Fire Regime Condition Class (FRCC) Interagency Handbook
Reference Conditions

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PNVG Code: RPWP

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

Geographic Area: Michigan, Minnesota, and Michigan

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.

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 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.

Percentage of trees in each species recorded by General Land Office surveyors as line trees in the mid-1800's for northern lower Michigan and the upper peninsula of Michigan are displayed in Figures 1 and 2. In lower Michigan, red, jack, and white pine comprised 75% of line trees recorded within this community, and early successional aspen, birch and oak comprised 12% of line trees. In the upper peninsula, white, red, and jack pine comprised 53%, spruce-fir 16%, and early successional aspen, birch, and oak 13% of line trees. Subregional differences include more oak in the lower peninsula, and more spruce ands fir in the upper peninsula.

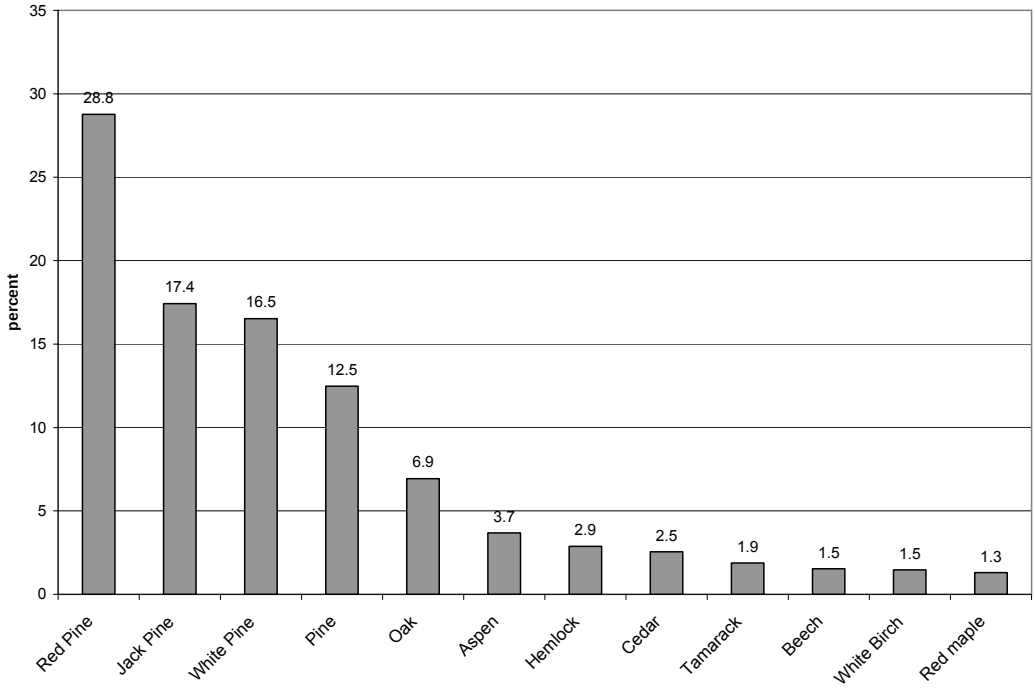

Figure 1. Percentage of trees in each species recorded within GLO line notes for the “red pine - white pine” potential natural vegetation group of northern lower Michigan.

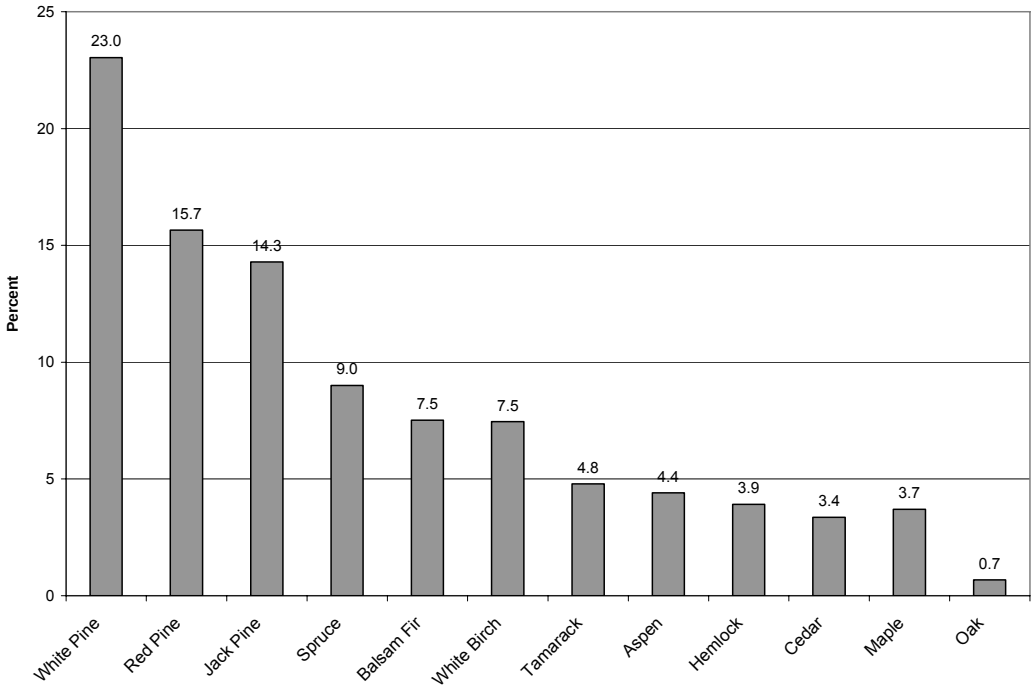

Figure 2. Percentage of trees in each species recorded within GLO line notes for the “red pine - white pine” potential natural vegetation group of Michigan’s Upper Peninsula

Fire Regime Description: 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 – 30 year cycles) reduced fuel loadings, eliminated living fuel ladders, and promoted widely- spaced trees that became increasingly resistant to crown fires through 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.

Vegetation Type and Structure

Class*	Percent of Landscape	Description
A: post replacement	5	Barrens dominated by *Carex*, grasses, and herbaceous plants. Trees comprise less than 10% canopy coverage.
B: mid-seral closed	20	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 stand < 50 years old.
D: late open	50	Mature red pine/white pine stands (> 50 yrs) maintained by frequent surface fires
E: late closed	10	Mature red pine/white pine stands (> 50 yrs) with significant ladder fuels that result from lack of fire for ≥ 30 years
Total	100	

Fire Severity	Fire Frequency (yrs)	Probability	Percent, All Fires	Description
Replacement Fire	83	.012	25	All fires in barrens and 80% of fires in mature jack pine
Non-Replacement Fire	31	.032	75	Primarily surface fire in older red pine. Mixed fire in young classes.
All Fire Frequency*	22	.044	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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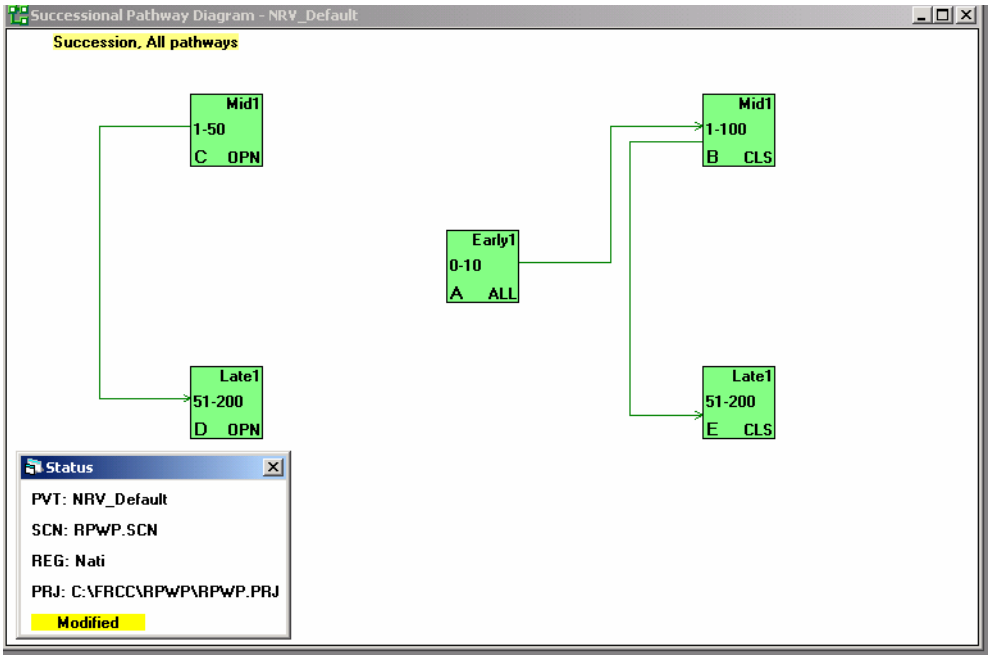
VDDT file documentation: Model RPWP located in C:/FCCC/RPWP. Load VDDT text files into C:/FCCC for project file to work. Diagram shows succession only.



Disturbances by class: **Model RPWP**

Class	To	Agent	Prob	TSD	Freq/ FRI	Rel Age
A	A	Replacement fire	.08	10	22	-25
A	C	AltSuccession**	.5	0	NA	0
B	A	Replacement fire	.008	10	135	0
B	B	Replacement fire	.032	10	41	-100
B	B	Mixed fire	.04	10	35	0
B	B	Wind/weather/stress	.002	0	500	-100
B	E	AltSuccession**	.5	0	NA	0
C	C	Replacement fire	.02	10	60	-50
C	A	Replacement fire	.02	10	60	0
C	C	Mixed fire	.04	10	35	0
D	C	Replacement fire	.004	10	260	-150
D	C	Surface fire	.076	10	26	0
D	D	Wind/weather/stress	.002	0	500	
D	D	AltSuccession	1.0	50	NA	0
E	C	Replacement fire	.008	0	125	0
E	D	Mixed fire	.042	0	24	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.*

All classes burn at an average rate of 8% per year with the caveat that stands do not reburn for 10 years. This is equivalent to a 22-year fire return interval. Catastrophic wind replaces mature stands at an average frequency of 500 years. Fire regime/severity assumptions by class follow:

A: **Barrens**: All fires are replacement. Barrens persist for 10 years before regenerating to jackpine/red pine/oak (50%) or red pine/white pine (50%).

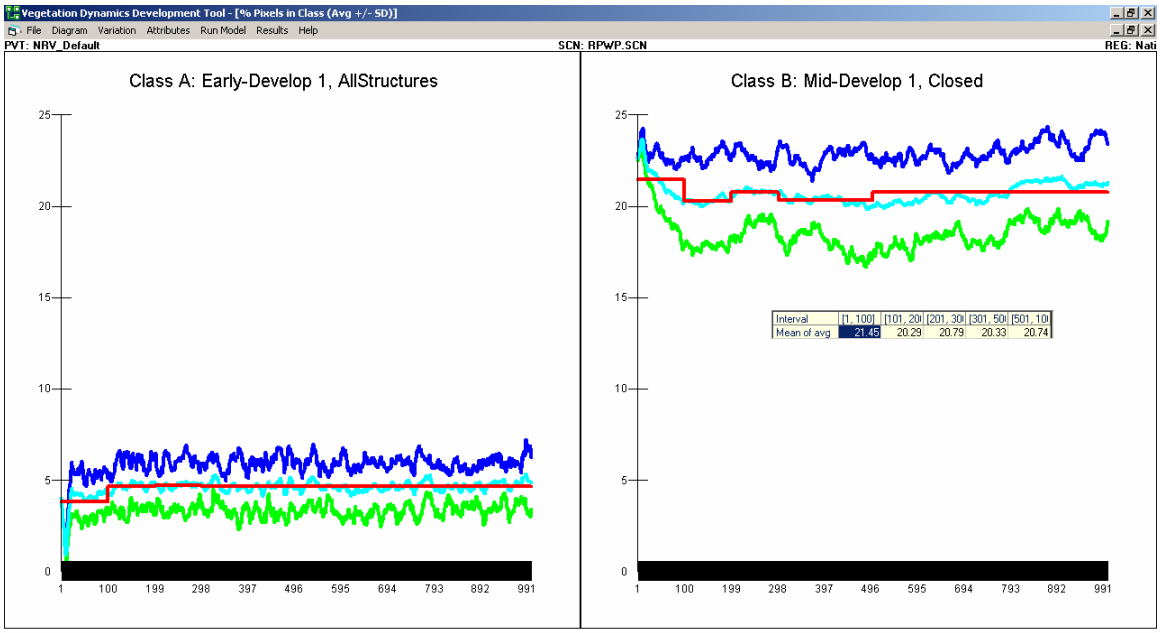
B: **Mid seral: Jack pine/red pine/oak stands**. Fires are 50% replacement and 50% mixed. Replacement fires result in a young mixed jack/red pine stand (80%) or barren (20%). Stands that escape replacement fire succeed to closed red pine/white pine stands (class D) after 100 years.

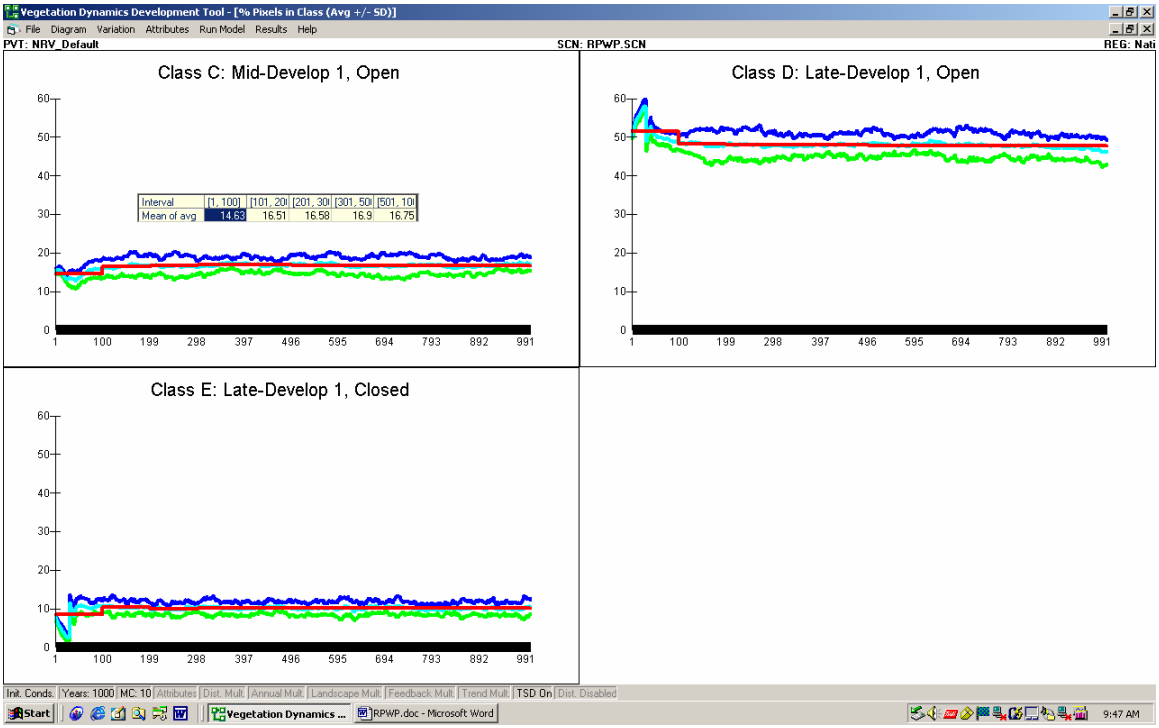
C: **Young red pine/white pine stands**. Fires are 50% replacement and 50% mixed.

D: **Old open red pine/white pine.** Fires are 95% surface and 5% replacement. This corresponds to a replacement fire rotation of 250 years.

E: **Old multi-story red pine/white pine.** Fires are 90% mixed and 10% replacement. The probability of a replacement fire is thus twice that of open stands.

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

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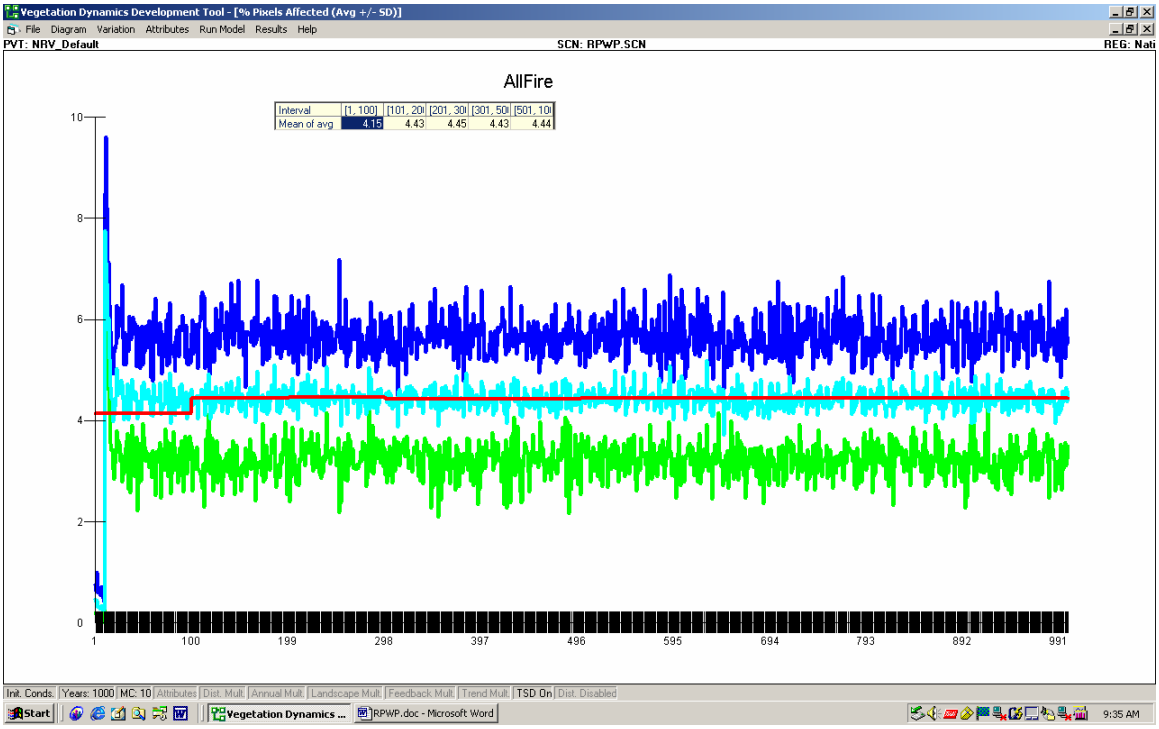
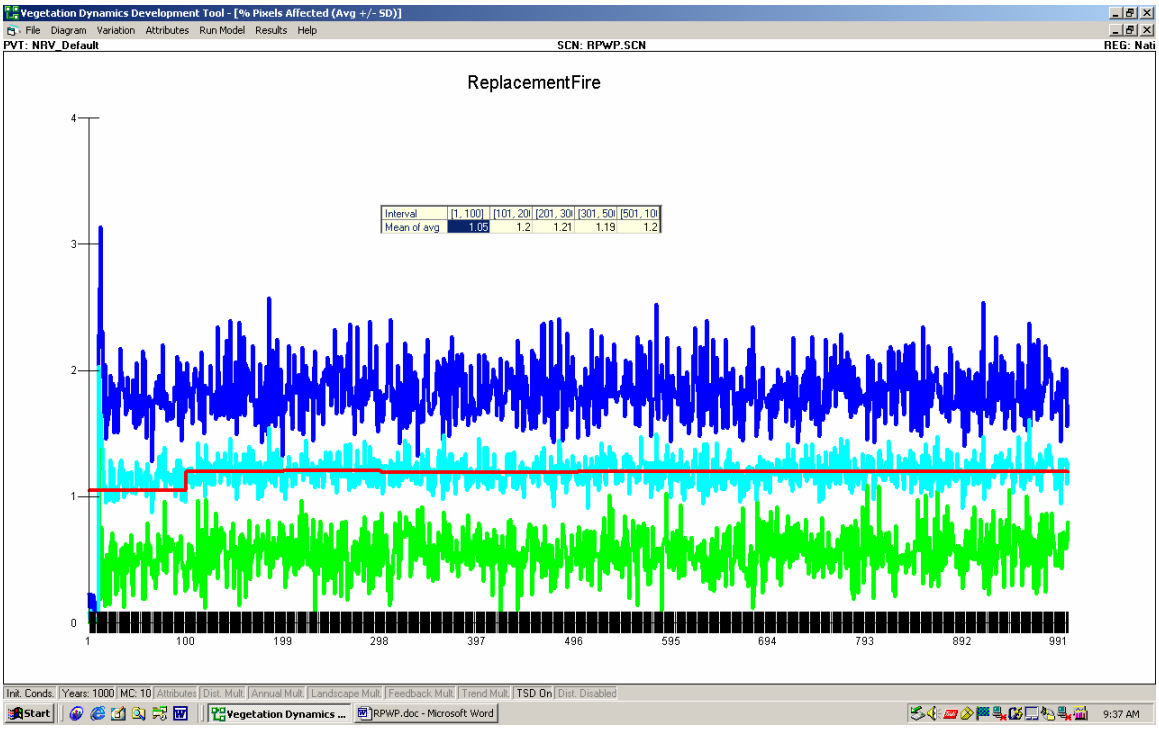
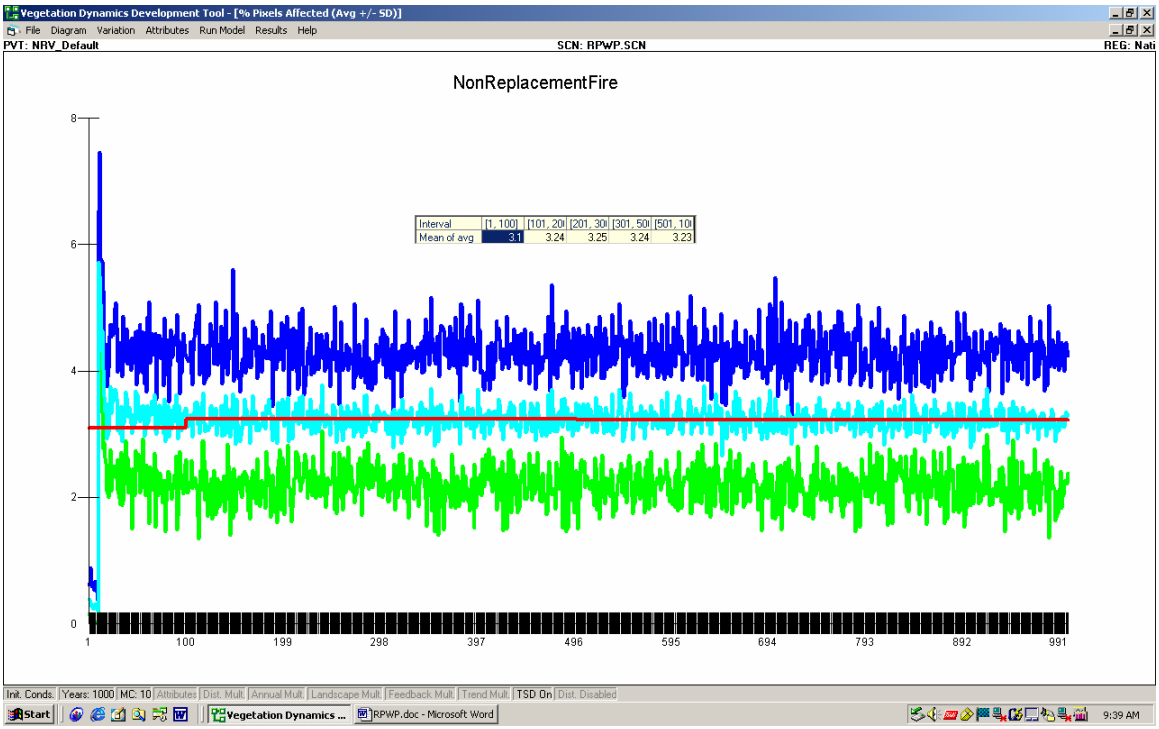
All fire frequency: 4.4% of the area burns per year for a FRI of 22 years.



Replacement fire frequency: Approximately 1.2% of the area burns per year for a replacement FRI of 83 years.



Non-replacement fire frequency: Approximately 3.2% of the area burns per year for a non-replacement FRI of about 31 years.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