval.

Heinselman (1981) suggested there are two types of red-white pine systems: those maintained by frequent surface fires and crown-fire rotation less than 150 years, and those maintained by less frequent surface fires and crown-fire rotations between 150-300 years. In the former, even-aged stands dominate, whereas in the latter, multi-aged white pine systems develop. This description applies to red – white pine communities occurring within landscape ecosystems with properties resulting in long (150-300 year) stand-replacing fire rotations. Surface and crown fire regimes historically interacted to regulate age, landscape and within-stand structure, and succession within this community. Natural fuel breaks imposed by high lake and wetland densities inhibited fire spread within the landscapes this community dominated, resulting in a relatively long fire rotation of 250 years. In northwestern Quebec, Dansereau and Bergeron (1993) similarly found that a large, homogenous landscape, devoid of lakes, had larger fires and fires of greater intensity compared with a landscape containing numerous water bodies and rough topography. Bergeron (1991) also documented similar traits for mainland versus islands in a large lake.

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. This community may have promoted surface fires by forming a deep, well-aerated litter layer of pine needles (McCune 1988). Relatively infrequent surface fires (30 – 50 years) reduced fuel loadings, eliminated living fuel ladders, and promoted widely spaced trees that became increasingly resistant to crown fires. Surface fires also reduced competition and succession to more shade tolerant species.

Red – white pine forests were disturbed by large-scale stand replacing crown fires within rotations of 130 to 260 years (Whitney 1986) in northern lower Michigan and by relatively frequent surface fires. In Michigan's upper peninsula, Zhang et al. (1999) estimated mixed red-jack-white pine communities burned on 160-year rotations, and red-white pine communities 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 and resulting smaller surface area of upland landforms.

Surface fires burned at 30 – 50 year intervals on these more mesic or protected sites (Clark 1990). The amount of 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. Surface fire regimes favored species with survival adaptations including thick bark and tall crowns, and maintained a landscape with a large proportion of widely spaced, large pine.

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 with two separate components. A single fire could represent one or both of these regimes.

Vegetation Type and Structure

Class*	Percent of Landscape	Description
A: post replacement	0 (1)	Barrens dominated by <i>Carex</i> spp., grasses, and herbaceous plants. Trees comprise less than 10% canopy coverage.
B: mid-seral closed	5	Mixed jack pine/ red pine/ oak stands. May include red maple and small patches of aspen/birch.
C: mid-seral open	15	Young red pine/white pine stands < 50 years old.
D: late-seral open	40	Mature red pine/white pine stands (> 50 yrs) maintained by frequent surface fires
E: late-seral closed	40	Mature red pine/white pine stands (> 50 yrs) with significant ladder fuels that result from lack of fire for 30 or more years
Total	100	

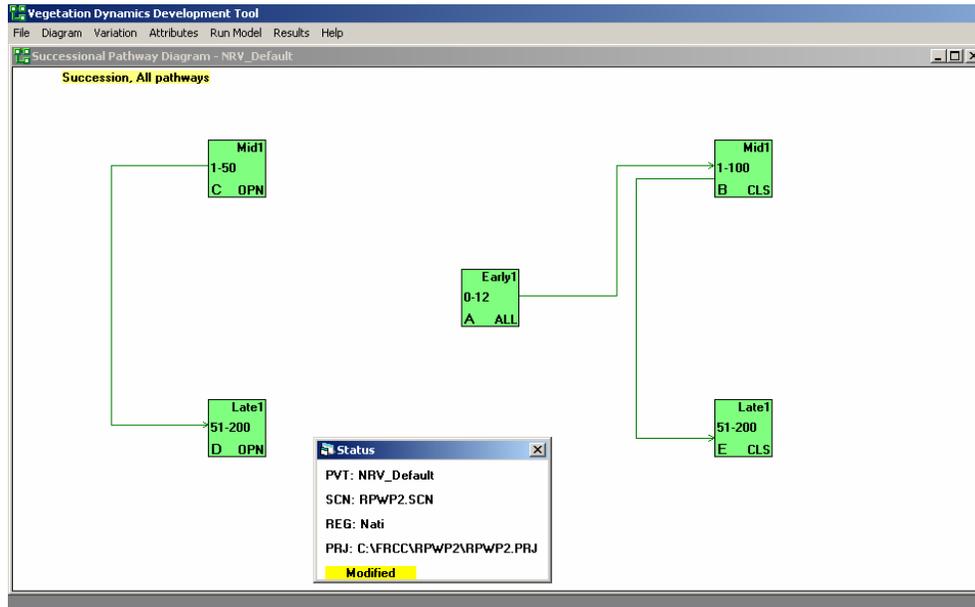
Fire Severity	Fire Frequency (yrs)	Probability	Percent, All Fires	Description
Replacement Fire	290	.0034	15	Primarily surface fire in older red pine. Mixed fire in young classes.
Non-Replacement Fire	60	.0168	85	
All Fire Frequency*	50	.02	100	

*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 RPWP2 located in C:/FCCC/ RPWP2. Load VDDT text files into C:/FCCC for project file to work. Diagram shows succession only.



Disturbances by class: Model RPWP2

Class	To	Agent	Prob	TSD	Freq/ FRI	Rel Age
A	A	Replacement fire	.025	10	50	-12
A	C	AltSuccession**	.5	0	NA	0
B	A	Replacement fire	.0025	10	410	0
B	B	Replacement fire	.0100	10	110	-100
B	B	Mixed fire	.0125	10	90	0
B	B	Wind/weather/stress	.001	0	1000	-100
B	E	AltSuccession**	.5	0	NA	0
C	C	Replacement fire	.00625	10	170	-50
C	A	Replacement fire	.00625	10	170	0
C	C	Mixed fire	.0125	10	90	0
D	C	Replacement fire	.00125	10	810	-150
D	C	Surface fire	.02375	10	52	0
D	D	Wind/weather/stress	.002	0	500	
D	D	AltSuccession	1.0	30	NA	0
E	C	Replacement fire	.0025	0	400	0
E	D	Mixed fire	.0225	0	44	0
E	C	Wind/weather/stress	.002	0	500	0

** Alternative succession is only applied at the last age of the class. On the VDDT disturbance (Pathways from) table select **Display**, then **Show Ages**, to apply.

The average fire return interval for all classes is 50 years. There is a minimum 10 year interval between fires. Catastrophic wind replaces mature stands at an average frequency of 500 years.

A: Barrens: All fires are replacement and set this class back to barrens. Without fire, barrens persist for 12 years before they regenerate to jack pine/red pine/oak/aspens (50%) or open red pine/white pine (50%).

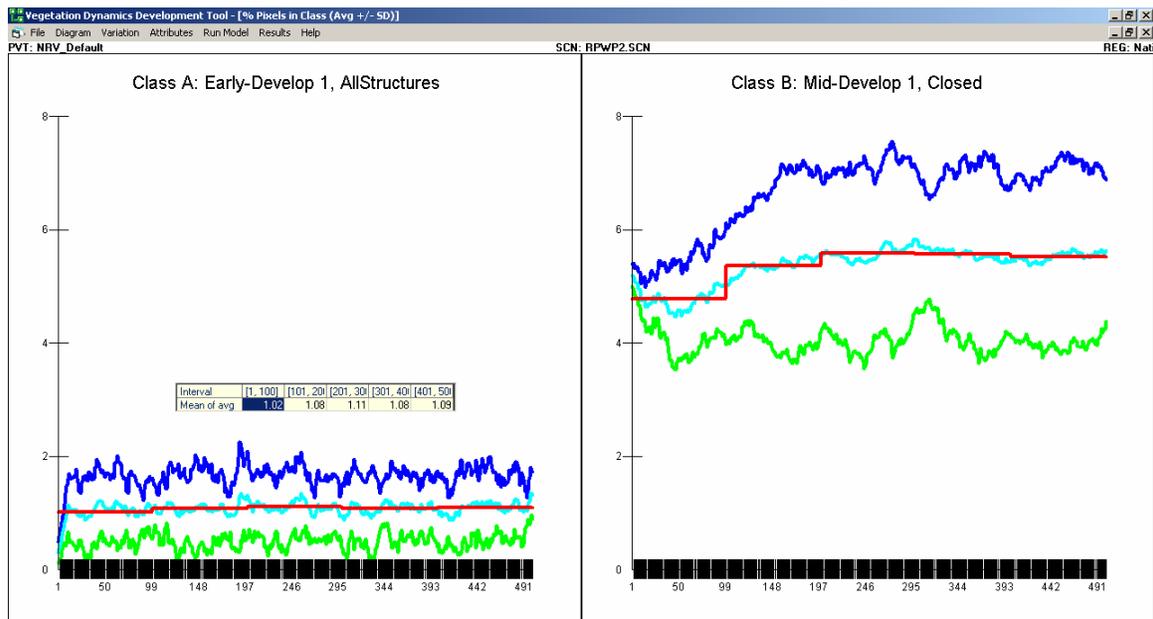
B: Mid seral: Jack pine/red pine/oak stands. Fires are 50% replacement and 50% mixed. Replacement fires result in a young mixed jack pine/red pine stand (80%) or barren (20%). Stands that escape replacement fire succeed to mature red pine/white pine stands (class E) after 100 years.

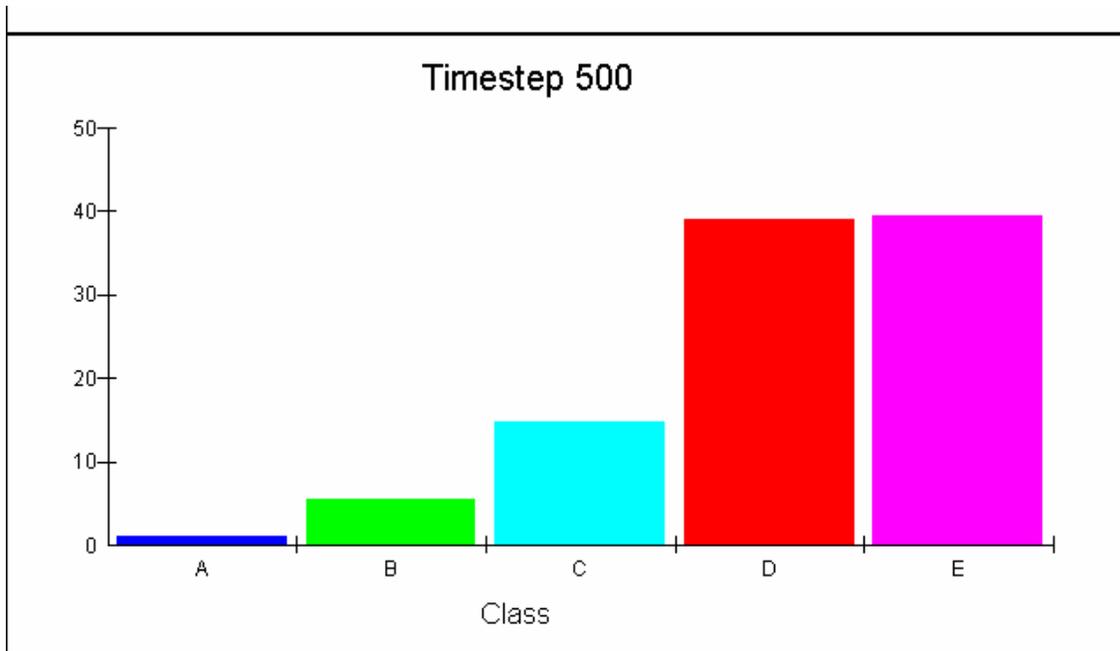
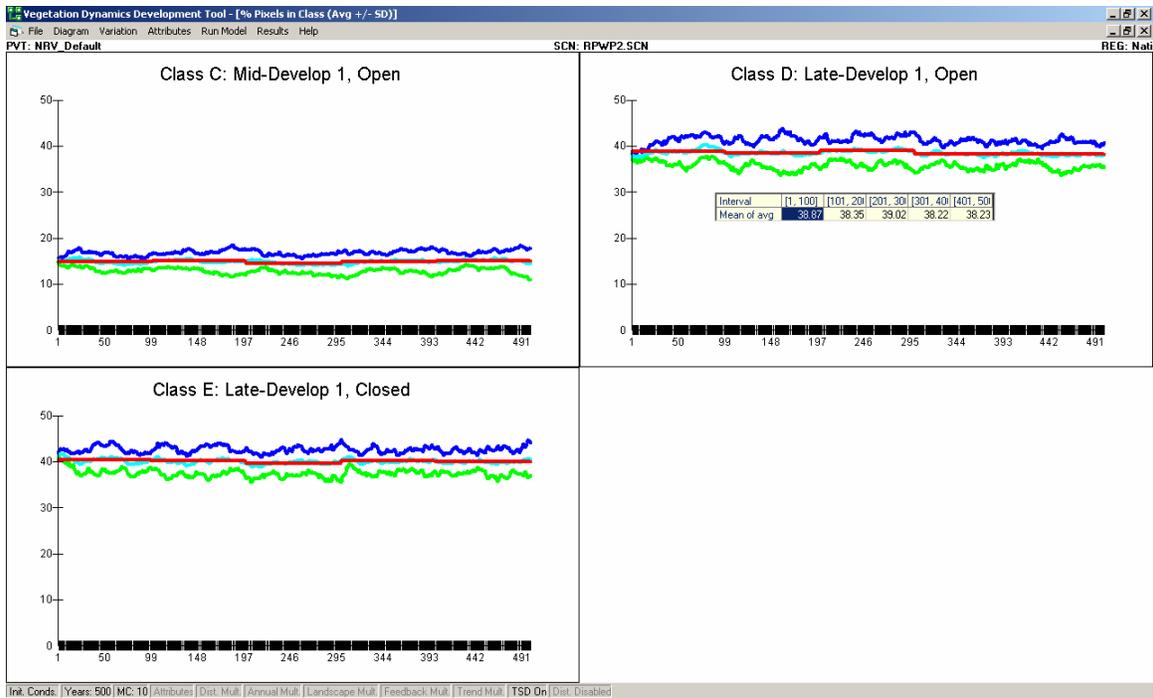
C: Young red pine/white pine stands. Fires that occur in this class are 50% replacement and 50% mixed. This class succeeds to class D.

D: Old open red pine/white pine. Fires are 95% surface and 5% replacement. The replacement fire rotation is 810 years. Stands move to a closed state (class E) after 30 years elapse without a fire.

E: Old multi-story red pine/white pine. The probability of a replacement fire is twice that of open stands.

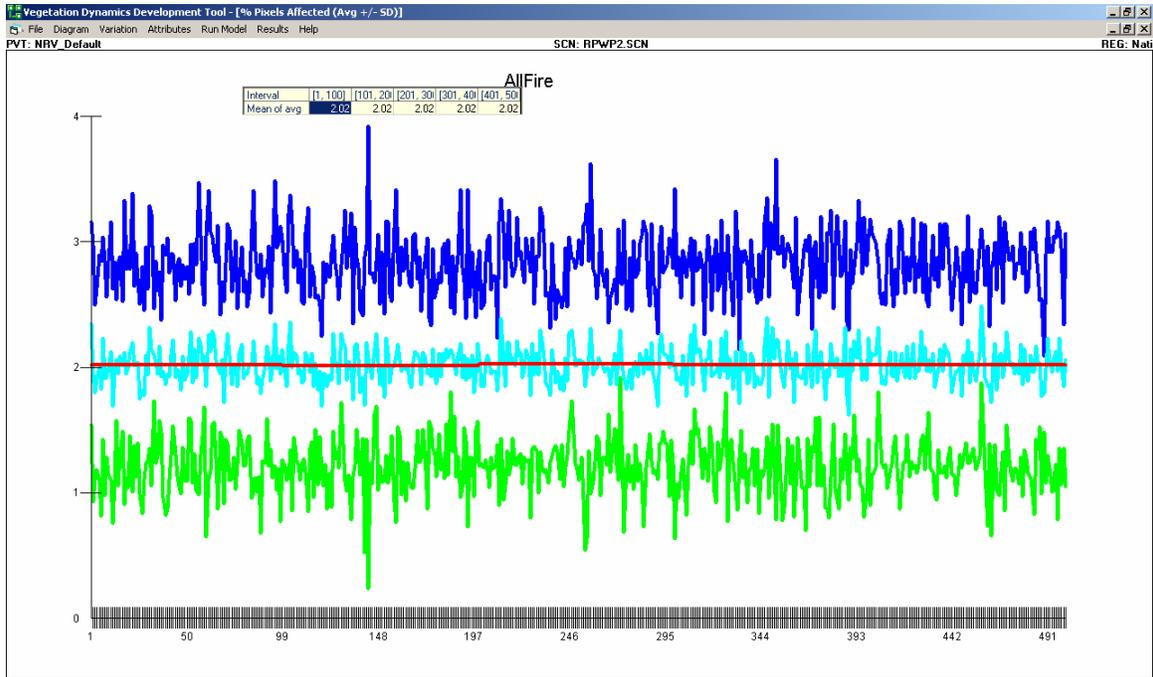
Results graphs: These graphs show the average per cent of area in each class projected for 500 years.



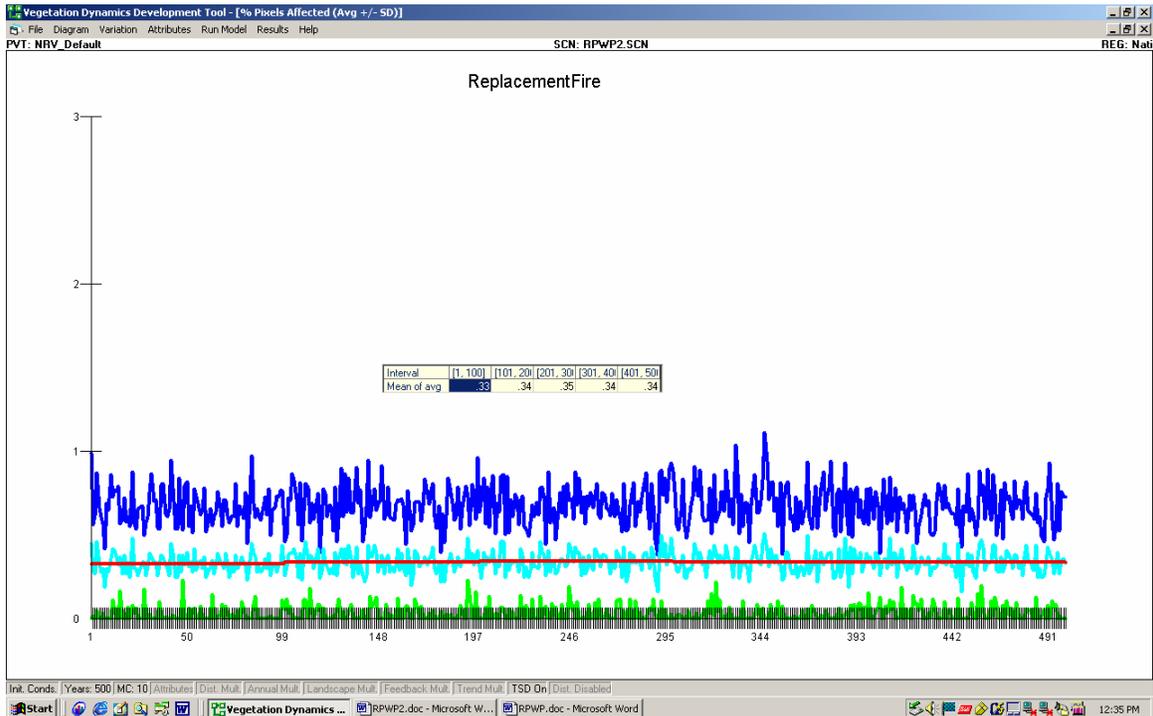


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All fire frequency: Approximately 2% of the area burns per year for a fire return interval (FRI) of about 50 years. Graphs show average percent burned per year \pm 2 standard deviations.



Replacement fire frequency: Approximately 0.34% of the area burns per year for a replacement FRI of 290 years.



Non-replacement fire frequency: Approximately 1.68% of the area burns per year for a non-replacement FRI of about 60 years.

