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Early Fire History near Papineau Lake, Ontario

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Introduction

Research that defines the role of fire in upland red oak-pine ecosystems in central Ontario is being conducted by the Great Lakes-St. Lawrence Silviculture program. Site-specific fire histories are being developed that document fire frequency, fire behavior, fire effects on forest regeneration and growth, and the influence of human activities on fire disturbances. This information will provide an ecological basis for developing silvicultural prescriptions that use prescribed burning to promote oak regeneration, and to maintain or restore fire dependent forests by emulating natural disturbance processes.

This report presents the fire history of an oak-pine stand near Papineau Lake from 1634 to 1875. Fire scars in old white pine stumps were used to develop the fire chronology. The study site is adjacent to one used by Guyette and Dey (1995a), and therefore represents an extension of that fire chronology.

Methods

The study site is about 1 km^2 in area and is located just north of Papineau Lake (45° 21′ N, 77° 48′ W), 75 km southwest of Pembroke, Ontario. The topography is gently sloping to steep and elevations range from 317 to 500 m. The average slope of the area surrounding the study site is 9%. The mixed hardwood-conifer stand was previously described by Guyette and Dey (1995a). About 40% of the stand basal area (31 m^2/ha) is in red oak (*Quercus rubra* L.). Isolated white pine (*Pinus strobus* L.), red pine (*Pinus resinosa* Ait.), and clumps of hemlock (*Tsuga canadensis* (L.) Carr.) occur throughout the hardwood overstory.

Fire scars from 18 white pine stumps were dated using sampling and dendrochronological methods reported by Guyette et al. (1995). The site ring-width chronology was dated in absolute time with a nearby (60 km west) white pine chronology derived from old, living white pine at Dividing Lake, Ontario. COFECHA, a computer tree-ring dating program (Holmes et al. 1986), was used to correlate ring-width series and ensure the accuracy of both relative dating among the samples and absolute dating ($r=0.60$, $p=0.001$) of the site chronology. Fire scar years were identified and combined to produce a composite fire scar chronology. FHX2, a tree-ring fire history program (Grissino-Mayer 1996), was used to graph the fire chronology (Figure 1).

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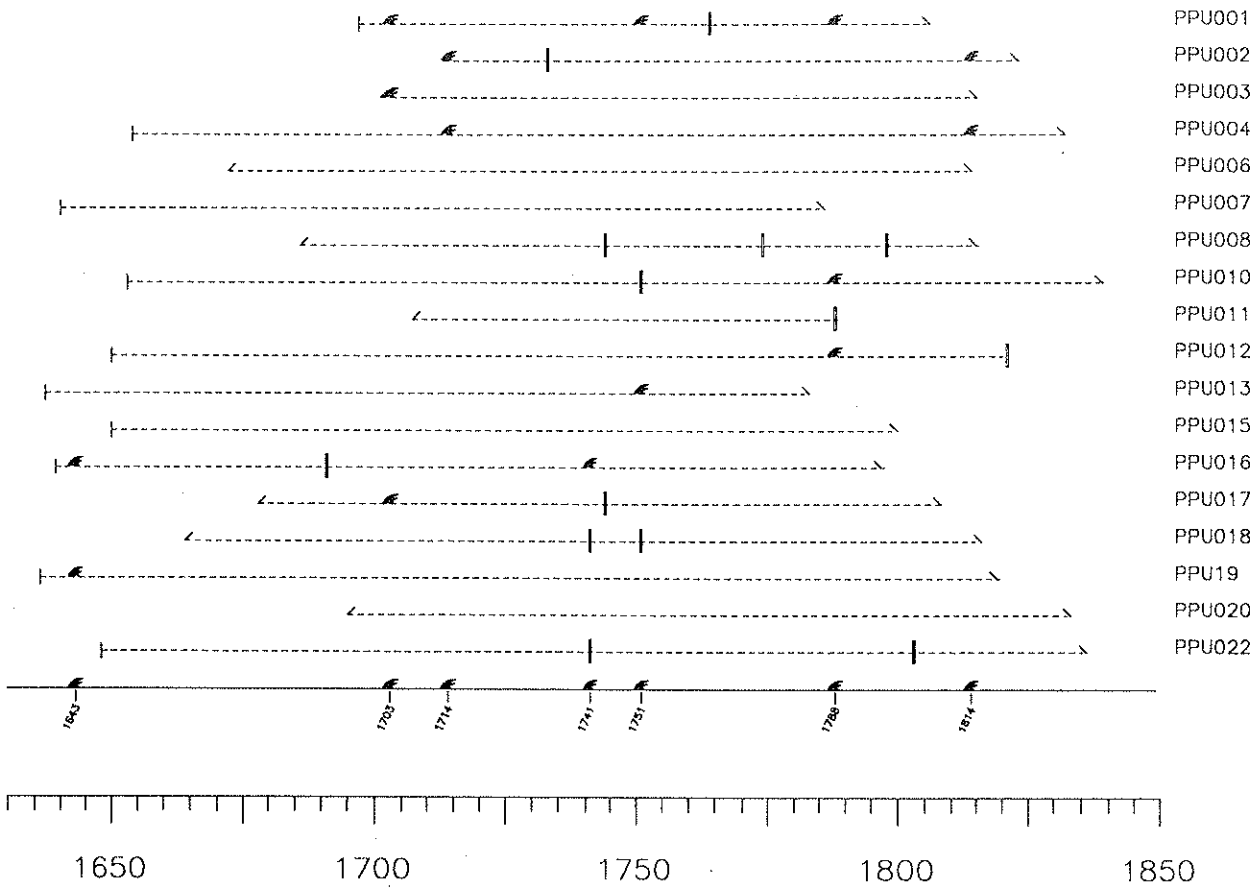

Figure 1. Time lines of dated white pine cross-sections and their associated fire scars and injuries. A composite fire chronology is given at the bottom. Flames indicate fire scars. Long vertical bars indicate injuries that may or may not have resulted from fires. Vertical lines at the beginning of the time lines indicate pith dates with approximate germination dates. Slanted thin bars indicate inside and outside ring dates of the sample.

Results and Discussion

The fire chronology for this site covered the period 1634 to 1875. The mean fire-free interval (MFI) for the period 1643-1814 was 29 years, although individual fire-free intervals ranged from 10 to 60 years. This fire chronology added 241 years to the more recent fire history (developed by Guyette and Dey 1995a) for this area. They reported that the MFI was 6 years during the late 19th and early 20th centuries, which represents the highest fire frequency at this site since 1634. The increase in fire frequency beginning in the mid-1800s coincides with logging, agricultural development, and European settlement in the area (Figure 2).

Before the early 1700s, only 1 fire was observed at the study site. Fires then became relatively more frequent during the 18th century. The MFI was 18.5 years from 1703 to 1814 compared to an average MFI of 29 years for the entire fire chronology. This low frequency of fire during the mid- to late-17th century followed by an increase in fire frequency has also been observed in an oak-pine stand near Bracebridge (Guyette et al. 1995) and at Opeongo Lookout, Algonquin Park (Guyette and Dey 1995b).

Figure 2. Original European settlement near the study area is still evident today. This homestead is about 1 km from the study site.

From the mid-1600s to the late-1800s, the low percentage of sample trees that were scarred in any given fire year indicates that fires were probably low intensity surface fires. During the same time period, similar fire behavior has been observed in oak-pine stands at Bracebridge (Guyette et al. 1995) and near the Jocko River (Dey and Guyette 1996a). Other fire histories in Ontario oak-pine stands were also characterized by low intensity surface fires, but they also had periodic (e.g., 40 to 50 years) fires of moderate intensity (Guyette and Dey 1995b, 1995c; Dey and Guyette 1996b). The distribution of sample tree pith dates (circa 1640) suggests that the previous forest, dominated by a super-canopy of white pine, originated from a stand replacement-type disturbance such as a high intensity fire or major wind storm.

Topographic and cultural factors may have limited the frequency of fire near Papineau Lake during the 17th and 18th centuries. The close proximity of surrounding lakes and the steep, hilly topography of the area may have limited the spread of fire to the site and thus decreased fire frequency by reducing fire size and spread rate. The study site is 1 km northeast of Papineau Lake, 7 km southwest of Kamaniskeg Lake, and 8 km south of Bark Lake. The study site was isolated from known 17th and 18th century travel routes and villages (Harris 1987) that might have contributed to an anthropogenic fire regime.

The number of white pine stumps in the understory far exceeds the density of living mature white pines, indicating a substantial decline in white pine at this site over the past 350 years. The 19th century logging of white pine at the study site followed by frequent fires contributed to the dramatic reduction in white pine from the present day overstory. Frequent fires in the late 19th century probably favored the regeneration of red oak and led to its present dominance in the overstory.

Conclusion

This study quantified the role of fire in an upland oak-pine forest on the Bancroft District based on an analysis of fire scars in old white pine stumps. It extended a previous fire history for this site from 1875 to 1634. The periodicity of fire at this site has varied substantially over the past 360 years. From the mid-17th century to the early 19th century, fires occurred every 29 years on average. However, during the 1700s, the study site burned more frequently (MFI=18.5

years), a trend that has been observed in other oak-pine forests in central Ontario. With the advent of European settlement at the turn of the 20th century, fire became even more frequent (MFI=6 years) in the area. No fires were observed after 1954.

White pine logging followed by frequent fires promoted the development of red oak at the study site. The preferential harvesting of white pine and forest burning by Europeans resulted in a succession to hardwoods dominated by red oak. The frequent low intensity surface fires inhibited conifer regeneration, reduced competing vegetation and favored species such as red oak that are adapted to repeated disturbances.

Forty-two years (1954 to 1996) of fire exclusion is causing yet another shift in forest composition towards more shade tolerant species such as sugar maple (*Acer saccharum* Marsh.), ironwood (*Ostrya virginiana* (Mill.) K. Koch) and beech (*Fagus grandifolia* Ehrh.). Changes in the frequency of fire over the past 360 years has drastically altered forest composition and structure. Forest succession has also been affected by the selective harvesting of red and white pine. Periodic prescribed underburning with low intensity surface fires emulates natural disturbance processes in oak-pine ecosystems and can be used to to restore historic forest conditions.

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