Effects of Native American Agricultural Practices on Colonial Point Forest Composition

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Fire was a commonly used practice for managing the forests on Colonial Point by Native Americans up until the late 19th century. The main use of fire was to clear land and supplement soils with nutrients for agricultural purposes. We surveyed two areas of similar ecosystem types; one in the North with little reported agriculture and one in the South with more extensive reports of agriculture. In each of these areas we surveyed ten plots and analyzed data about the forest composition. We hypothesized that there would be a significant difference in the forest composition of the two areas; specifically that red oak would be more prevalent in the farmed area and that the unfarmed area would be dominated by sugar maple and American beech. Our data supported the hypothesis that red oak would be dominant in the farmed area and American beech is dominant in the unfarmed site however no statistical difference existed in sugar maple composition. We believe that this is due to the nutrient differences in the sites as a result of the farming and access of seeds to the mineral soil. We also believe that both sites are succeeding towards sugar maple dominated forests.

Introduction

Colonial Point, a peninsula on Burt Lake in Pellston, Michigan, has seen several changes in land occupation over the past two centuries. Prior to European settlement, Native Americans occupied the land, and their style of living has been instrumental in shaping the ecosystem found in Colonial Point today. Perhaps the biggest impact their lifestyle had on the land is their implementation of fire in land management. Fires were used for a variety of purposes, among which were to hunt game, attract deer with prime browsing material, and promote berry growth (Day 1953), but the primary purpose was to clear area for agriculture (Albert and Minc 1987). Native Americans would only use land designated for agriculture for at most ten years, and then would move on to a new area and restart the fire agriculture process. According to Albert and Minc (1987), this farming style likely ended around 1855 as Native

Americans adopted the agricultural techniques of the European settlers. In 1900, Native Americans were forced to leave the land. Further land use by settlers was primarily restricted to logging, with some burning of slash, but the source species that provided for the forest composition we see today are primarily a result of Native American land use (Albert and Minc 1987).

A large component of the modern forests at Colonial Point are sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and Northern red oak (*Quercus rubra*). The pre-colonial forest type, circa 1800, of the area was beech-sugar maple. According to Albert and Minc (1987), the north of the peninsula still consists of this forest type, but the southern portion of the peninsula is red oak dominated. This is likely to be the result of Native American agriculture, as red oak is fire tolerant, having the ability to asexually sprout from the root collar (Barnes and Wagner 1981). Without fire, the intermediately shade tolerant oak is eventually overshadowed by the more tolerant sugar maple and American beech (Curtis 1959).

In this study, we investigate the effect of Native American agricultural practices, namely their use of fire, on the forest composition of Colonial Point, and our work may serve as a comparison to the results found by Albert and Minc (1987); however, we have the advantage of ecosystem-type maps created by Pearsall et al. (1995), which will help us control variables between the two sites. This study addresses questions pertaining to how the areas farmed by Native Americans are different both in current forest composition, and in successional trends to the areas unfarmed by Native Americans. Is Northern red oak (*Quercus rubra*) more dominant in farmed areas than in unfarmed areas? What species are dominant in the unfarmed areas? In terms of forest succession, what species are likely to become dominant in both the farmed and the unfarmed areas? In order to answer these questions, we sampled farmed and unfarmed sites within the same ecosystem type in Colonial Point. We hypothesize that there will be differences in forest composition between the areas farmed and unfarmed by Native Americans. Specifically, red oak will dominate the areas farmed by Native Americans due to their use of fire, and sugar maple and American beech will dominate the areas unfarmed. Furthermore, due to the suppression of fire and the similarity of ecosystem type between the two areas, we hypothesized that the farmed area will succeed to a sugar maple – American beech forest.

METHODS

We conducted our field survey in the Colonial Point Forest in Burt Lake, in Cheboygan County, MI. Colonial Point Forest is on a gently sloping moraine with somewhat excessively drained to well-drained loamy sand soil over sandy clay loam (Pearson et al. 1995).

In order to determine what areas had been burnt and used for agriculture by Native Americans, we consulted the General Land Office survey map and section line descriptions: their notes indicated that the southern part of Colonial Point had been extensively farmed, while the more northern areas experienced little or no agriculture (Albert and Minc 1987). Consulting the landscape ecosystem type map (Pearsall et al. 1995), we plotted two south to north baselines, one in the southern portion of Colonial Point and one in the northern portion of Colonial Point. Both of these baselines were in ecosystem type 110 to keep our comparison consistent. In order to randomize the maximum number of plots we would be able to cover within both the spatial and temporal constraints we used a random number table and plotted five intersects on the north to south baseline at random distances from an established starting point. At each of these intersections we plotted east to west baselines. Again we used a random number table to determine the distance away from the north to south transect our plots should be on east to west baseline. We plotted one survey plot east of each intersect and one plot west of the intersections at our previously determined randomized distances. This resulted in ten plots in the southern farmed area and ten plots in the northern unfarmed area. The points on our east to west baseline represented the north-west corner of the plots.

In each plot, we measured the dominant and subdominant overstory, the understory, and the ground cover above one half meter. We recorded the species and DBH of every tree in the overstory (trees with diameters 9.1 and above) in each plot and calculated the relative densities, basal areas and relative dominances. For the understory, we recorded the species and number in the entire plot and calculated the relative densities. We also recorded the species and number of individual groundcover plants over one half meter in height using a 0.5m wide belt transect along one 15m meter edge and one 30m edge of the plot. Only individuals over one half meter were recorded to determine which species were most likely to recruit into the overstory in the future and we calculated the relative densities for each species. Finally, we statistically analyzed our collected data using paired t-tests in SPSS.

Results

Significant differences in overstory basal area existed between the Farmed and unfarmed sites. Acer rubrum had a significantly greater basal area in the overstory of the unfarmed plot than in the farmed plot (Ttest p=0.023)(Figure 1). Fagus grandifolia also had a significantly greater basal area in the overstory of the unfarmed plots than in the farmed plots (Ttest p=0.011)(Figure 1). Fraxinus Americana demonstrated a greater basal area in the overstory of the unfarmed plots than in the farmed plots (Ttest p=0.013)(Figure 1).

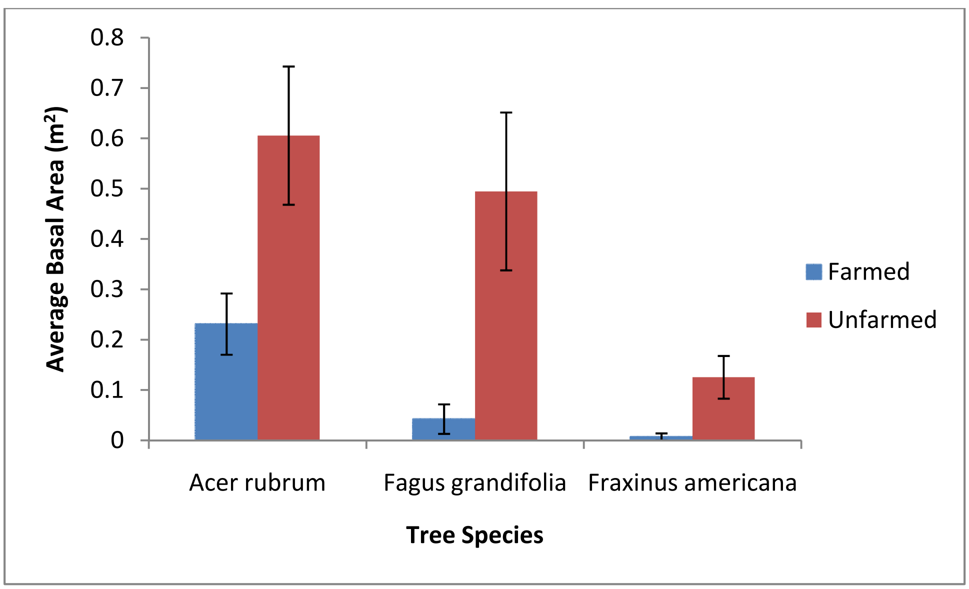

Figure 1 Average basal area in the overstory of Acer rubrum, Fagus grandifolia, and Fraxinus Americana for the farmed and unfarmed sites.

No significant differences were found in overstory basal area for the following species: *Acer saccharum,* Betula Papyrifera, *Ostrya virginiana, Pinus resinosa, Pinus strobus, Populus grandidentata, Quercus rubra, and Tsuga canadensis* (Figure 2, Figure 3).

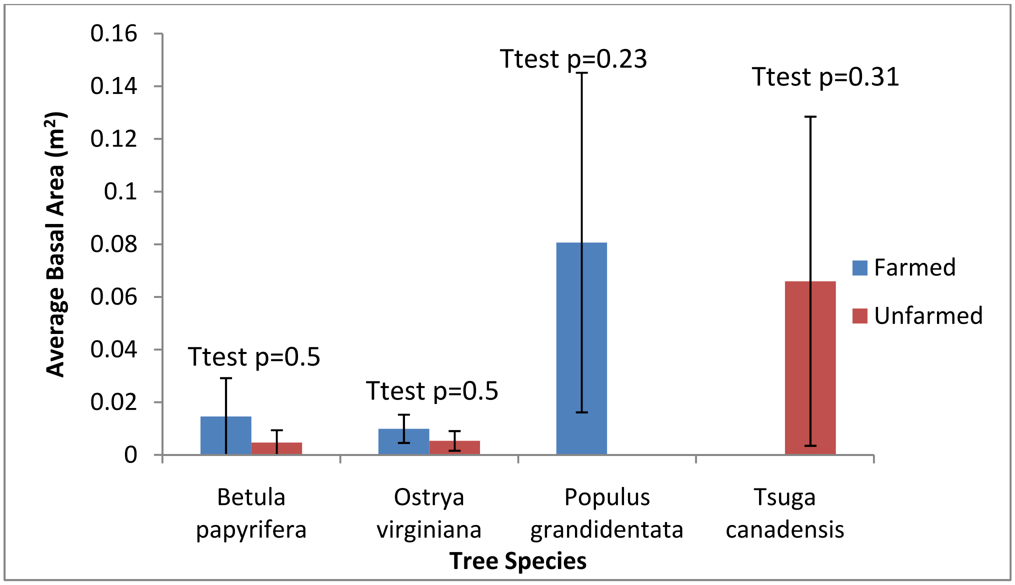

Figure 2 Average basal area in the overstory of Betula papyrifera, Ostrya virginiana, Populus grandidentata, and Tsuga canadensis at farmed and unfarmed sites. Error bars represent standard deviation.

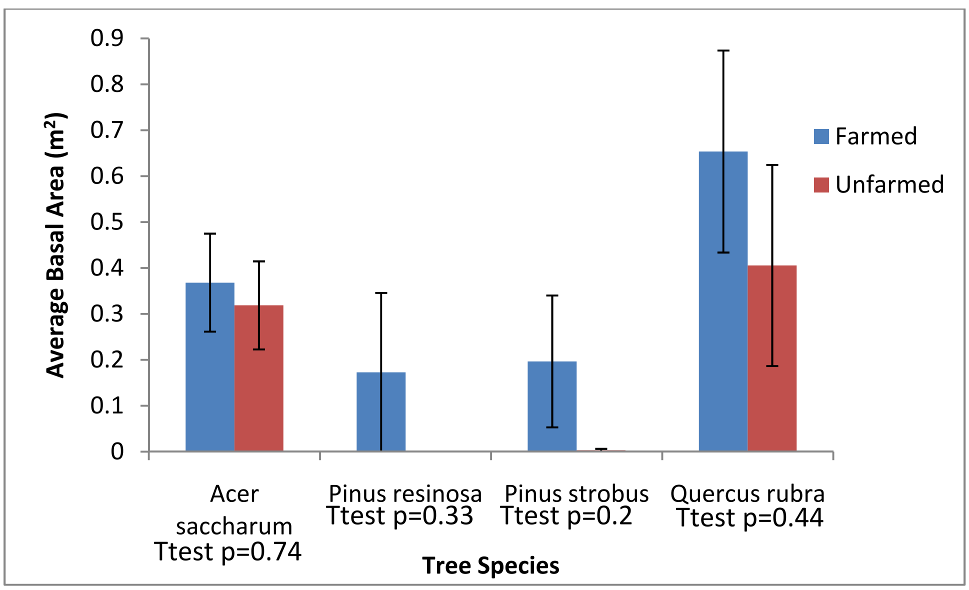

Figure 3 Average basal area in the overstory of Acer saccharum, Pinus resinosa, Pinus strobus, and Quercus rubra at farmed and unfarmed sites. Error bars represent standard error.

Tsuga canadensis was only found in the site that was unfarmed (Figure 2), and Pinus resinosa and Populus grandidentata were only present at farmed sites (Figure 1, Figure 2).

However there was no significant difference for these species between sites because so few trees were sampled.

Relative dominance was also calculated for the overstory of both sites. In site 1, *Quercus rubra* and *Acer saccharum* were the most dominant species (Figure 4). Site 2 showed a dominance of *Acer rubrum* and *Fagus grandifolia* (Figure 5).

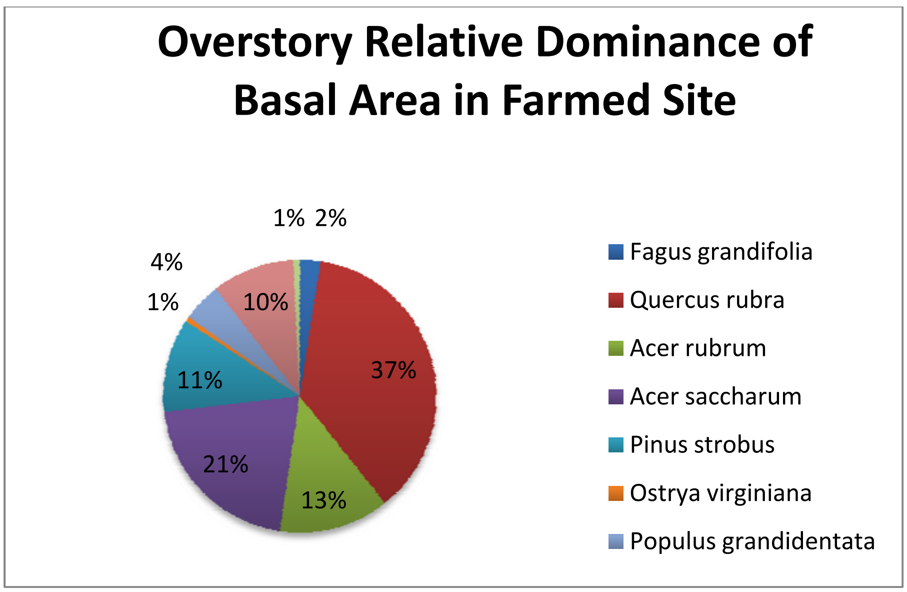

FIGURE 4: OVERSTORY RELATIVE DOMINANCE OF BASAL AREA IN FARMED SITE AT COLONIAL POINT
Quercus rubra was the most dominant species at the farmed site, though it was not significantly different than at the unfarmed site.

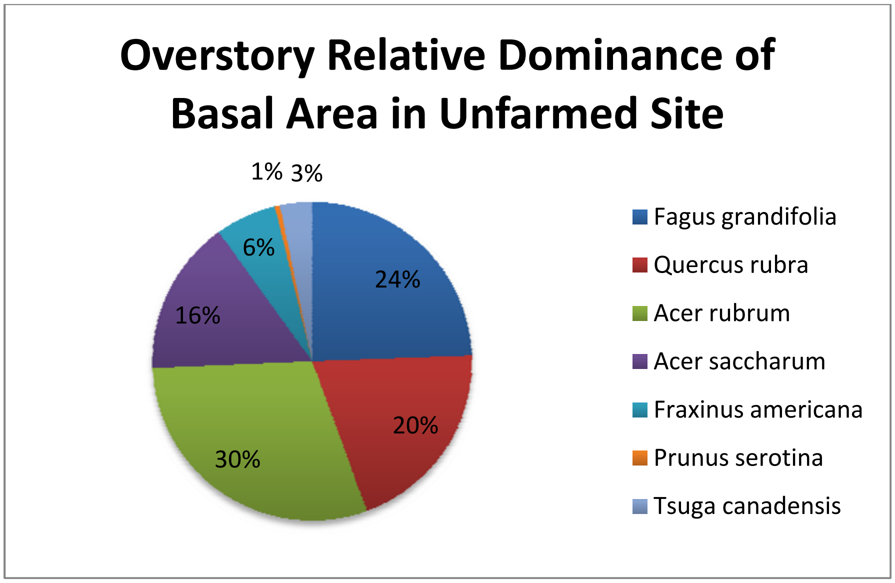

FIGURE 5: OVERSTORY RELATIVE DOMINANCE OF BASAL AREA IN UNFARMED SITE AT COLONIAL POINT *Acer rubrum was the most dominant species at the farmed site and was significantly different than at the unfarmed site, with p-value=0.028.*

When comparing the number of stems in the understory, there was no significant difference between species in the two sites (Figure 6). Though there was no significance, *Acer saccharum* and *Fagus grandifolia* were most abundant at both sites.

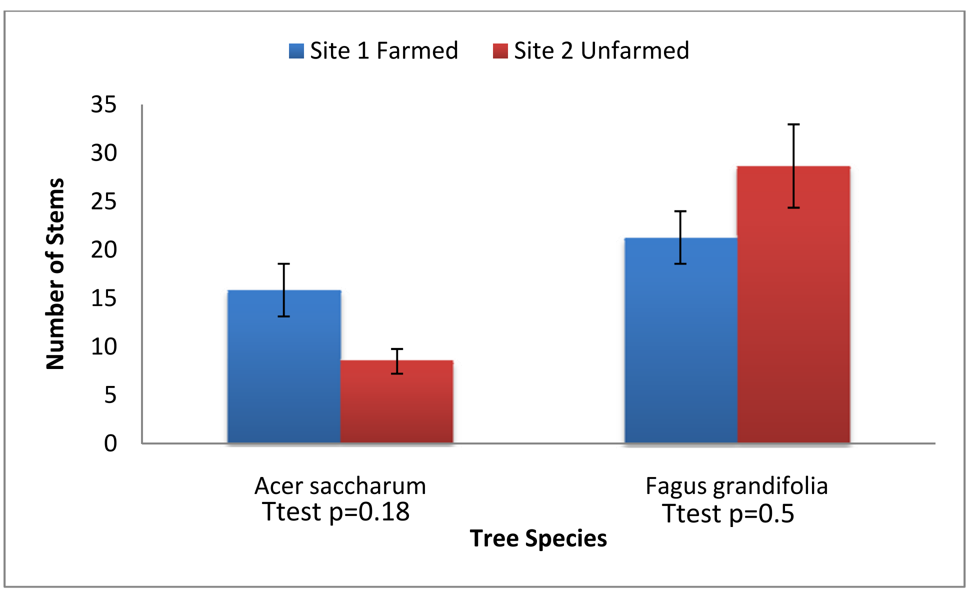

FIGURE 6: AVERAGE NUMBER OF STEMS OF *ACER SACCHARUM* AND *FAGUS GRANDIFOLIA* IN THE UNDERSTORY AT THE FARMED AND UNFARMED SITES AT COLONIAL POINT. *Error bars represent standard error.*

Discussion

As we predicted, *Quercus rubra* is the dominant overstory species in the farmed plots. There is a trend of lower quantities of *Quercus rubra* in unfarmed areas, however this difference is not significant. Our prediction was also correct in regard to *Fagus grandifolia*, which appeared in significantly greater quantities in the overstory of the unfarmed plots. These findings concur with those of Albert and Minc (1987). However, with regard to *Acer saccharum* our prediction proved to be incorrect, as no significant differences were found in the presence of sugar maple in the overstory at either site. This finding differs from that of Albert and Minc (1987), possibly because our study only utilized plots within the same ecosystem type, lending greater potential for accuracy to our study.

The quantity of *Fraxinus americana* was significantly greater in the unfarmed site than in the farmed site. As this tree species is a nutrient indicator (Barnes 2004), this suggests the unfarmed site has a greater nutrient availability than the farmed site. Farming is well known to remove nutrients from the soil, as the nutrients contained within the plants harvested are not returned to the soil from which they came (Mclauchlan 2006).

However, similar basal areas of *Acer saccharum* and *Ostrya virginiana*, also nutrient indicators (Barnes 2004), at both sites suggest the farmed soil is not completely devoid of nutrients. Native Americans did not completely exhaust the soil of nutrients the way farming techniques of European settlers often did (Russell 1983). Native Americans only farmed fields for a maximum of ten years, and they frequently burned their fields, which returns nutrients to the soil (Albert and Minc 1987). This may explain why some nutrient indicator species can exist in the farmed plots in equal quantities as the unfarmed sites.

A greater number of stems of *Pinus strobus* occur in the farmed plot than in the unfarmed plot. *Pinus strobus* produces small wind-dispersed seeds that require bare mineral soil to germinate (Dovčiak et al. 2003). Frequent fires and farming reduce the thickness of the organic soil layer (Bonan 1989; McLauchlan 2006). In the time that these pines were germinating, the mineral soil at the farmed site may have been more exposed, allowing more pines to germinate. However, although more pines established at the farmed site, we found no significant difference in the basal area of *Pinus strobus* growing at either site. We attribute this finding to the fact that both sites were of the same ecosystem type (Pearsall et al. 1995).

Both sites have similar basal areas of *Pinus strobus* and *Quercus rubra*. Both of these species are mid-shade tolerant and would appear to indicate that both plots are in a mid-successional phase (Abrams et al. 1995). However, the farmed site contained very small quantities of *Populus grandidentata* and *Pinus resinosa* in its dominant overstory. These trees are shade intolerant and typically early successional (Barnes and Wagner 2004). As these trees occur in such low numbers in the farmed plot, they are probably the remnants of an early successional forest. However, as no early successional tree species were witnessed in the unfarmed plots, it could be concluded that the unfarmed plots are at a slightly later stage of succession than the farmed plots. This is further supported by the presence of *Fagus grandifolia*, *Fraxinus americana*, and *Tsuga canadensis* in the unfarmed plot. These trees are considered late-successional species (Woods 2001) and are not present or present in significantly lower quantities in the farmed plot.

Farming is a form of disturbance (McLauchlan 2006), and it seems to have set back the successional phase of the farmed site in comparison to the unfarmed site. However, although their quantities are currently small, late successional species are beginning to appear in the dominant overstory of the farmed plots. The early successional species are not present in the understory and will soon be nonexistent in the overstory because they are short-lived and are reaching the end of their maximum lifespan.

Examination of the understory trends at each site suggests that barring any major disturbance, the currently dominant mid-successional species, *Quercus rubra* and *Acer rubrum*, will be replaced by late successional *Fagus grandifolia* and *Acer saccharum*. At this point few differences in dominant tree species would exist between the sites. However, earthworms are present on Colonial Point and could interfere with germination and establishment of *Acer saccharum*. *Acer saccharum* is adapted to germinate and establish through the thick surface duff that usually accumulates in old growth forests (Lawrence et al. 2002). Earthworms reduce the amount of organic matter covering the forest floor, removing *Acer saccharum's* advantage in this ecosystem (Lawrence et al. 2002). Earthworms have also been shown to reduce the colonization and nutrient transfer of arbuscular mycorrhizal fungi, a type of fungi that provides nutrients to *Acer saccharum's* roots in a symbiotic relationship (Lawrence et al 2002). Therefore the presence of earthworms at Colonial Point could have detrimental effects on the sugar maple population.

Additionally, beech bark disease (*Nectria coccinea var. faginata*) has already begun to invade this ecosystem (Shigo 1972). Beech bark disease is a fungus that infects the feeding wounds inflicted by the scale insect, *Cryptococcus fagi* (Shigo 1972). The spread of this fungus to Colonial Point could prevent *Fagus grandifolia* now present in the understory from being recruited into the overstory. Therefore future studies are necessary to monitor ecosystem trends as we cannot currently predict with great certainty the future dominant species of these sites.

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