Fire season influences vegetation communities in red and white pine forests at Voyageurs National Park

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Fire seasonality (i.e., dormant-season or growing season) is an important component of historic fire regimes, but its influence on fire effects is not well understood. The season in which a fire occurs is important because the phenological stage of the plants (i.e., whether a plant is germinating, flowering, or senescing, etc.) ultimately determines the effects of the fire on the resulting plant community, and can even influence post-fire successional patterns.

The "near-boreal" red and white pine forests in Voyageurs National Park historically experienced low-intensity understory fires every 20-40 years, and stand replacing fires every 150-200 years. Historic fires occurred between May and mid-October as a result of lightning ignition (primarily during summer droughts) or anthropogenic ignition, whereas prescribed burns now are typically conducted in late spring during brief periods of time that are relatively dry. Burning in Spring is often preferred to summer because suitably dry periods during summer may also be associated with increased potential for greater fire intensity and escape. This study by Weyenberg and Pavlovic (2014) examined differences in ground layer vegetation communities among pre-burn, Spring, and Summer fire treatments in Voyageurs National Park (Minnesota, USA). There were no previous fires in these areas since 1936.

Spring fires were prescribed burns, whereas the Summer fires included lightning ignitions, prescribed fires, and one human-caused fire. All fires were surface fires. Most plots were burned once, although four plots experienced two burns. Fire severity was visually assessed before fire and immediately post-fire at all locations along a scale of 0 (unburned) to 5 (severely burned); mineral soil exposure was also evaluated. The authors collected vegetation data from permanent plots in six sites at intervals of: one to 36 months before fire; immediately post-fire; and at 1, 2, 5, and 10 years post-burn. Vegetation

MANAGEMENT IMPLICATIONS

1. Summer burns resulted in significant changes to understory vegetation community composition (increased species richness and diversity) and that these areas showed a clear successional trajectory over time since fire. Summer burns replaced pioneer species with tolerant species, whereas there were no significant changes to community composition after Spring burns.

2. Summer burns may be more effective for preparing a seedbed for pine regeneration, controlling competing understory vegetation, and by helping to control hardwood species.

3. Summer prescribed burns are likely to represent historic burns more closely than Spring burns.

4. Safety precautions are necessary for conducting prescribed fire in Summer when fuels are drier and more intense fire behavior may occur.

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sampling was performed between mid-June and July in each measurement year, and species were classified by reproductive strategy (propagule dispersers, resprouters, and seed-banking species) and tolerance to environmental conditions and competition (tolerant, intolerant, and tolerant with requirements). The authors used multivariate statistical approaches and analysis of variance (ANOVA) to evaluate similarities and differences in vegetation communities between fire seasons and over time after fire.

Results showed that fire severity and mineral soil exposure levels were lower in Spring fires than Summer fires. Fire severity rating varied more in Summer than Spring burns. Multivariate statistical analysis showed that overall vegetation composition was similar between pre-burn conditions and Spring burn areas, and both differed from the composition of Summer burn areas. Summer burn areas contained 37 species that were primarily absent from pre-burn and Spring burn areas, and 24 of these were not present in pre-burn measurements of the Summer burn areas. Summer burn areas were dominated by intolerant (pioneer) species that originate from the seedbank or by propagule dispersion; resprouter species (tolerant and intolerant) were also present. The species that were considered "indicators" of Summer burns included the majority of the seed-banking and intolerant species (67% and 46%, respectively). The authors suggest that lower fuel moisture content and therefore greater mineral soil exposure and burn severity in Summer burns explain the greater abundance of seed-banking species and overall species richness that occurred in Summer burn areas.

The change in overall species composition over time (1 to 10 years after fire) was greater for areas burned in Summer than those burned in Spring, and the number of burns (1 or 2) did not affect the results. The Summer burn species composition was significantly different than the pre-burn and Spring burn composition. The difference between the pre-burn and Spring burn composition was also statistically significant. Changes in species composition over time were greatest for Summer burn areas and included increases in the abundance of pioneer species, whereas no clear patterns were evident in Spring burn areas, where the abundance of pioneer species was low. The total number of species observed in Summer burn areas was almost double the number observed in the pre-burn and Spring burn treatments for years 1 through 10. Species diversity metrics (Shannon and Simpson indices) were greatest for Summer burn areas than Spring burn areas, although differences between burn season were not statistically significant in all years. Species richness in Summer burn areas was greatest in year 5, when pioneer species were still present while the abundance of tolerant species began to increase. In contrast, Spring burns had no significant effects on species composition. Approximately 15 species were common to all treatments, many of which have high heat tolerance; the authors suggest that these common species provide stability to the plant community.

In conclusion, the main results of this study showed that Summer burns resulted in significant changes to understory vegetation community composition (increased species richness and diversity) and that these areas showed a clear successional trajectory over time since fire, with pioneer species replaced by tolerant species. In contrast, there were no significant changes to community composition after Spring burns.' The authors suggest that low duff moisture content (e.g., <40% according to Van Wagner 1963) is necessary for fire to result in a significant change to vegetation communities. Summer burns may also be more effective for preparing a seedbed for pine regeneration, controlling competing understory vegetation, and by helping to control hardwood species. This study is one of the few existing comparisons of differences in fire seasonality. Summer prescribed burns are likely to represent historic burns more closely than Spring burns, but additional safety precautions are necessary for conducting prescribed fire in Summer when fuels are drier and more intense fire behavior may occur.

References

Van Wagner, C. E. 1963. Prescribed burning experiments: red and white pine. Publication No. 1020, Department of Forestry, Forest Research Branch, Ottawa, Canada. 27 p.

Weyenberg, S. A. and N. B. Pavlovic. 2014. Vegetation dynamics after spring and summer fires in red and white pine stands at Voyageurs National Park. Natural Areas Journal 34:443-458.