PreEuropean Horticultural Impact on the Forest Landscape and Forest Succession of Southern Ontario, Canada

by Ian and Celina Campbell

Abstract

Increased *Pinus strobus* frequency in Southern Ontario, Canada, A.D. 1300-1500, has been ascribed to succession on abandoned Iroquoian fields. Pollen diagrams show forest succession was more widespread than Iroquoian occupation, and was caused by the Little Ice Age. Iroquoian horticulturalists and *Pinus strobus* had similar edaphic preferences, leading to the coincidence of pine stands and archaeological sites. Ontario's mixed forest responded rapidly to climate change, but low intensity swidden horticulture had no observable regional impact on the forest.

Key Words: Little Ice Age, Ontario, *Pinus strobus*, Iroquois

White pine (*Pinus strobus*) is a typical species of the Great Lakes - St. Lawrence forest region (Rowe, 1972). It grows in a wide range of habitats, but is most common on rocky ridges, steep slopes, and well-drained sandy soils (Rowe, 1972; Fowells, 1965). It is fairly shade intolerant, and is common as an old-field species (Fowells, 1965). In Southern Ontario, it was of major economic importance for timber (Aird, 1985). Stands of white pine occur near several archaeological sites (Bowman, 1980). Fossil pollen analysis shows an increase in the frequency of white pine during the period of prehistoric Iroquoian horticulture (Figure 1). These observations have led to a belief that Iroquoian swidden horticulture, practised over several centuries prior to European contact, caused the prehistoric increase in white pine (Burden *et al.*, 1986; McAndrews and Boyko-Diakonow, 1989). A corollary of this belief is that old stands of white pine in Southern Ontario delimit abandoned Iroquoian fields (Bowman, 1980; Lennox *et al.*, 1986).

Cluster analysis of trends in Ontario pollen diagrams shows that white pine increased in relative abundance throughout Ontario south of Lake Nipissing during the 1000 years prior to EuroCanadian disturbance, and decreased in relative abundance north of Lake Nipissing (Campbell and McAndrews, 1991) (Figure 2). If the increase in white pine was due to Iroquoian disturbance, it should have been strongest in areas densely populated by Iroquoians (Figure 3). Instead, there is no significant correlation between Indian occupation and forest dynamic trends (Campbell and McAndrews, 1991).

The pollen trends south of Lake Nipissing show a decline beech (*Fagus*), followed by a peak in oak (*Quercus*), poplar (*Populus*), or other early-successional species, leading to a rise in white pine (Campbell and McAndrews, 1991). White pine peaks after the beginning of EuroCanadian disturbance, and the subsequent decline is likely the result of logging in the late 19th and 20th centuries. In the north, white pine generally declines, followed by an increase in red and jack pine (*Pinus resinosa* and *Pinus banksiana*) and spruce (*Picea*) (Campbell and McAndrews, 1991). Both the northern and southern dynamics can be adequately explained by a climate cooling (commonly known as the Little Ice Age [Grove, 1988; Ladurie, 1971; Lamb, 1971]), which would have increased mortality at the northern edges of species ranges, while decreasing mortality at the southern edges. Such a cooling is known to have occurred both in the Great Lakes region, as well as elsewhere in the world (Cermack, 1971; Gajewski, 1987; Grove, 1988).

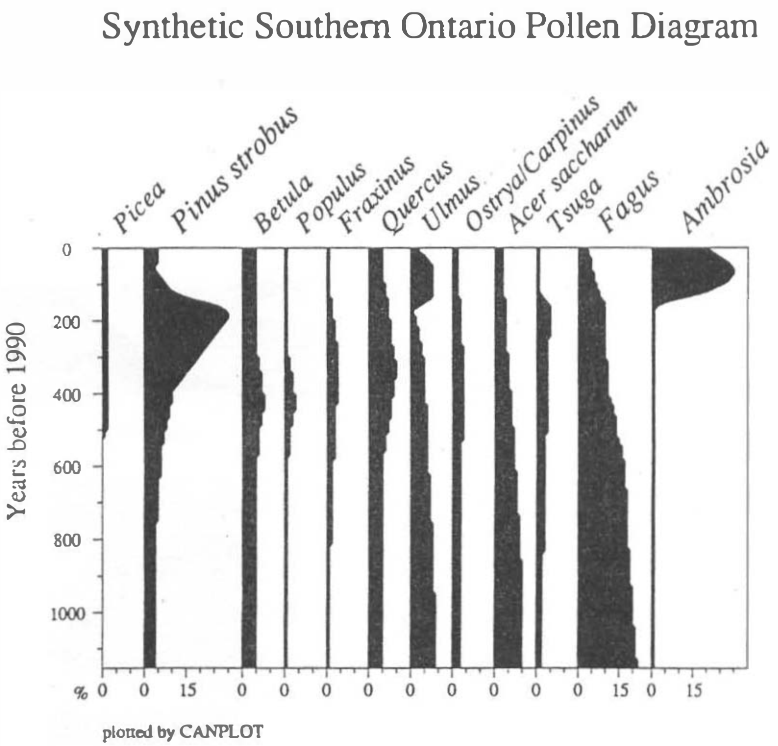

Figure 1. Synthetic Southern Ontario pollen diagram for the period A.D. 850-1990. (Note: an increase in ragweed [Ambrosia sp.] marks the beginning of EuroCanadian disturbance ca. 1850 throughout the region [Anderson, 1974]).

The natural forest of southern Ontario is dominated by beech and sugar maple (*Acer saccharum*), of which beech has the more southerly distribution, reaching its limit near Lake Nipissing (Fowells, 1965; Rowe, 1972). An increase in the mortality of beech in Southern Ontario would cause an increase in the rate of canopy gap formation, allowing early- and mid-successional species to temporarily increase in abundance. White pine, which reaches peak abundance in Ontario at the latitude of Lake Nipissing, would increase to the south of Lake Nipissing, where it is an early mid-successional species. Further north, where it is subclimax, it would decline. This would allow red pine, jack pine, and spruce to increase in abundance north of Lake Nipissing. Because these are the dynamics observed in the regional pollen diagrams, climate change rather than Iroquoian horticulture is the likely cause (Campbell and McAndrews, 1991).

If the Iroquoians did not cause the increase in white pine, what explains the apparent coincidence of white pine and Iroquoian sites? The answer appears to be that Iroquoians and white pine both prefer similar edaphic conditions in parts of Southern Ontario.

Location Quotients compare the frequency of Iroquoian village sites linked with particular phenomena to the frequency of those

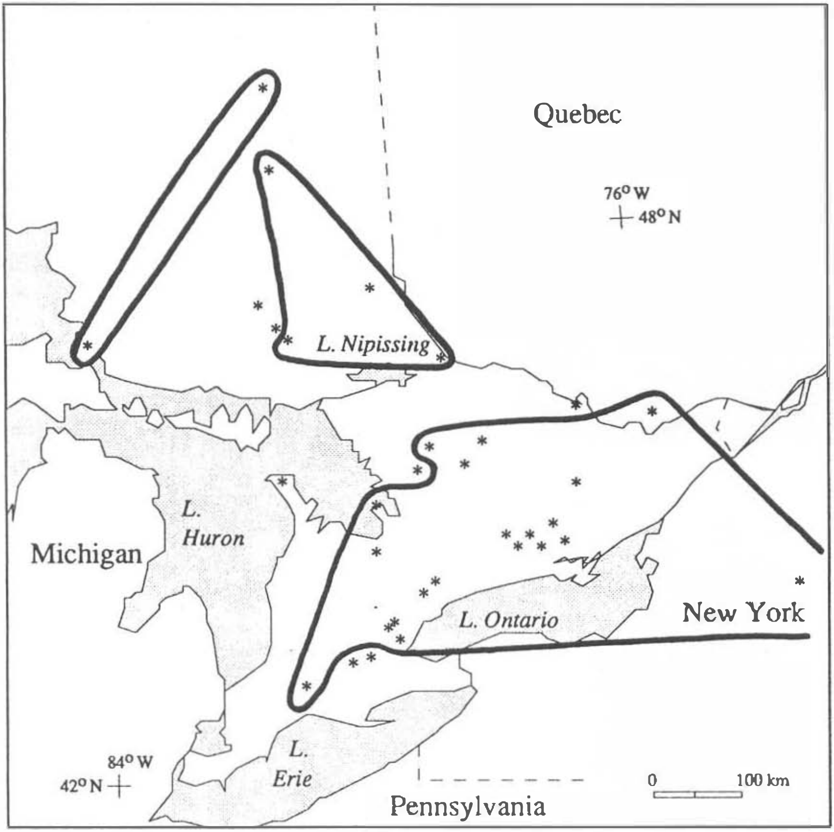

Figure 2. Cluster analysis of Ontario pollen diagrams shows all of Southern Ontario as a coherent region of similar forest dynamic over the 1000 years prior to A.D. 1850, with no separation between areas with and without dense Iroquoian occupation (Campbell and McAndrews, 1991). Beech (Fagus grandifilia) declines and white pine (Pinus strobus) increases throughout the southern cluster; the two northern clusters are defined largely in the dynamics of red pine (P. resinosa), jack pine (P. banksians) and spruce (Picea spp.). * indicates the locations of pollen cores used in the analysis.

phenomena within the study area (Campbell, 1991; Campbell and Campbell, 1992). For example, the location quotient for clay is:

$$\text{Location quotient for clay} = \frac{\text{\% of sites on clay}}{\text{\% of study area with clay}}$$

Location quotients greater than 1 indicate attraction; that is, those phenomena were chosen more frequently than would be expected if the choices were random. Location quotients below 1 indicate aversion to the phenomena.

Location quotients were calculated for various edaphic parameters for the 333 prehistoric and protohistoric Iroquoian agricultural village sites (*ca.* AD 900 - 1550; Figure 3), and the probable minimum duration of the frost-free season nine years in ten (Table 1). Clearly, the Iroquoians had a strong preference for sandy, well-drained soils, with moderate relief

(Campbell, 1991; Campbell and Campbell, 1992). They also seem to have found areas with fewer than 90 or more than 130 frost-free days nine years in ten unattractive. These preferences were likely the result of the combination of the requirements of their staple crop (Maize), their horticultural technology (digging sticks and no irrigation or drainage ditchers), and the physiography and climate of Southern Ontario (Campbell, 1991).

The strains of maize grown by the Iroquoians required at least 90 frost-free days to grow to maturity (Campbell, 1991). With maize contributing as much as 58% to 65% of their diet (Heidenreich, 1971; Moncton, 1990), the Iroquoians would have selected only those sites with a reasonably low frequency of killing frosts during the growing season; hence they would have selected sites having 90 frost-free days or more in most years. They preferred sandy soils both for their drainage, since maize requires good drainage, and for ease of digging, since they used only digging sticks made of wood, bone, or hafted stone. The aversion to clay soils is likely the result of this technological limitation, as well as the poor drainage often associated with clay soils. The aversion to low relief is also likely due to the poor drainage associated with such sites (Campbell, 1991; Campbell and Campbell, 1992). The apparent aversion to sites with very long frost-free seasons is due to the coincidence of low relief and clay soils throughout most of the warmest part of Southern Ontario (Campbell, 1991; Campbell and Campbell, 1992).

Table 1. Location quotients demonstrate a strong correlation between Iroquoian village sites and light-textured, well-drained soils with more than 90 frost-free days nine years in ten (Campbell 1991).

Soil Texture	Location Quotient
Sand	0.
Sandy Loam	2.2
Loam	1.3
Silt loam	0.9
Clay and Clay loam	0.5
Relief	
Depressional to Level	0.
Very gently undulating	0.3
Undulating	1.7
Moderately Rolling to Rolling	1.2
Hilly	0.2
Drainage	
Good	1.5
Imperfect	0.9
Poor	0.3
Very poor	0.1
Minimum Frost-free season, nine years in ten (in days)	
0 - 89	0.
90 - 109	0.7
110 - 129	1.4
130 - 149	0.6
150 +	0.7

Since white pine is less shade tolerant than beech or maple, it requires sites in which beech and maple can not compete, or in which large canopy gaps are frequent. Beech and maple both prefer mesic sites, while white pine prefers dry soils (Fowells, 1965). Furthermore, moderate to steep slopes encourage gap formation by increasing the instability of roots. Hence, within the region of overlap between the range of white pine and the Iroquoians, both would tend to occur on similar sites with well-drained soils and at least moderate relief.

The only study to seriously test this association on a regional scale did not find one; instead, large white pine stands were found to have no archaeological sites, while areas with only scattered pines were densely populated by prehistoric Iroquoians (Heidenreich, 1971). This study was conducted near the northern limit of Iroquoian villages in Ontario, in an area where white pine is abundant. That archaeologists perceive an association between white pine and Iroquoian sites is likely a result of these similar edaphic preferences in relatively small areas densely populated by Iroquoians, primarily further south along the north shore of Lake Ontario where white pine is frequent but forms large stands only on the most favourable sites. In this area, white pine stands may indeed be a reasonably good predictor of archaeological sites, but out of coincidence rather than out of a causal relationship.

Prehistoric swidden horticulture is neither a sufficient nor even a necessary explanation for the observed forest successions, while climatic

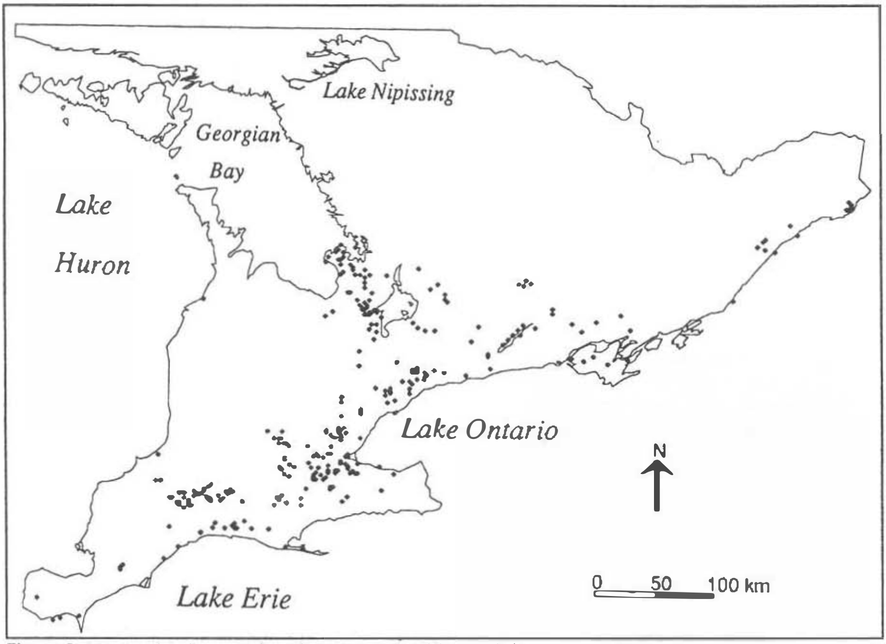

Figure 3. 333 prehistoric Iroquoian sites from A.D. 600 - 1550 (Campbell, 1991)

cooling is both sufficient and well-supported. The beech decline and pine rise found in pollen diagrams of the region are likely due to the Little Ice Age. Furthermore, despite the relatively high density of swidden horticulturalists, the Iroquoians do not seem to have seriously affected their environment.

This study leads to two conclusions of more than regional importance. Firstly, forest ecotones, like the mixed forest region of Southern Ontario, may respond both rapidly and strongly to relatively minor climatic changes. Secondly, low intensity swidden horticulture, such as that practised by the Iroquoians, is unlikely to have a significant regional impact on the forest, even over several hundred years.

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Acknowledgements

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1992 OAS ANNUAL REPORT

Just a reminder that the Society's Annual Report for 1992 is available in the office and by mail postage paid to any member.

VOLUNTEER SERVICE AWARDS

The five members nominated by the Society for provincial Volunteer Service Awards in 1993 received their pins and certificates in a ceremony held in the Metro Convention Centre, Toronto, April 22nd. Congratulations go to Annie Gould and Jane Sacchetti (each ten-year pins), Greg Purmal, Duncan Scherberger, and Geoffrey Sutherland (five-year pins).

Returned Mail

This month's missing members are below. Returned mail awaits them at the office. Somebody and respective Chapters must know these people and where they are. Please help us find them.

CREWE, Nola, Toronto "moved"
HUNTEN, Janet, London
SINCLAIR, Mary Jane, Ottawa "address incomplete"
WILLIS, Jay & Carolyn, Ottawa ■