Mid to late Holocene fire history of Eastern James Bay: investigating the environmental impact of early humans

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ABSTRACT

We used three new charcoal and pollen records to reconstruct the mid to late Holocene fire and vegetation history of Eastern James Bay, an isostatically emerging region in northeastern Canada. We explore links between early human occupation in the region and fire history. Our charcoal records document increased fire activity near archaeological sites and suggest that Shield Archaic populations could have played a greater role in shaping their local landscape than previously thought.

RÉSUMÉ

Nous avons utilisé trois nouveaux diagrammes polliniques et du charbon du bois pour reconstituer l'histoire du feu et de la végétation a la fin de l'Holocène dans l'est de la Baie James, une région isostatique émergente. Nous explorons les liens entre l'occupation humaine au début de l'histoire de la région et les feux de foret. Nos données de charbon de bois montre un nombre accru des feux de foret dans la proximité des sites archéologiques et suggèrent que les populations archaïques du Bouclier Canadien aurait pu jouer un rôle plus important dans leur paysage local qu'on le pensait avant.

1 INTRODUCTION

Prehistoric Canadian Shield hunter-gatherers from high-boreal and subarctic regions have been portrayed as living in small and highly mobile groups scattered over large territories (Wright, 1981). Recent work questions these assumptions and suggests that social complexity and population densities varied over time and space (e.g., McCaffrey M, 2006). Our work at Old Factory Lake in eastern James Bay (Fig. 1) uncovered sites that represent larger investments of energy than have previously been found in the region, suggesting lower mobility and higher density than expected.

The earliest possible time of occupation is constrained by the geomorphic evidence of the Tyrrell Sea, which covered the Old Factory Lake area after retreat of glacial ice until 5700 cal yr BP (Pendea et al., 2010). Archaeological evidence suggests subsistence was based on marine resources and terrestrial game, primarily seal and caribou.

Our study provides evidence of initial occupation and consistent use of the area. Sediment cores from the region's wetlands reveal a unique fire history at Old Factory Lake suggesting a regular presence by 5000 cal yr BP. These records challenge the view that Shield Archaic peoples were highly mobile. Our results are the first evidence of long-term anthropogenic fire origin in the Canadian high boreal region. Elsewhere in North America, evidence of anthropogenic fires is abundant throughout the Pre-Contact period and it is assumed that aboriginal people employed broadcast burning for hunting, resource improvement, and swidden agriculture (e.g., Day, 1953; Russell, 1983; Clark and Royall, 1996). Reports of anthropogenic fires have been largely absent from the extensive literature on fires in Eastern Canada (e.g., Filion et al., 1991; Carcaillet and Richard, 2000; Carcaillet et al., 2001; Ali et al., 2009). Most researchers consider that climate and local factors such as short-term fuel wetness and landscape connectivity have controlled Holocene fire regimes in the region.

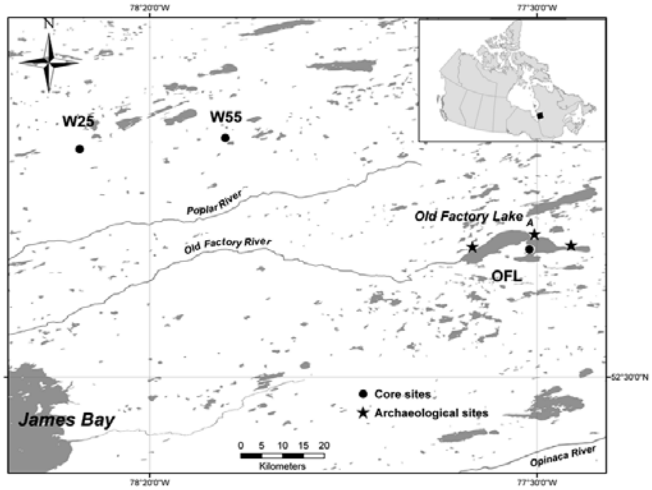

Figure 1. Location Map. 'A' represents the location of the main archaeological site covering > 5 acres.

We examine the potential for anthropogenic fire origin at Old Factory Lake by comparing charcoal and pollen records near the site with those from control sites, 50 and 70 km to the north-east (Fig. 1). If fire activity was driven by natural causes (regional climate and vegetation changes) we expect charcoal influx values and trends to be similar at all three sites. If anthropogenic burning was common near the archaeological sites at Old Factory Lake, we expect charcoal influx trends to be different from those at the control sites and/or show significantly higher values. We use pollen records to reconstruct local and regional vegetation and thus document the degree of landscape similarity among sites.

2 STUDY AREA AND SITE DESCRIPTION

The study region is located in the high-boreal zone of eastern James Bay, northwestern Québec (Fig. 1). The region was covered by the last remnants of the Laurentide ice sheet until the early Holocene when marine waters invaded the newly deglaciated surface (Dyke et al., 2003). The marine transgression was brief and was followed by shoreline regression under the influence of glacio-isostatic rebound. In the study region, a progressive landscape emergence from east to west began ~7000 years ago and it is still underway (Pendea et al., 2010).

The climate is continental subarctic, with a mean January temperature of −23°C and mean July temperature of 14°C (Environment Canada, 2005). Annual precipitation reaches ~ 700 mm. Regional vegetation consists of open boreal taiga dominated by *Picea mariana*, with *Pinus banksiana*, *Alnus spp.*, *Larix laricina*, and *Betula glandulosa* as secondary constituents.

At site W55 (53°1’ N, 78°10’ W; 130 m a.s.l) the peatland developed after 6400 cal yr BP when it emerged from the Tyrrell Sea (Pendea et al., 2010). The bog surface is dominated by *Sphagnum* mosses and ericaceous shrubs with patches of sedges and lichens. Stunted trees (*Picea mariana*) border the margins of the bog.

The peatland at site OFL (52°47’ N, 77°31’ W; 106 m a.s.l.) developed after 5700 cal yr BP when the marine waters retreated from the area (Pendea et al., 2010). The surface vegetation is dominated by *Sphagnum* and ericaceous shrubs. *Picea mariana* is found as isolated trees throughout the bog.

At site W25 (52°59’ N, 78°29’ W, 49 m a.s.l.) the peatland developed after 3200 cal yr BP when marine waters retreated from the area (Pendea et al., 2010). The surface vegetation is dominated by *Sphagnum*, ericaceous shrubs and sedges.

3 SAMPLE COLLECTION, FOSSIL PREPARATION AND DATING

Core retrieval, macrofossil extraction, pollen preparation, and radiocarbon dating and calibration are described in Pendea et al. (2010).

Mean sampling resolution within cores was 6 ±3 cm (180 ±166 yrs, s.d) for the W55 core, 6 cm ±2 cm (133 ±90 yrs, s.d.) for OFL core, and 7 ±2 cm (82 ±28 yrs, s.d.) for the W25 core. At least 300 grains excluding aquatics and *Sphagnum* spores were counted in most samples. Pollen retrieval was poor for three samples in core W55 and two samples in core OFL with pollen counts <300. Tree and shrub taxa were used to subdivide the pollen diagrams into local pollen assemblage zones (LPAZ) using constrained cluster analysis by sum-of-squares (CONISS) as implemented in the Psimpoll 4.26 program (Bennett, 2007).

Microscopic charcoal particles with lengths between 20 and 125 µm were counted on the pollen slides following recommendation by Blackford (2000) for non-lacustrine sediments. Blackford (2000) found that airborne charcoal particles <20 µm are representative of the regional background signal, while particles > 125 typically record fires that occurred within 200 m of the sampling site. We aimed for a charcoal record that would represent for a source area >200 m around the sampled bogs, but minimize the representation of extra-local charcoal signal (>10-15 km from the sampling site). Our charcoal data is used to infer fire activity (*sensu* Power et al., 2008) rather than fire frequency, as the latter requires contiguous sampling and a calibration set comparing modern regional fire frequencies with microscopic charcoal influx in surface sediments (Tinner et al., 1998). The charcoal signal is expressed as influx (particles cm^{-2} yr^{-1}), termed CHAR (charcoal accumulation rates) and as charcoal/pollen ratio (ratio charcoal particles to tree and shrub pollen sum).

4 RESULTS

4.1 Archaeology

On the northern shore of Old Factory Lake, Costopoulos and team found archeological evidence such as domestic stone structures, burial cairns and storage pits (Fig. 1). The stone structures are associated with domestic remains, such as unburnt bone layers, hearths, and remains of stone tool making, tool use and maintenance. Radiometric dates cannot be obtained from charcoal or bone due to stratigraphic mixing and poor preservation. However, indirect evidence suggests long-term use of the site from as early as 5000 cal yr BP through the Contact Period. A seal bone (phalanx) recovered from one of the domestic stone structures suggests a probable use of the site during the early marine phase of the lake (5700-5000 cal yr BP). Also, the stone structures stand on a former marine terrace ≈8 m above the present lake level. There is clear evidence of later prehistoric and Contact Period occupations. Storage pits yielded dense clusters of wild cherry seeds (*Prunus pennsylvanicus*) dated between 1450 and 1650 AD (330±40 ^{14}C yr BP, BETA-257584) and incised ceramics are of 17th century Huron-style.

The structural make-up, quality of the archeological remains, organization and the size of the Old Factory Lake sites (up to 5 acres) suggest long-term use of the site, substantial density and low mobility of the population. If energy investment is an indication of the amount of time people spend in one place, this site was occupied by less mobile hunter-gatherers at least at some points in its history.

4.2 Chronology and Lithostratigraphy

We retrieved peat cores from bogs (Fig.1) near the Old Factory Lake archaeological sites (OFL) and from two control sites (W55 and W25).

The basal stratigraphy at all sites, represented by marine sediments, is presented in detail by Pendea et al. (2010).

The W55 peatland (130 m a.s.l.) was cored to 264 cm. The basal sediments consist of marine silty sands overlain by tidal marsh, fen and bog peats (Fig. 2).

The OFL peatland (106 m a.s.l.) was cored to 250 cm. Basal sediments are marine grey-blue clayey silts. At 237 cm there is an abrupt shift to tidal marsh peat. The general peat stratigraphy is similar to that at W55 (Fig. 3). The W25 peatland was cored to 305 cm. Basal sediments are marine grey-blue clayey silts. At 281 cm there is an abrupt shift to tidal marsh peat. The general peat stratigraphy is similar to the other two sites (Fig. 4). The Chronology was established based on AMS radiocarbon dates of emergent plant macrofosils (Table 1).

4.3 Charcoal record

At site W55 charcoal accumulation rates (CHAR) are <15 particles cm^{-2}yr^{-1} from 6400 to 3800 cal yr BP .There are no distinct peaks in either CHAR (Fig. 5) or charcoal/pollen ratio (Fig. 2) except a slight increase in charcoal/pollen ratio at 4000 cal yr BP relative to previous levels. CHAR increase considerably after 3800 cal yr BP with values ranging from 3 to 1400 particles cm^{-2}year^{-1}. There are several distinct peaks notably between 3200-2900, 2300-2000, 800-300, and around 1600 cal yr BP. The most pronounced two peaks (at 1600 and 300 cal yr BP) also are well-defined on the charcoal/pollen curve.

The CHAR values at OFL are <310 particles cm^{-2}year^{-1} from the beginning of the record at 6000 cal yr BP to 3800 cal yr BP (Fig. 5). CHAR reaches a maximum of 5900 particles cm^{-2}yr^{-1} at 2450 cal yr BP (Fig. 5). There are two distinct period in terms of charcoal signal variability. Between 6000 and 4000 cal yr BP, CHAR are less variable and generally lower (38-310 particles cm^{-2}year^{-1}) than between 4000 cal yr BP and present (3-5900 particles cm^{-2}year^{-1}). During the former period only one peak (at 6000 cal yr BP) is apparent on both CHAR and charcoal/pollen ratio curves (Fig. 5 and Fig. 3). The sediment at the depth corresponding to that time also contained abundant charred material (seeds, wood and *Picea* needles) >1 mm, which suggests local burning. Between 4000 cal yr BP and present there are several distinct CHAR peaks (Fig. 5) notably at 3500, 2450, 1800, 1000, and 450 cal yr BP, which are also well-defined on the charcoal/pollen ratio curve (Fig. 3).

At site W25 CHAR vary between 2 and 1950 particles cm^{-2}yr^{-1} (Fig 5). High CHAR values (above 1500 particles cm^{-2}yr^{-1}) are recorded at 3200 and 2000 cal yr BP. Other, less pronounced peaks (300-500 particles cm^{-2}yr^{-1}) are around 2450, 1500 and 400 cal yr BP. The charcoal/pollen ratio curve (Fig. 4) is less variable then the CHAR curve, although most of the peak CHAR values correspond with peak charcoal/pollen ratios.

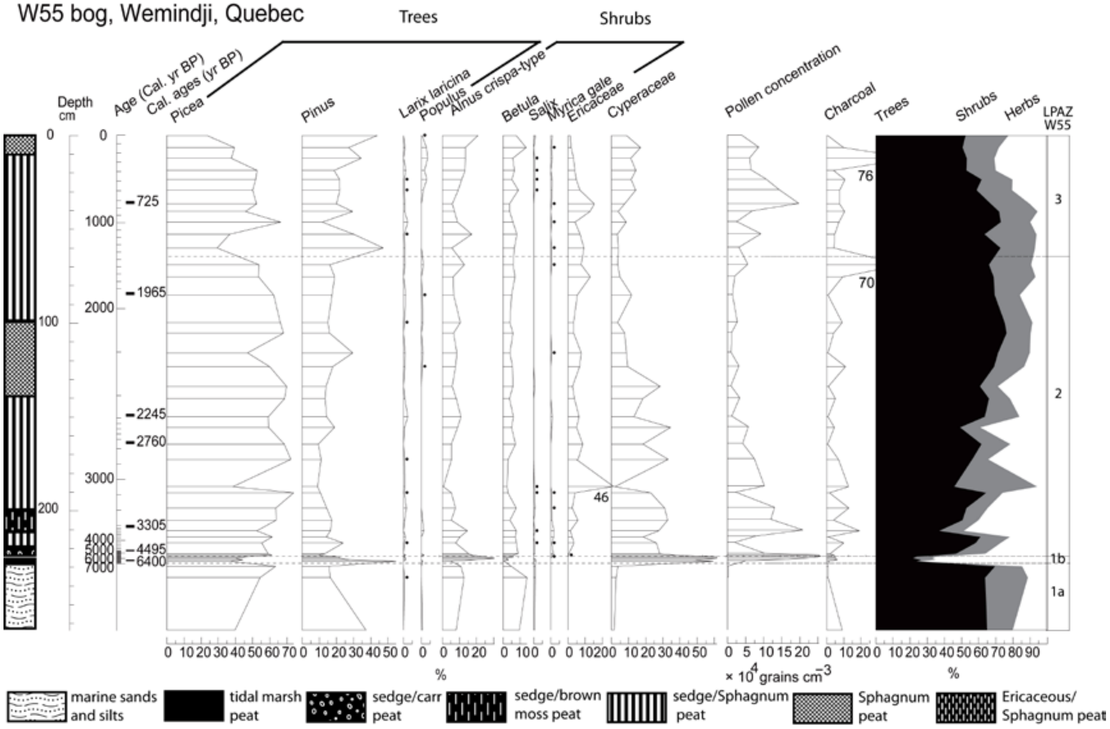

Figure 2. Pollen percentages and charcoal/tree pollen ratio for W55 core, Wemindji, Quebec. Selected pollen only. The summary diagram is based on the pollen and spore sum excluding *Sphagnum* spores and aquatics. Trees, shrubs, and charcoal are expressed as % of tree and shrub sum. All other taxa are expressed as % of the main sum. The charcoal signal is presented as the ratio of charcoal particles to the sum of tree and shrub pollen (%). LPAZ are local pollen zones identified by Psimpoll 4.26 program (25) using CONNIS. Dots represent abundances < 0.5 %.

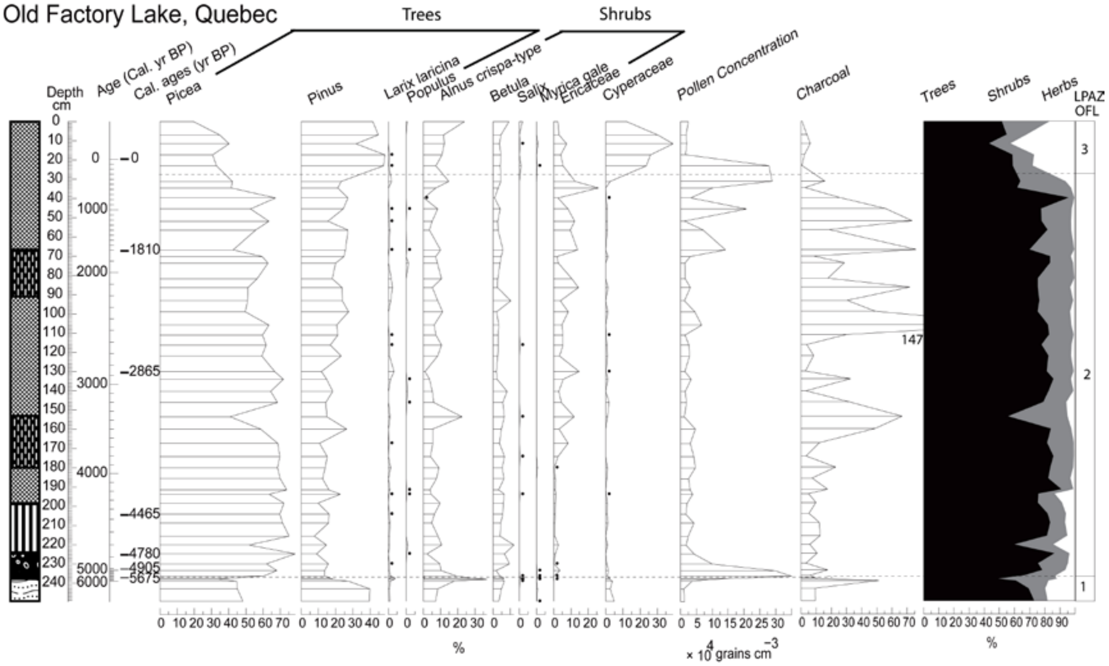

Figure 3. Pollen percentages and charcoal/pollen ratio for OFL core, Wemindji, Quebec. See figure 2 for diagram details and legend for lithostratigraphic units.

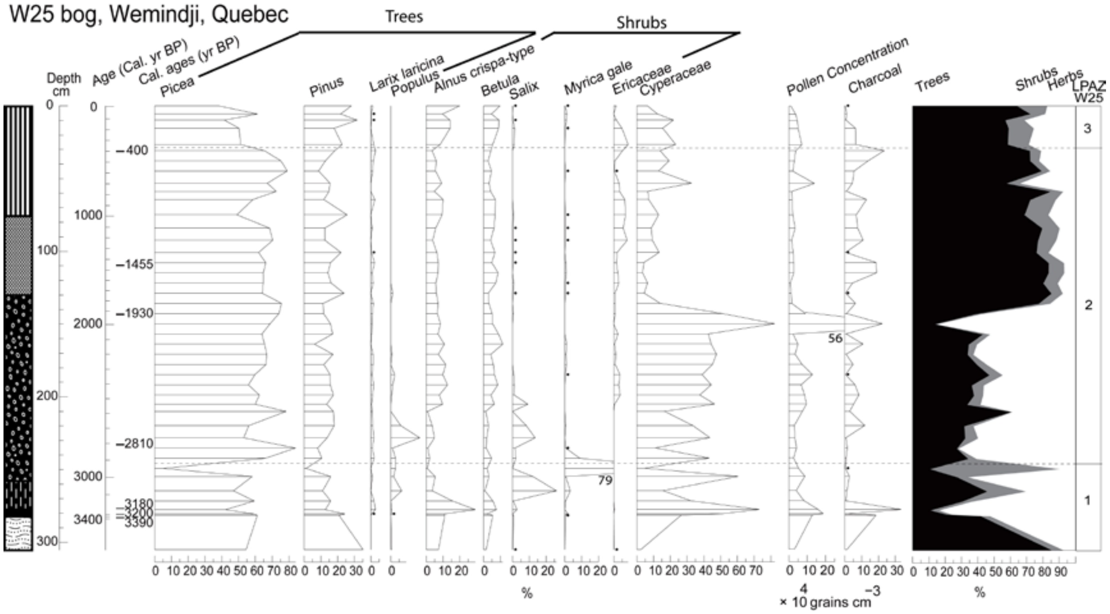

Figure 4. Pollen percentages and charcoal/pollen ratio for W25 core, Wemindji, Quebec. See figure 2 for diagram details and legend for lithostratigraphic units.

Table 1. Radiocarbon dates for cores W55, OFL, and W25 Eastern James Bay, Canada

Core	Depth (cm)	Dated material	Beta code	Radiocarbon age (yr BP)	2σ probability CAL age (yr BP)		
					1st	2nd	Midpoint
W55	36	twig	251810	800±40	**670-780**		725
	84	*Sphagnum* stems and leaves	257588	2010±40	**1880-2050**		1965
	149	*Sphagnum* stems and leaves	251809	2240±40	**2150-2340**		2245
	164	*Larix laricina* spurs	251808	2640±40	**2730-2790**		2760
	208	*Alnus* twig	251807	3090±40	**3220-3390**		3305
	221	*Alnus* twig, *Betula* leaf	251806	3930±40	4510-4480	**4440-4250**	4345
	226	*Alnus* twig	251805	5630±40	**6490-6310**		6400
OFL	19	*Sphagnum* stems and leaves	263331	123.9±0.5 pMC	modern		0*
	67	charred twig, *Betula* bark	251803	1880±40	**1720-1900**		1810
	130	*Sphagnum* stems and leaves	257587	2770±40	**2770-2960**		2865
	204	*Sphagnum* stems and leaves	251801	3980±40	**4400-4530**		4465
	225	*Alnus* twig	251802	4040±40	**4770-4790**	4420-4620	4780
	233	*Alnus* bark and twig	251800	4320±40	**4970-4840**		4905
	237	charred material (seeds, wood, and *Picea* needle)	257586	4970±40	5830-5860	**5600-5750**	5675
W25	31	Ericaceous leaf fragments, Coleopteran head	251815	340±40	**300-500**		400
	110	conifer wood fragment	257590	1570±40	**1370-1540**		1455
	143	Sedge leaf, *Carex* seed, *Alnus* twig	251814	1980±40	**1860-2000**		1930
	233	*Alnus* wood fragment	257591	2710±40	**2750-2870**		2810
	277	*Carex* leaf, *Eleocharis* and *Lathyrus* seeds	251813	3060±40	3370-3200	**3190-3170**	3180
	281	*Carex* leaf and seeds	251812	3000±40	**3330-3070**		3200
	282	grass leaves	251811	3150±40	**3450-3330**	3280	3390

Bold face indicates the 2σ probability calendar age range used in the age-depth model. In case of multiple 2σ ranges we used the highest probability age range. * We assume this to be close to AD 1950 given its subfossil depth.

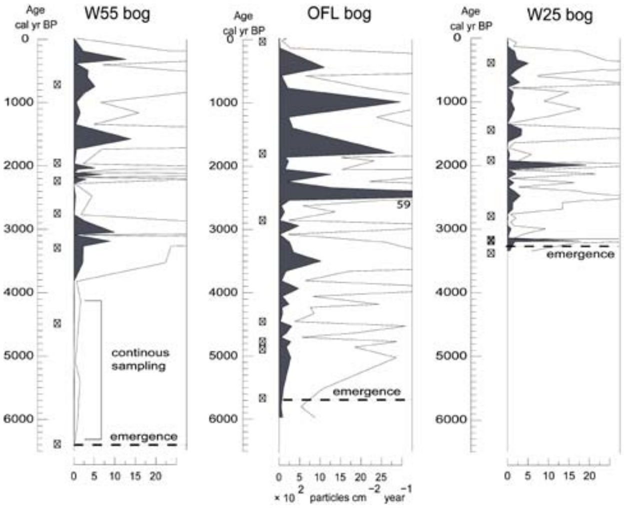

Figure 5. Charcoal accumulation rates (CHAR) for cores W55, OFL and W25, eastern James Bay, Quebec, Canada. Clear curves represent 10 times exaggeration. Checked dots represent ^{14}C measurements. Interrupted lines indicate the coastline emergence events at each site.

4.4 Pollen record

Cluster analysis of tree and shrub pollen at site W55 distinguishes three major pollen zones. Zone W55-1a (Fig. 2) represents the marine and tidal marsh phase of the site. Pollen concentration is very low and is dominated by pollen of *Picea, Pinus*, *Alnus crispa,* and *Betula* which together comprise 80-90% of the total pollen assemblage. Subzone W55-1b (6500-6000 cal yr BP) marks the peat inception at the site and is dominated by 70-80% herbaceous pollen, particularly Cyperaceae. Among the tree and shrub taxa, *Pinus* pollen is briefly dominant (50%), while *Picea* maintains steady proportions (40-45%). *Alnus crispa* pollen spikes at 30%, the highest level recorded at this site.

Zone W55-2 (6000-1500 cal yr BP) is dominated by *Picea* pollen (50-70%) followed by *Pinus*, *Alnus crispa* and *Betula.* The summary diagram shows an increase in the proportion of trees and shrubs, reaching 80-90% between 2150 and 1500 cal yr BP.

Zone W55-3 marks a change in tree pollen assemblage with an increase in the proportion of *Pinus,* which occasionally becomes dominant. *Picea* pollen proportions vary throughout this zone, but decrease after 800 cal yr BP. It reaches 23% at the surface, which is the lowest value recorded at this site. Distinct decreases in the proportion of *Picea* (at 1600 cal yr BP and during the last 300 yr) correspond with increases in *Pinus* and these seem to follow major increases in charcoal/pollen ratio (Fig. 2). The summary diagram shows a decrease in the proportion of tree pollen relative to herbaceous pollen particularly after 800 cal yr BP.

At the OFL site, cluster analysis indicates indicate 3 major pollen zones (Fig. 3). Zone OFL-1 corresponds with the oldest sediments (marine clayey silts and tidal marsh peat) deposited before 5000 cal yr BP. Pollen concentration is low in the marine sediments, but increases by an order of magnitude in the tidal marsh peat layer. *Picea* and *Pinus* pollen are co-dominant (40-50% and 30-40%) except between 5800 and 5700 cal yr BP when *Alnus crispa* is briefly the most abundant pollen taxa (37%). The summary diagram (Fig. 3) shows the dominance of tree and shrub taxa throughout (~80%).

Zone OFL-2 (5000-300 cal yr BP) is characterized by the dominance of *Picea* (50-80%). Some of the lowest *Picea* values (i.e., at 3500 and 1800 cal yr BP) seem to correspond to or follow major charcoal/pollen ratio peaks. *Pinus* pollen increases particularly after 800 cal yr BP, from 10-15%, between 5000-4500 cal yr BP, to ~30% around 300 cal yr BP. The *Pinus* increase corresponds to an overall increase in pollen/charcoal ratio. The summary diagram shows an almost absolute dominance of tree and shrub taxa around 90-95 % of the pollen spectra.

Zone OFL-3 represents the pollen record of the last 350 years. *Pinus* becomes dominant (40-50%) for the first time in the terrestrial history of this site, while *Picea* reaches its lowest values (20%). The summary diagram (Fig. 3) shows a considerable decrease in the proportion of tree pollen relative to the previous pollen zone.

At site W25 there are three major tree and shrub pollen zones (Fig. 4). Zone W25-1 corresponds with the marine sediments, tidal marsh peat and the oldest freshwater peat, deposited prior to 2900 cal yr BP. The arboreal pollen assemblage is dominated by *Picea* (50-60%), followed by *Pinus,* and shrub pollen. Local herbaceous taxa increase as marine sediments are replaced by peat, reaching almost 90% during the tidal marsh phase of this site.

In zone W25-2 (2900-350 cal yr BP) *Picea* remains dominant, but shrub taxa decrease. *Pinus* is the second most abundant pollen type followed by *Alnus crispa* and *Betula* (after 2500 cal yr BP). Around 2000 cal yr BP, the proportion of tree and shrub taxa increase, probably reflecting local (wetland) vegetation shifts (i.e., decrease in Cyperaceae).

In zone W25-3 (350-0 cal yr BP) *Pinus* abundance increases and *Picea* decreases, although it remains slightly dominant (40-60%). Also, *Alnus crispa* increases considerably from 4% to 20%. Overall, the proportion of tree taxa decreases slightly relative to shrub and herbaceous pollen.

5 DISCUSSION

Postglacial fire and vegetation history for eastern James Bay is inferred from three pollen and charcoal records spanning the last 6500 yr at sites W55 and OFL and the last 3400 yr at site W25.

5.1 Fire history

The greater magnitude of CHAR at OFL as compared to W55 and W25 suggests a difference in magnitude of fire activity (Fig. 5). The CHAR record at sites W55 and OFL suggests a similar trend as these locations. The CHAR is low with little variability between 6000 and 4000 cal yr BP and presents high values and large variability thereafter. The low charcoal influx at site W55 between 6000 and 4000 cal yr BP suggests virtually fire-free conditions. Yet, the CHAR for the same period at OFL are an order of magnitude higher suggesting fires occurred in the vicinity. The low variability of the charcoal influx values at the OFL site between 6000 and 4000 cal yr BP may indicate frequent fires of similar magnitude. At least one of these fires, at 6000 cal yr BP, was local as indicated by abundant charred plant material (seeds, wood fragments and *Picea* needles). The size of the remains indicate a fire source <100 m away. The other possibility is that the charcoal fragments were deposited by tidal waters as Old Factory Lake was a semi-closed paleo-bay at that time (Pendea et al., 2010). In the latter case, the source could have been more distant, but would have been within the watershed of this paleo-bay, thus <20 km from the coring site.

The last four millennia feature the beginning of fire activity near W55 site and an increase in fire activity (i.e., increase in CHAR values) at the OFL site (Fig. 5). Site W25 emerged around 3400 cal yr BP thus fire records for previous periods are not available. Several phases with increased fire activity are obvious for each site and some may have been synchronous at all sites during at least three periods: 3500-3000, 2200-2000 and 400-300 cal yr BP. The synchronicity of individual CHAR peaks is more difficult to establish given the age uncertainty associated with the carbon-14 dating. For instance, the CHAR peak around 3200 cal yr BP is synchronous at sites W55 and W25, but seems to have occurred earlier (3500 cal yr BP) at site OFL. One explanation is that the 3500 cal yr BP CHAR peak at OFL has in fact occurred around 3200. Another possibility is that the 3200 cal yr BP CHAR peak is synchronous only at W55 and W25 because they are spatially closer to each other (Fig. 1). Despite these limitations in establishing synchronicity, the inter-site comparison of CHAR signals points to an overall higher fire activity at the OFL site relative to sites W25 and W55. Higher fire activity at the OFL site could mean more severe, more frequent or closer fires, which would produce a higher influx of charcoal. Similar interpretations have been made by others (Clark and Royall, 1996; Higuera et al., 2005) and are supported by an experimental burn study in boreal settings that revealed a strong relationship between charcoal influx and distance from the burn edge (Clark et al., 1998). The regional fire history inferred from our charcoal records in eastern James Bay is consistent with other fire records in northeastern Canada. Payette and Gagnon (1985) showed an increase in soil charcoal frequency during the last 3500 years in the forest-tundra of northern Quebec. Ali et al. (2008) documented increased fire frequency and severity beginning 3300 cal yr BP in the southern boreal zone of western Quebec. Carcaillet and Richard (2000) analyzed the charcoal records of 30 lakes across northeastern Canada and concluded that overall fire activity increases after 4000-3000 cal yr BP, following a period of low fire activity between 8000 and 4000 cal yr BP.

5.2 Forest history

Our pollen evidence indicates a common regional vegetation trend across eastern James Bay during the mid to late Holocene. The earliest landscape at each site represents the primary succession phase typical for newly emerged coastlines. The primary succession front was led by shrub taxa (mainly *Alnus crispa*) and herbaceous communities, followed by *Picea*-dominated forests. The pollen signal between 6500 and 6000 cal yr BP, recorded only at site W55, suggests that the secondary succession vegetation was a *Picea* woodland rather than forest. This is indicated by the brief dominance of *Pinus* pollen (most likely extra-regional), low *Picea* pollen abundance and low pollen concentration. Low pollen concentration and high *Pinus* representation, not present in the region before 6000 cal yr BP, were previously documented by Richard (1979) who links them to treeless and/or woodland conditions. The late Holocene (4000-0 cal yr BP) landscape was dominated by *Picea* forests. An increase in *Pinus,* particularly after 800 cal yr BP marks a shift in the regional vegetation although *Picea* remains dominant. The advent of the shade-intolerant *Pinus* together with a decrease in the proportion of tree pollen suggest an opening of the regional taiga forest, probably in response to increased fire activity of the Late Holocene.

5.3 Fire regimes: human or natural?

The higher fire activity at the OFL site relative to W55 and W25 could have natural or anthropogenic origins. Environmental factors influencing fire ignition and the temporal fire regimes are moisture conditions (e.g., Ali et al., 2009; Clark, 1989), landscape connectivity (Ali et al., 2009), flammability of species (e.g., Forgeard and Lebouvier, 1991), and fuel availability (e.g., Suffling, 1993). Our sites are within a 70 km of each other, thus large-scale (climatic) moisture and temperature conditions should have been similar, thus similar fire regimes. Also, all sites had similar ecological conditions (similar size wetlands within a forested landscape) and forest composition during the late Holocene (Fig. 2, 3 and 4), thus fuel availability and flammability of species should have been similar.

Local oceanic influence during the coastal phase of the sites or influence of large water bodies could have increased local relative humidity and short-term fuel wetness, thus decreased fire susceptibility. All three sites experienced a decreasing oceanic influence with time as the shoreline was continuously displaced westward. Sites W55 and OFL emerged from the sea roughly at the same time (6400-5700 cal yr BP) thus they likely experienced contemporaneous oceanic influence. Site W25 emerged later (3200 cal yr BP) and was probably subjected to various degrees of oceanic influence during most of its terrestrial evolution. Yet, high fire activity occurred ~3200 cal yr BP (Fig. 5) discounting a direct relationship between fire susceptibility and oceanic influence.

Conditions at OFL suggest that fires were not of natural origin. The influence of Old Factory Lake (Fig. 1) would have increased the relative humidity during summer and decreased its susceptibility to fire. The site also has poor landscape connectivity due to its position at the tip of a boggy lacustrine peninsula (Fig. 1). Despite these conditions, the OFL site displays the highest fire activity in the region.

The archaeological evidence near the OFL site also suggests a human origin of local fire regimes there, between 6000 and 4000 cal yr BP when fire-free conditions were prevalent at the control site (W55). During the last four millennia, when fire activity was high throughout the region, the higher CHAR peak values at the OFL site were likely produced by a combination of natural and anthropogenic originated fires.

The pattern of local and frequent use of fire at Old Factory Lake is similar to patterns of aboriginal burning in eastern North America described by Russell (1983) and Clark and Royall (1996). The Old Factory Lake occupation could have been a non-agriculturalist society that used burning to improve hunting condition (i.e., create open spaces to attract game). The abundant caribou bones found at Old Factory Lake could suggest a specialization of caribou hunting, for which closed-canopy forest landscapes are not favorable (Stuart-Smith et al., 1997).

The time frame for the Old Factory Lake occupation is difficult to establish based upon archaeological evidence. Bone recovered from the site did not produce enough datable material and cultural indicators range from early Shield Archaic to early Contact period (see Archaeology). We speculate that the low-magnitude, low-variability and contiguous charcoal signal between 5500 and 4000 cal yr BP at Old Factory Lake indicates of the earliest occupation at the site. Further archeological work will test this hypothesis.

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