

POST-EUROPEAN SETTLEMENT FOREST CHANGES IN OSCODA AND OGE MAW COUNTIES, MICHIGAN

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ABSTRACT

Witness trees from Ogemaw and Oscoda counties were used to identify presettlement forest composition in order to compare how different historical land uses altered early settlement and present-day forests. Presettlement forests in Ogemaw County were dominated by *Tsuga canadensis* (17%), *Pinus banksiana* (13%), and *Fagus grandifolia* (12%). Oscoda County was dominated by *Pinus banksiana* (42%) and *Pinus resinosa* (16%). *Tsuga canadensis* was significantly ($P = 0.05$) associated with sandy loams in depressions; *Fagus grandifolia* was significantly associated with sandy loams on uplands; *Pinus banksiana* was significantly associated with sandy plains; and *Pinus resinosa* was significantly associated with sandy uplands. Both counties were logged of *Pinus strobus* and valuable hardwoods in the late 1800s. In the early 1900s, farms were established on the cutover hardwood sites. Temporary use of these logged sites for agriculture prevented successful regeneration of hardwoods. Thus, following agricultural declines in the 1930s, *Pinus banksiana* seedlings invaded these abandoned farmlands. Other cutover sites experienced repeated slash fires, which also favored the invasion of the fire-adapted *Pinus banksiana*. In contrast, pre-European settlement *Pinus banksiana* sites were not logged; however, these sites experienced fire suppression during the last 70 years and fire-intolerant early successional hardwoods have invaded these sites. This study demonstrated the strong influence of soils and topography on the distribution of pre-European settlement vegetation in northern lower Michigan, but post-European settlement species distribution has been more influenced by land use history.

INTRODUCTION

Original land surveys and other historical data serve as a base line from which to evaluate how post-European settlement land-use history has altered North American forests (Ahlgren & Ahlgren 1983; Foster et al. 1996; Russell 1997). European settlers introduced many new land uses when they settled in North America (Cronon 1983; Flader 1983; Whitney, 1994). Most vegetation was significantly changed as a result of introduced anthropogenic disturbances such as charcoal production, exotic species, fire suppression, firewood cutting, grazing, intensive agriculture, logging, maple syrup production, and slash fires (Siccama 1971; Dodge 1987; Abrams & Ruffner 1995; Mikan & Abrams 1995; Motzkin et al. 1996; Simard & Bouchard 1996; Cowell 1998). In areas where fewer Europeans settled, the landscape remained relatively similar to its pre-European settlement composition and structure (Kenoyer 1930; Donnelly & Murphy 1987; DeSalm 1994).

Two methods of land surveying were used in the United States: metes and

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bounds surveys and rectangular surveys. In general, the eastern states were surveyed with the metes and bounds system and the western and central states were surveyed with the rectangular system. In the metes and bounds system, witness trees were identified at irregular intervals across the landscape resulting in an unintentional, albeit highly biased, sampling of pre-European settlement forests (Bourdo 1956; Black & Abrams 2001). In 1785, the Continental Congress designated the rectangular survey method as the official survey method for all public lands. Surveyors using the rectangular survey method recorded the species and diameter of two to four trees at every intersection within a one-square mile grid system. In most surveys, two quarter-section trees (witness trees marked at the half-mile point between grid intersections) were also recorded. The stratification of this survey method reduced sampling location biases associated with the metes and bounds data; however, the risk of individual surveyor bias (selection of preferred species and diameter for witness trees, misidentification of species, and falsification of data) still existed (Bourdo 1956). The higher potential for biases associated with the metes and bounds surveys resulted in most early forest historians reconstructing maps of the pre-European settlement forests in areas that had been surveyed with the rectangular method (Sears 1925; Kenoyer 1933; Gordon 1940).

Michigan, which was surveyed with the rectangular system, was one of the earliest states where witness trees were used to understand historical forest composition (Livingston 1905; Kenoyer 1930). Many of the studies focused their analysis on constructing maps of pre-European settlement forest composition (Kenoyer 1933; Dick 1937; Kenoyer 1940; Kenoyer 1942; Merk 1951). Later studies combined the original land survey data with other data sets to explore relationships between original species composition and soils and topography (Fisher 1994; Barrett et al. 1995), Native American influences on pre-European settlement vegetation (Jones & Kapp 1972), the influence of the pre-European settlement disturbance regime on vegetation (Whitney 1986), and comparisons between current and pre-European settlement vegetation (Janke et al. 1978; Frelich 1995; Zhang et al. 2000).

In this study, we worked with original land surveys from Oscoda and Ogemaw counties in northern lower Michigan. The pre-European settlement forest composition of the two adjacent counties on the west (Crawford and Roscommon) has been thoroughly studied (Livingston 1905; Whitney 1986; Whitney 1987). Studying Oscoda and Ogemaw counties allowed us to contrast our findings with the previous studies to obtain a better understanding of some of the variability in the pre-European settlement forest. The Native American populations in Oscoda and Ogemaw counties were low and the impacts of native land use were minimal. Therefore, these study sites also provided a good baseline to examine the influence of introduced European land use on a relatively undisturbed forest (Twining 1983; Tanner 1986). Thus, our study objectives were to (1) identify presettlement forest composition and structure based on the Public Land Survey notes for Oscoda and Ogemaw counties, Michigan; (2) determine the importance of edaphic factors on presettlement forest composition; (3) compare presettlement, early settlement and present day forest transitions; (4) relate

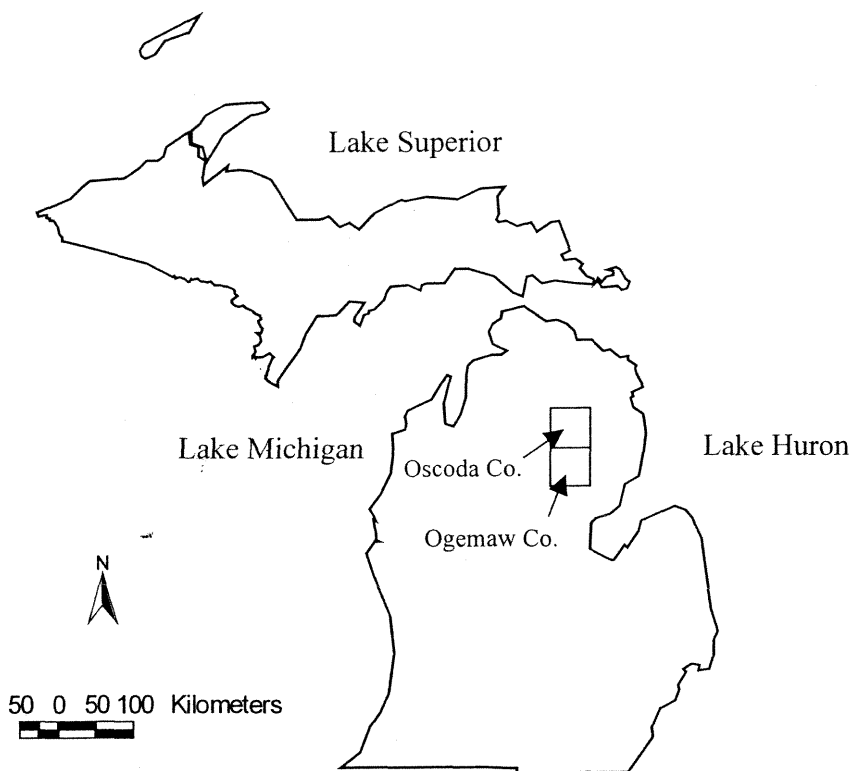


FIGURE 1. Oscoda and Ogemaw counties are located in northern lower Michigan.

land-use history to changes in forest composition; (5) compare the results from this study with findings from previously published studies.

THE STUDY AREA

Ogemaw and Oscoda counties (44°N, 84°W) are located in the northeastern portion of Michigan's lower peninsula (Figure 1). Ogemaw County contains 148,950 ha and Oscoda County has 147,629 ha. Their similarity in area allowed direct comparison of forest composition data between the two counties. The parent material in both counties is glacial till and glacial outwash deposited 10,000 years ago during the last glaciation (Veatch et al. 1931; Johnson 1990). Temperatures in Ogemaw County ranged from an average winter minimum of -11.2°C to an average summer maximum of 26.4°C . Temperatures in Oscoda County ranged from an average winter minimum of -11.8°C to an average summer maximum of 26.7°C . Annual precipitation was 75 cm in Ogemaw County and 69 cm in Oscoda County (<http://www.ncdc.noaa.gov/ol/climate/climatedata.html>).

Michigan remained largely uninhabited by Native Americans until the Hopewell culture (100 BC to AD 70). The Hopewell hunted, but did not have permanent settlements in Ogemaw and Oscoda counties (May & Brinks 1974). By the early 1600s, the Algonquians occupied most of the upper Great Lakes Region and four Algonquian earthworks, from temporary dwellings, existed in Ogemaw County along the AuSable River (Leach 1885; Hinsdale 1925; Dustin 1932; Dunbar & May 1995).

Ogemaw and Oscoda counties became part of the United States with the Treaty of Saginaw in 1836. Ogemaw County established its current boundaries in 1875 (Historical Committee 1975) and Oscoda County in 1881 (Nash 1979a). *Pinus strobus* L. and *Pinus resinosa* Aiton were harvested from both counties between 1870 and 1890. This logging period also indirectly influenced the growth of some of the lesser-valued trees as evidenced by Mayr's (1890) observation at the end of the 19th Century that many *Pinus banksiana* Lambert (a low-value tree) were dying in northern lower Michigan because clearcutting of other species had altered the water table.

From 1890 to 1920, a second phase of timber cutting occurred with removal of hardwoods (*Acer*, *Betula*, *Fagus*, *Quercus* and *Ulmus*) and less desirable conifers (*Tsuga*, *Thuja*, *Picea* and *Abies*) (Randall 1979). Much of this timber was transported to mills on logging railroads (Nash 1979b; Parker 1983). After the second phase of cutting, large portions of both counties burned in numerous slash fires (Miller 1963; Historical Committee 1975). Some areas regenerated naturally, but the Civilian Conservation Corps planted pine and hardwood seedlings in both counties in the 1930s (Symon 1983).

Agriculture became a common land use in the 1890s, and eventually replaced logging as the dominant land use. Agriculture proved unsuccessful due to infertile, excessively well-drained soils. Therefore, most farms were abandoned in the early 1900s (Weaver 1942). The Great Depression brought bank failures and exacerbated agricultural hardships, causing abandonment of many of the remaining farms (Weaver 1942). Following the 1930s, the economy of these two counties was supported by production of *Populus* spp. and *Pinus banksiana* for pulpwood, a few small industries, and oil and gas wells in the West Branch Oil Field (Newman 1936; Blyth 1973, Michigan Dept. of Commerce 1985a;b). The close of the agricultural era also ushered in the tourist trade and the former saw log industry began to manufacture log cabin materials for new summer homes (Michigan Dept. of Conservation 1955). With the creation of the Huron National Forest in 1928, more than half of the privately owned land in Oscoda County was converted to public ownership and other large blocks of privately owned land were divided into small, vacation properties (Schallau 1965; Adams 1966).

METHODS

Presettlement forest composition and structure.

The Public Land Survey notes were available at the county courthouses. John Mullett and Benjamin Hall surveyed Ogemaw County from 1837 to 1846 and

identified 3,989 witness trees. John Randall, Edward Albertson, and Clarence O'Seeley surveyed Oscoda County from 1838 to 1840 and identified 4,033 witness trees. The survey instructions from the Surveyor General's Office indicated that witness tree selection was not biased by size or species as a result of survey instructions nor were the data manufactured by fraudulent surveyors because in two subsequent resurveys (1884 and 1908) the remains of many of the original witness trees were relocated (Clasen 1836; Lyon 1846).

To evaluate the presettlement species associations, the Cole/Hurlbert C_8 association coefficient was calculated from the paired witness tree data on species that occurred at a minimum of 20 locations in each of the two counties (Hurlbert 1969, Anderson & Anderson 1975). In the witness tree data, frequency varied by species and the Cole/Hurlbert C_8 association coefficient allowed valid comparisons across species of different frequencies because it was frequency independent. Survey points with only one witness tree were eliminated from the analysis. We constructed a dissimilarity matrix from the C_8 values and performed cluster analysis (Bastow et al. 1990) using multivariate analysis program, SAMPL (W. Myers, University Park, PA). SAMPL derived the first cluster formation by linking nearest neighbors; the program then evaluated the second closest neighbors for all species; this occasionally resulted in one species being identified within two of the initial clusters. If this occurred, these clusters were consolidated based on the linkage of second closest neighbors. After the linkage of second closest neighbors, the cluster analysis stopped.

Soils and topography

Contingency table analysis was used to assess the importance of edaphic factors on presettlement forest composition (Strahler 1978). We pooled the witness tree data from both counties for this analysis to allow inclusion of minor species without encountering problems associated with small predicted values (Steel et al. 1997). All witness trees were transcribed onto the USGS topographic quadrangles. Three topographic positions were identified: depressions, plains, and uplands. Depressions were areas lower than the average elevation and typically had swampy or boggy conditions. Plains were flat topographic areas and uplands were isolated ridges or rolling hills. A species by topographic position matrix was developed. A G-statistic was calculated for each species where $G^2 = 2 \sum (\text{observed} * \ln(\text{observed} / \text{expected}))$. These values were examined for significance at $\alpha = 0.05$. For species with significant relationships between species presence and topographic position, corrected standardized residuals were calculated by $E_{ij} / (V_{ij})^{0.5}$. Where

$$E_{ij} = \frac{(\text{observed} - \text{expected})}{(\text{expected})^{0.5}}$$

and

$$V_{ij} = \frac{((\text{observed column total} - \text{expected}) \times \text{observed row total})}{((\text{observed row total} - \text{expected}) \times \text{observed column total})}.$$

These corrected standardized residuals were plotted to identify relationships between species presence and topographic position.

Six of the USDA soil textures (based on particle size) were present in the two counties: loam, loamy sand, organic soils, sand, sandy loam and silt loam (Veatch et al. 1931; Johnson 1990). The witness trees were transcribed on the soil surveys and a species-soil matrix was created. G-statistics were calculated in the same manner as for topographic position and when significant relationships existed ($\alpha = 0.05$), the corrected standardized residuals were calculated.

Changes in forest composition and historical land use

Forest composition data were available from three time periods: the witness tree data from the public land survey (1837–1846); the Michigan Department of Conservation land economic survey maps (1923–1931); and the Michigan Department of Natural Resources forest cover type map (1990). Combining several historical records to track forest changes has risks because each data set had different surveyors, objectives, and sampling methods (McCune & Menges 1986). To minimize potential interpretation errors, all data sources had to be reduced to the level of the least informative data set. The witness trees from the public land survey created a point-intercept sampling grid of trees at section corners and quarter section posts (Muller-Dombois & Ellenberg 1974). Therefore, even though both later data sets had forest cover data available, we reduced those data sets to sampling points from the same locations as the witness trees. Thus, we created matrices of forest change from a point-intercept sampling of the same locations over three time periods.

To examine whether the distribution of logging railroads occurred equally in all forest associations, we performed a chi-square goodness-of-fit test on the ratio of railroad presence in each of the forest associations. The expected values were based on the frequency of each association in the witness tree data. The chi-square value was examined for significance at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Presettlement forest composition and structure

Witness trees were used to determine species frequency and diameter distribution within presettlement forests in Ogemaw and Oscoda counties (Table 1, Figure 2). Ogemaw County was dominated by *Tsuga canadensis* (L.) Carrière (17%), *Pinus banksiana* (13%), *Fagus grandifolia* Ehrh. (12%), *Pinus resinosa* (12%), and *Pinus strobus* (10%). Oscoda County was dominated by *Pinus banksiana* (42%) and *Pinus resinosa* (16%). Oscoda County's presettlement forest had more small diameter trees than Ogemaw County. Sixty percent of Ogemaw County's witness trees were over 20 cm in diameter, but only 44% of Oscoda County's witness trees were over 20 cm in diameter (Figure 2). The dominance of small-diameter trees and the high percentage of pines in Oscoda County (65% compared to 35% in Ogemaw County (Table 1)) indicate a more

TABLE 1. Relative frequency of species in the Public Land Survey data collected from 1836–1846 in Ogemaw and Oscoda counties, Michigan. The values in parentheses are the species rank for each county; tied species are indicated with an asterisk.

Species	Surveyor's names	Ogemaw County	Oscoda County
<i>Abies balsamea</i>	balsam, fir	1.5 (13)	0.9 (15)
<i>Acer rubrum</i>	maple	4.3 (8)	1.1 (14)
<i>Acer saccharum</i>	sugar, hard maple	4.4 (7)	1.6 (11)
<i>Alnus incana</i>	black alder	0.2 (21*)	0.0 (20)
<i>Betula alleghaniensis</i>	yellow birch	0.5 (19)	0.1 (19*)
<i>Betula papyrifera</i>	white birch	1.0 (17)	1.2 (13*)
<i>Betula</i> sp.	birch	1.6 (12)	2.3 (8)
<i>Fagus grandifolia</i>	beech	12.2 (3)	5.6 (5)
<i>Fraxinus americana</i>	white ash	0.2 (21*)	0.1 (19*)
<i>Fraxinus nigra</i>	black ash	3.4 (10)	0.2 (18*)
<i>Larix laricina</i>	tamarack	3.5 (9)	2.8 (7)
<i>Ostrya virginiana</i>	ironwood	0.3 (20*)	0.1 (19*)
<i>Picea</i> sp.	spruce	1.1 (16)	0.5 (16)
<i>Pinus banksiana</i>	spruce pine, pitch pine	13.3 (2)	42.4 (1)
<i>Pinus resinosa</i>	yellow pine	11.9 (4)	16.3 (2)
<i>Pinus</i> sp.	pine	0.1 (22*)	1.4 (12)
<i>Pinus strobus</i>	white pine	9.6 (5)	4.6 (6)
<i>Populus</i> sp.	aspen	2.0 (11)	7.0 (3)
<i>Prunus serotina</i>	black cherry	0.1 (22*)	0.0 (20)
<i>Quercus alba</i>	white oak	1.2 (15)	0.4 (17)
<i>Quercus prinoides</i>	dwarf oak	0.0 (23)	1.7 (10)
<i>Quercus rubra</i>	red oak	0.3 (20*)	0.1 (19*)
<i>Quercus velutina</i>	black oak	1.5 (14)	1.2 (13*)
<i>Thuja occidentalis</i>	cedar	7.2 (6)	2.2 (9)
<i>Tilia americana</i>	linden	0.9 (18*)	0.2 (18*)
<i>Tsuga canadensis</i>	hemlock	17.0 (1)	6.0 (4)
<i>Ulmus americana</i>	elm	0.9 (18*)	0.2 (18*)

frequent disturbance regime which resulted in a younger, *Pinus*-dominated forest compared to the *Fagus-Tsuga* dominated forests in Ogemaw County. One structural characteristic common to both counties was the presence of large diameter *Pinus resinosa* (in Ogemaw County 68% of the *Pinus resinosa* were over 37 cm and in Oscoda County 60% were over 37 cm).

The cluster analysis of the Cole/Hurlbert C_g association coefficients divided the 22 species into three clusters or pre-European settlement forest communities. A community of xeric species contained: *Acer rubrum* L., *Pinus banksiana*, *Pinus resinosa*, *Populus* sp., *Quercus prinoides* Willd., and *Quercus velutina* Lam. (this species association will hereafter be referred to as the *Pinus banksiana*-*Pinus resinosa* association). A community of mesic to hydric species included: *Abies balsamea* (L.) Miller, *Acer saccharum*, *Betula alleghaniensis*, *Betula papyrifera*, *Fagus grandifolia*, *Fraxinus nigra*, *Larix laricina* (DuRoi) K.Koch, *Picea* sp., *Thuja occidentalis* L., *Tilia americana*, *Tsuga canadensis*, and *Ulmus americana* (this association will hereafter be referred to as the *Tsuga canadensis*-*Fagus grandifolia* association). This cluster contained the most heterogeneous group of species because many species were grouped during the second linkage. The third community contained xeric to mesic species and included: *Pinus strobus* and *Quercus alba* L. (this association will hereafter be

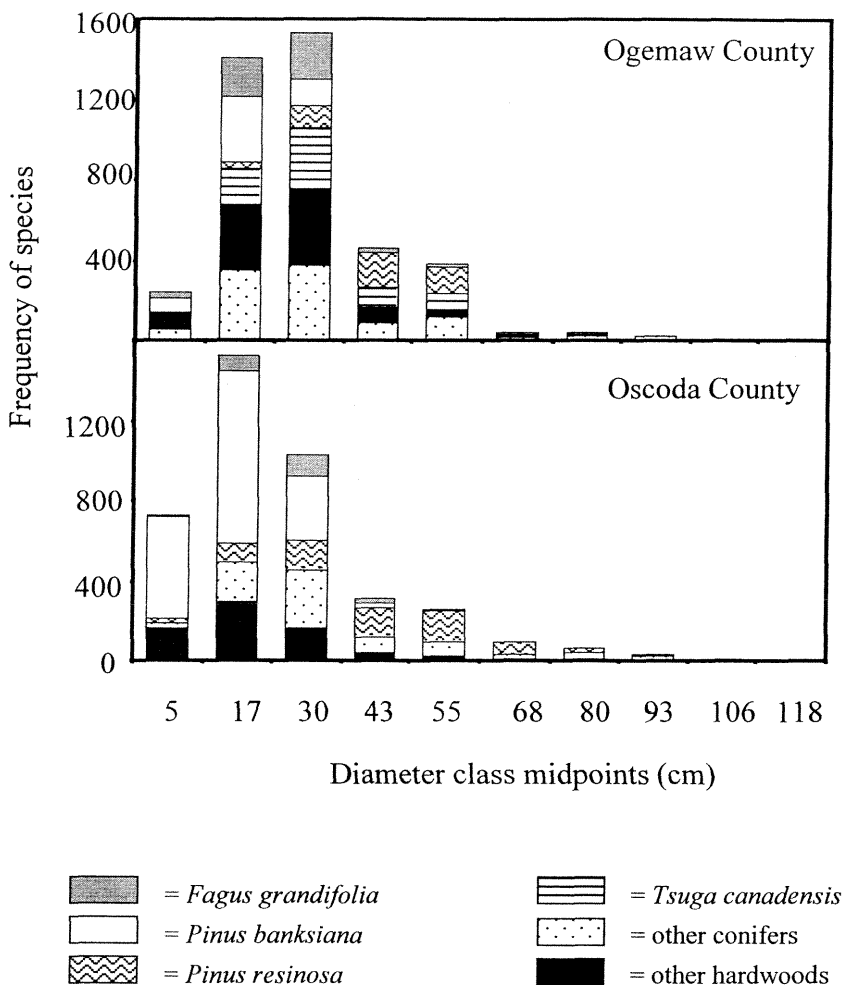


FIGURE 2. Diameter distributions for Ogemaw and Oscoda counties, Michigan based on witness tree data in Public Land Survey notes from the early 1800s. The category "other conifers" includes *Abies balsamea*, *Larix laricina*, *Picea* sp., *Pinus strobus* and *Thuja occidentalis*. Other hardwoods includes: *Acer rubrum*, *Acer saccharum*, *Alnus incana*, *Betula alleghaniensis*, *Betula papyrifera*, *Fraxinus americana*, *Fraxinus nigra*, *Ostrya virginiana*, *Populus* sp., *Prunus serotina*, *Tilia americana* and *Ulmus americana*.

referred to as the *Pinus strobus* association). Species composition in communities does not necessarily remain static through time (Gleason 1926; Abrams & Ruffner 1995; Abrams & McCay 1996). Therefore, it was important to identify the species associations contemporary with the sampling period. In Ogemaw and Oscoda counties, our cluster analysis showed that pre-European settlement species associations were very similar to modern associations. The combination

of cluster analysis and Cole/Hurlbert C_8 association coefficients appeared to be a valuable tool for evaluating historical community composition from paired witness tree data.

One common feature identified in many of the southern Michigan reconstructions of presettlement forest was the presence of prairie intrusions in the form of small grassy openings within a hardwood-dominated forest (Dick 1937; Brewer et al. 1984; Dodge 1987). The southern counties in Michigan were closer to the midwestern prairies and therefore, grass quickly invaded fire-caused openings. However, in Ogemaw and Oscoda counties, fire-caused openings were filled with the small-diameter, young *Pinus banksiana* (Figure 2). *Pinus banksiana* reaches its southern range limit at the middle of Michigan's lower peninsula; therefore, the post-fire niche filled by grasses in the southern part of the peninsula is filled by the fire-adapted *Pinus banksiana* in the northern portion of the peninsula.

Soils and topography

Soils and topography determined pre-European settlement species distribution in northern lower Michigan's forests. *Abies balsamea*, *Acer rubrum*, *Fraxinus nigra*, *Picea* sp., *Thuja occidentalis*, and *Tsuga canadensis* had significant ($\alpha = 0.05$) positive associations with depressions (Figure 3), although Whitney's (1986) work in the two adjacent counties identified *Acer rubrum* as associated with rolling extensive uplands rather than depressions. *Acer rubrum* has a bimodal distribution and grows well in hydric depressions and xeric uplands, but is outcompeted by *Acer saccharum* at mesic sites (Abrams 1998). Only by combining the results of this study with Whitney's (1986) was *Acer rubrum*'s bimodal distribution identified, thus indicating that larger sampling sizes were required to detect a non-normal distribution. *Pinus banksiana* and *Populus* sp. had significant positive associations with plains. *Acer saccharum*, *Fagus grandifolia*, *Pinus resinosa*, *Quercus alba*, *Quercus prinoides* and *Quercus velutina* had significant positive associations with uplands. A few species showed a significant positive association with two topographic positions (i.e., *Larix laricina* had significant positive associations with depressions and uplands), but most species were positively associated with only one topographic position (Figure 3).

Acer rubrum, *Betula papyrifera*, *Fraxinus nigra*, *Pinus strobus* and *Quercus velutina* had significant positive associations with loamy soils (Figure 4). *Acer saccharum* and *Quercus alba* had significant positive associations with loamy sand. *Larix laricina*, and *Thuja occidentalis* had significant positive associations with organic soils. *Pinus banksiana*, *Pinus resinosa* and *Quercus prinoides* were significantly associated with sand. *Fagus grandifolia* and *Tsuga canadensis* were significantly associated with sandy loam. *Abies balsamea* and *Populus* sp. had significant positive associations with silt loam. Most species showed positive significant associations with several soil textures (i.e. *Acer saccharum* had significant positive associations with loam, loamy sand and sandy loam) however, one species, *Pinus banksiana*, was positively associated with only one soil category (sand). The species not included in the figures were either not significantly

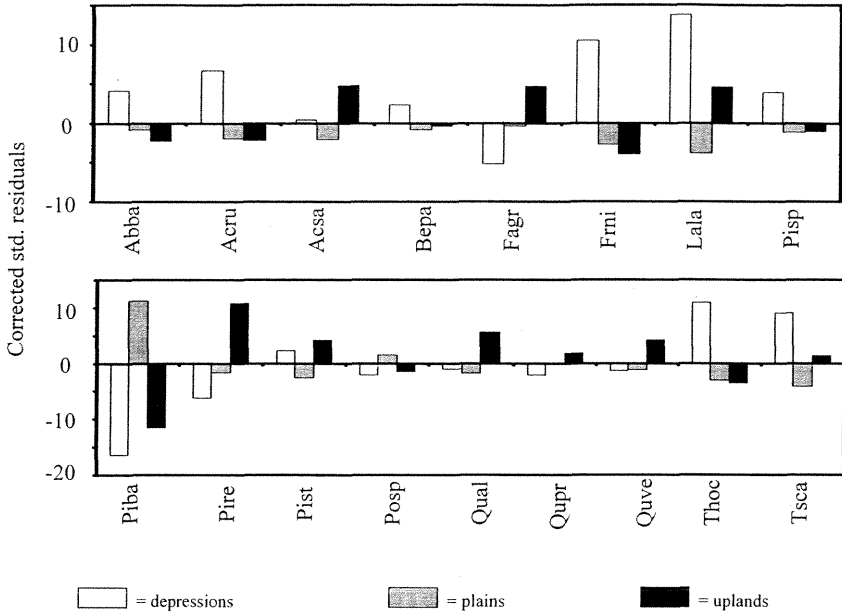


FIGURE 3. Significant ($P = 0.05$) relationships between witness trees and topographic position in Ogemaw and Oscoda counties, Michigan. A positive value indicates a positive association between that species and the topographic position. Species names are abbreviated as follows: Abba = *Abies balsamea*, Acru = *Acer rubrum*, Acsa = *Acer saccharum*, Bepa = *Betula papyrifera*, Fagr = *Fagus grandifolia*, Frni = *Fraxinus nigra*, Lala = *Larix laricina*, Piba = *Pinus banksiana*, Pire = *Pinus resinosa*, Pisp = *Picea* spp., Pist = *Pinus strobus*, Posp = *Populus* spp., Qual = *Quercus alba*, Qupr = *Quercus prinoides*, Quve = *Quercus velutina*, Thoc = *Thuja occidentalis*, and Tsca = *Tsuga canadensis*.

associated with soil or topographic categories or did not meet the assumptions for the G-statistic calculation due to small expected values (Steel et al., 1997).

Changes in forest composition and historical land use

After European settlement, both counties experienced a substantial reduction in *Tsuga canadensis*-*Fagus grandifolia* and *Pinus strobus* due to logging in these forest associations (Table 2; Hargreaves and Foehl 1964; Randall, 1979). Most of the harvested hardwoods and *Pinus strobus* were transported via railroads. Maps of logging railroads mirror the location of presettlement hardwoods, but railroads are mostly absent from areas dominated by *Pinus banksiana* (Figure 5; Nash 1979b). The distribution of logging railroads was not independent of presettlement forest association ($X^2 = 11.91$; d.f. = 2; $\alpha = 0.05$). The *Tsuga canadensis*-*Fagus grandifolia* and *Pinus strobus* associations had a significantly higher proportion of logging railroads than the *Pinus banksiana*-*Pinus resinosa* association. In Ogemaw County, by 1923, only 6% of the presettlement *Tsuga canadensis*-*Fagus grandifolia* remained undisturbed. If the land had been

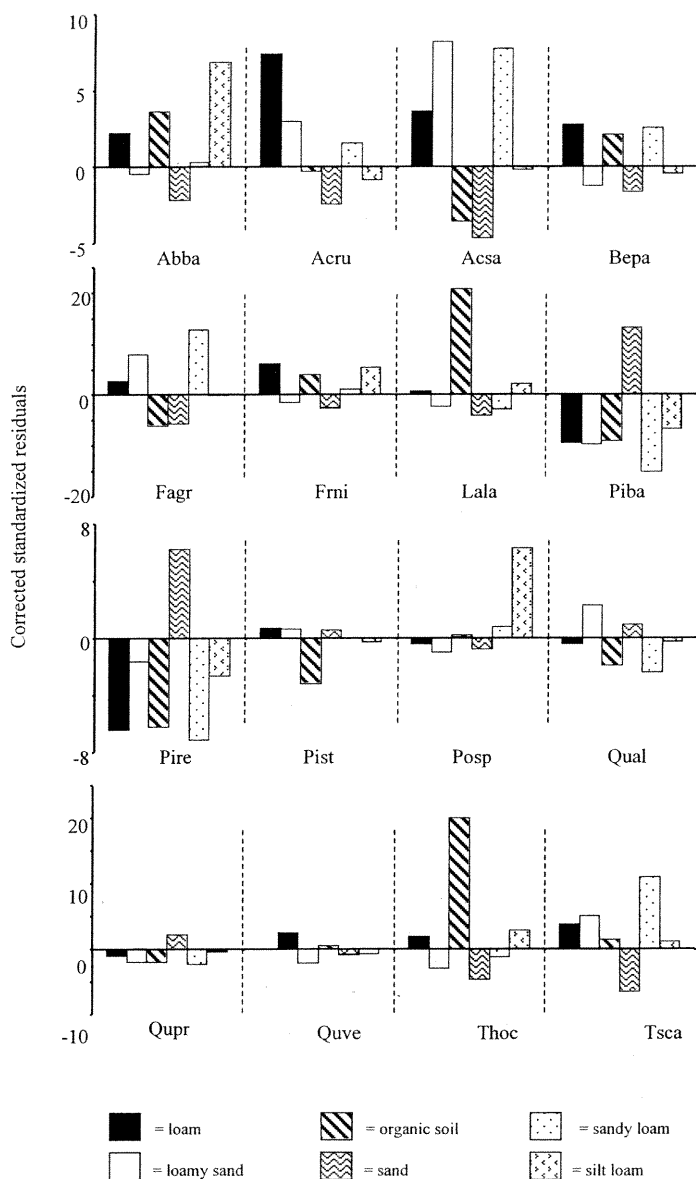


FIGURE 4. Significant ($P = 0.05$) corrected standardized residuals for witness tree and soil relationships. A positive value indicates a positive association between the species and soil category. A negative value indicates a negative association between the species and soil category. Species are abbreviated as follows: Abba = *Abies balsamea*, Acru = *Acer rubrum*, Acsa = *Acer saccharum*, Bepa = *Betula papyrifera*, Fagr = *Fagus grandifolia*, Frni = *Fraxinus nigra*, Lala = *Larix laricina*, Piba = *Pinus banksiana*, Pire = *Pinus resinosa*, Pist = *Pinus strobus*, Posp = *Populus* spp., Qual = *Quercus alba*, Qupr = *Quercus prinoides*, Quve = *Quercus velutina*, Thoc = *Thuja occidentalis*, and Tsca = *Tsuga canadensis*.

TABLE 2. This matrix shows the forest association changes that occurred in Ogemaw and Oscoda counties over three time periods. The rows show the percent change in each forest association over time with the forest associations abbreviated as follows: Piba-Pire = *Pinus banksiana*-*Pinus resinosa*, Tsca-Fagr = *Tsuga canadensis*-*Fagus grandifolia*, and Pist = *Pinus strobus*. The value in parentheses after the association name is the total number of sample points from the earlier period.

(A) Time periods: 1830 (left) to 1923 (top)						
	Piba-Pire	Tsca-Fagr	Pist	non-forest	burned	total
Piba-Pire (1973)	73.1	2.8	0.1	23.4	0.6	100%
Tsca-Fagr (1379)	37.9	12.3	0.4	48.4	1.0	100%
Pist (279)	67.0	3.6	0.7	28.3	0.4	100%
non-forest (155)	47.1	5.2	0.6	45.2	1.9	100%
burned (40)	80.0	0.0	0.0	20.0	0.0	100%
(B) Time periods: 1830 (left) to 1990 (top)						
	Piba-Pire	Tsca-Fagr	Pist	non-forest	burned	total
Piba-Pire (1973)	64.0	16.8	0.0	19.2	0.0	100%
Tsca-Fagr (1379)	32.1	31.3	0.0	36.6	0.0	100%
Pist (279)	45.5	35.5	0.0	19.0	0.0	100%
non-forest (155)	40.0	29.0	0.0	31.0	0.0	100%
burned (40)	87.5	2.5	0.0	10.0	0.0	100%
(C) Time periods: 1923 (left) to 1990 (top)						
	Piba-Pire	Tsca-Fagr	Pist	non-forest	burned	total
Piba-Pire (2123)	57.3	25.5	0.0	17.2	0.0	100%
Tsca-Fagr (232)	45.7	34.5	0.0	19.8	0.0	100%
Pist (10)	80.0	10.0	0.0	10.0	0.0	100%
non-forest (1151)	39.1	18.8	0.0	42.1	0.0	100%
burned (25)	64.0	8.0	0.0	28.0	0.0	100%

abandoned immediately after harvesting hardwoods may have regenerated on the better sites; however, developers sold much of this cleared land to farmers. Troyer lists a total of 4229 ha of cut-over “stump lands” for sale in Oscoda County in 1915. Some of these cut-over areas were quite extensive, but most occurred on former hardwood or *Pinus strobus* lands. One typical property was described as “about five thousand acres of cut-over hardwood land in Elmer township.” Although Ogemaw County experienced more extensive agricultural use than in Oscoda County, agricultural productivity in both counties declined in the 1930s. These largely unsuccessful attempts at agriculture destroyed the window of regeneration from seeds or stump sprouts left after the hardwood harvest. In addition to farming attempts, many cut-over lands experienced repeated slash fires which killed hardwood regeneration (Maybee, 1973; Kirkland, 1990). The only remaining seed source after agricultural abandonment and repeated slash fires was from the invasive xeric species left on the pine plains that had not been harvested. The absence of competition from mesic species allowed the early successional, fire-adapted pines to expand their range (Figure 5; Table 2). The fed-

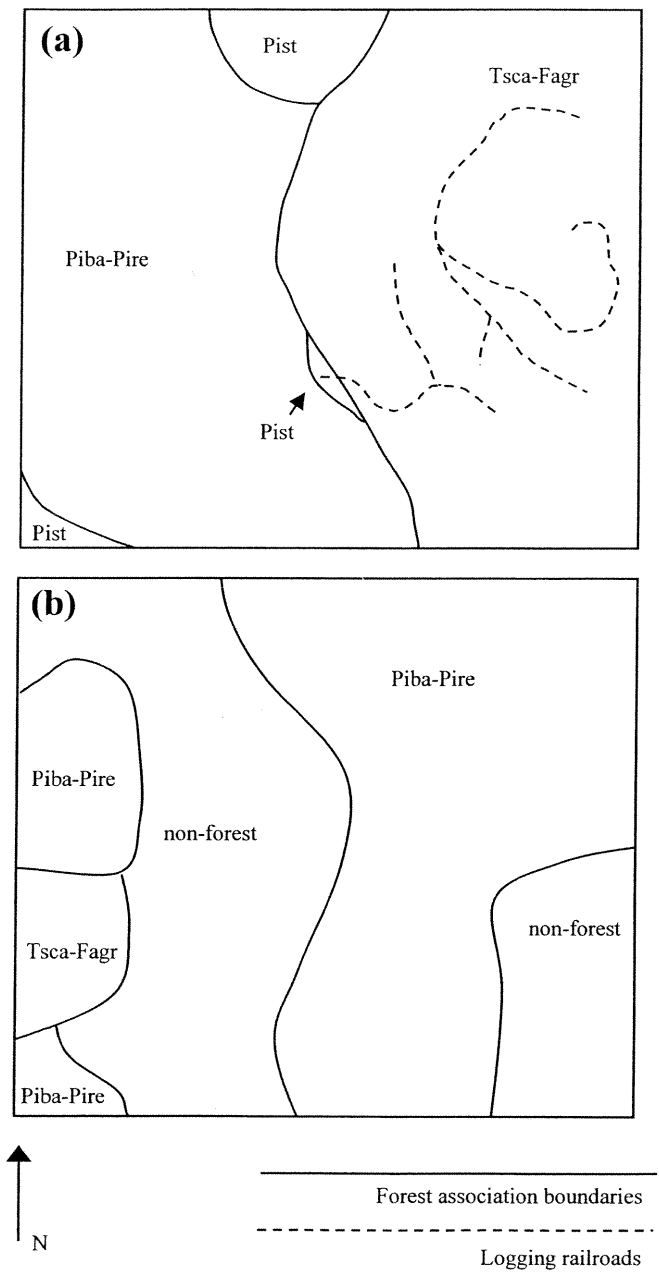


FIGURE 5. Forest changes in Township 27 North, Range 2 East in Oscoda County, Michigan. (a) presettlement (1838) forest associations with the location of early settlement railroads. (b) present-day (1990) forest associations.

eral and state reforestation of conifers on cut-over lands also contributed to the increase in the *Pinus banksiana*–*Pinus resinosa* association (Syman, 1983).

In an opposite trend from cut-over hardwood lands, the unlogged, pre-European settlement *Pinus banksiana*–*Pinus resinosa* forests experienced an increase in hardwoods and a decrease in *Pinus*. In Oscoda County, *Pinus banksiana* decreased by half (from 42% to 22%); *Pinus resinosa* decreased slightly (from 16% to 11%); while *Populus* spp. increased four-fold (from 7% to 29%) and *Quercus* spp. increased seven-fold (from 3% to 22%) (Table 1; Jakes, 1982). Fire suppression was responsible for this increase in hardwood species. Fire has always been an important disturbance agent in northern lower Michigan and has excluded hardwoods and favored conifers (Beal, 1888; Simard and Blank, 1982; Rouse, 1986). The original survey notes identify burned sections in 69% of the townships. The burned descriptions range from expansive township-sized fires to much smaller fires that only burned portions of stands (Mullett, 1838). One of the main reasons fire suppression was possible was the presence of the Civilian Conservation Corps (CCC) within these two counties. The CCC camps were specifically located on state and private land considered to be high fire hazards. The CCC fought forest fires, built fire towers, built roads to aid fire fighting in remote areas, and constructed landing fields for airplanes used for forest fire control work (Young, 1938). In northern lower Michigan, estimates of fire in *Pinus banksiana* forests decreased from an average return interval of 125 years during the presettlement period to 392 years during the fire suppression period (Whitney, 1987). Over a hundred years later, the consequences of fire suppression were evidenced in the increased dominance of hardwoods on lands formerly dominated by the *Pinus banksiana*–*Pinus resinosa* association.

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LITERATURE CITED

- Abrams, M. D. 1998. The red maple paradox. *Bioscience*. 48: 355–364.
- Abrams, M. D. & McCay, D. M. 1996. Vegetation-site relationships of witness trees (1780–1856) in the presettlement forests of eastern West Virginia. *Canadian Journal of Forest Research* 26:217–224.
- Abrams, M. D. & Ruffner, C. M. 1995. Physiographic analysis of witness-tree distribution (1765–1798) and present forest cover through north central Pennsylvania. *Canadian Journal of Forest Research* 25: 659–668.
- Adams, K. 1966. The Huron National Forest. In *Seventh Annual Great Lakes Forestry Exposition*, Mio, Michigan. 21–23 July 1966.
- Ahlgren, C. E. & Ahlgren, I. F. 1983. The human impact on northern forest ecosystems. In S. F. Flader (ed.). *The Great Lakes Forest: An environmental and social history*. The University of Minnesota Press, Minneapolis, MN. 336 pp.
- Anderson, R. C. & Anderson, I. F. 1975. The presettlement vegetation of Williamson County, Illinois. *Castanea* 40:345–363.
- Barrett, L. R., Liebens, J., Brown, D. G., Schaetzl, R. J., Zuwerink, P., Cate, T. W., & Nolan, D. S.

1995. Relationships between soils and presettlement forests in Baraga County, Michigan. *American Midland Naturalist* 134:264–285.
- Bastow, W. J., Partridge, T. R. & Sykes, M. T. 1990. The use of the Cole/Hurlbert C_g association coefficient in inverse ecological classification. *Journal of Vegetation Science* 1:367–374.
- Beal, W. J. 1888. Observations on the succession of forests in northern Michigan. In First report of the directors of the State Forestry Commission of Michigan for the years 1887 and 1888. Thorp and Godfrey, State Printers and Binders, Lansing. 92 p.
- Black, B. A. & Abrams, M. D. 2001. Influences of Native Americans and surveyor biases on metes and bounds witness tree distribution. *Ecology* 82:2574–2586.
- Blyth, J. E. 1973. Pulpwood production in the Northcentral Region by county. USDA For. Ser. Res. Bull. NC-18.
- Bourdo, E. A. Jr. 1956. A review of the General Land Office survey and of its use in quantitative studies of former forests. *Ecology* 37:745–768.
- Brewer, L. G., Hodler, T. W., & Raup, H. A. 1984. Presettlement vegetation of southwestern Michigan. *Michigan Botanist* 23:153–156.
- Clasen, L. 1836. Special instructions to Lewis Clasen, D.S. for extending township lines in Michigan. Located at: the Michigan State Archives, Lansing, MI.
- Cowell, C. M. 1998. Historical change in vegetation and disturbance on the Georgia Piedmont. *American Midland Naturalist* 140:78–89.
- Cronon, W. 1983. Changes in the land. Indians, colonists, and the ecology of New England. Hill and Wang, New York, NY. 241 p.
- DeSelm, H. R. 1994. Vegetation results from an 1807 land survey of southern Middle Tennessee. *Castanea* 59:51–68.
- Dick, W. B. 1937. A study of the original vegetation of Wayne County, Michigan. *Papers from the Michigan Academy of Science, Arts, and Letters* 22:329–334.
- Dodge, S. L. 1987. Presettlement forest of south-central Michigan. *Michigan Botanist* 26:139–152.
- Donnelly, G. T. & Murphy, P. G. 1987. Warren Woods as forest primeval: A comparison of forest composition with presettlement beech-sugar maple forests of Berrien County, Michigan. *Michigan Botanist* 26:17–24.
- Dunbar, W. F. & May, G. S. 1995. Michigan: A History of the Wolverine State. William B. Eerdmans Publishing Company, Grand Rapids, MI. 769 p.
- Dustin, F. 1932. Report on Indian earthworks in Ogemaw County, Michigan. Cranbrook Institute of Science. Scientific Publication. No. 1. Bloomfield Hills, MI. 25 p.
- Fisher, J. H. 1994. Pre-European settlement forests of northern lower Michigan: The role of landform in determining composition across the landscape. M.S. thesis. Department of Forestry. Michigan State University, East Lansing, MI. 67 pp.
- Flader, S. F. 1983. The Great Lakes forest: an environmental and social history. The University of Minnesota Press, Minneapolis, MN. 336 p.
- Foster, D. R., Orwig, D. A. & McLachlan, J. S. 1996. Ecological and conservation insights from reconstructive studies of temperate old-growth forests. *Tree*. 11:419–424.
- Frelich, L. E. 1995. Old forest in the Lake States today and before European settlement. *Natural Areas Journal* 15:157–167.
- Gleason, H. A. 1926. The individualistic concept of plant association. *Bulletin of the Torrey Botanical Club* 53:7–26.
- Gordon, Robert B. 1940. The primeval forest types of southwestern New York. *New York State Museum Bulletin* 321:1–102.
- Hargreaves, I. M. & Foehl, H. M. 1964. The Story of Logging the White Pine in the Saginaw Valley. Red Keg Press, Bay City, MI. 70 p.
- Hinsdale, W. B. 1925. Primitive man in Michigan. *Michigan Handbook Series No. 1*. University of Michigan Press, Ann Arbor, MI. 194 p.
- Historical Committee. 1975. West Branch Area: First 100 Years. 59 p.
- Hurlbert, S. H. 1969. A coefficient of interspecific association. *Ecology* 50:1–9.
- Jakes, P. J. 1982. Timber resource of Michigan's Northern Lower Peninsula, 1980. USDA Forest Service Research Bulletin NC-62.
- Janke, R. A., McKaig, D., & Raymond, R. 1978. Comparison of presettlement and modern upland boreal forests on Isle Royale National Park. *Forest Science* 24:115–121.

- Johnson, E. P. 1990. Soil Survey of Ogemaw County, Michigan. USDA Soil Conservation Service. 252 p.
- Kenoyer, L. A. 1930. Ecological notes on Kalamazoo County, Michigan, based on the original land survey. *Papers of the Michigan Academy of Science, Arts, and Letters* 11:211–217.
- Kenoyer, L. A. 1933. Forest distribution in southwestern Michigan as interpreted from the original land survey (1826–32). *Papers of the Michigan Academy of Science, Arts, and Letters* 19:107–111.
- Kenoyer, L. A. 1940. Plant associations in Barry, Calhoun, and Branch Counties, Michigan as interpreted from the original survey. *Papers of the Michigan Academy of Science, Arts, and Letters* 25:75–77.
- Kenoyer, L. A. 1942. Forest associations of Ottawa County, Michigan, at the time of the original survey. *Papers of the Michigan Academy of Science, Arts, and Letters* 28:47–49.
- Kirkland, C. M. 1990. *A New Home, Who'll Follow?* Rutgers University Press, New Brunswick, NJ. 218 p.
- Leach, M. L. 1885. Ancient forts in Ogemaw County, Michigan. *Smithsonian Institution Report for 1884*. p 849.
- Livingston, B. E. 1905. The relation of soils to natural vegetation in Roscommon and Crawford Counties, Michigan. *Botanical Gazette* 35:36–54.
- Lyon, L. 1846. Special instructions to John Mullett D.S. for completing defective surveys in Michigan. Located at: the Michigan State Archives, Lansing, MI.
- May, G. S. & Brinks, H. J. 1974. *A Michigan Reader: 11,000 BC to AD 1865*. William B. Eerdmans Publishing Company, Grand Rapids, MI. 287 p.
- Maybee, R. H. 1973. Michigan's White Pine Era 1840–1900. Michigan History Division. Pamphlet No. 1. Lansing, MI. 55 p.
- Mayr, H. 1890. *Die Waldungen von Nordamerika ihre Holzarten, deren Anbaufähigkeit und forstlicher Wert für Europa im Allgemeinen und Deutschland insbesondere*. Universitäts-Buchhandlung. Gustav Himmer k. b. Hoflieferant. München. 448 p.
- McCune, B. and Menges, E. S. 1986. Quality of historical data on midwestern old-growth forests. *American Midland Naturalist* 116:163–172.
- Merk, J. W. 1951. Tree species distribution on the basis of the original land survey of Washtenaw County, Michigan. M.S. thesis. Department of Conservation. University of Michigan. Ann Arbor, MI. 38 pp.
- Mikan, C. J. and Abrams, M. D. 1995. Altered forest composition and soil properties of historic charcoal hearths in southeastern Pennsylvania. *Canadian Journal of Forest Research* 25:687–696.
- Michigan Department of Commerce. 1985a. *Economic Profile of Ogemaw County*. Lansing, MI
- Michigan Department of Commerce. 1985b. *Economic Profile of Oscoda County*. Lansing, MI
- Michigan Department of Conservation. 1955. *Directory of wood-using industries in the lower peninsula of Michigan*. Forestry Division. Lansing, MI. 88 p.
- Miller, H. L. 1963. *The Old AuSable*. William B. Eerdmans Publishing Co. Grand Rapids, MI. 164 p.
- Motzkin, G., Foster, D., Allen, A., Harrod, J., & Boone, R. 1996. Controlling site to evaluate history: vegetation patterns of a New England sand plain. *Ecological Monographs* 66:345–365.
- Mueller-Dombois, D. & Ellenberg, H. 1974. *Aims and Methods of Vegetation Ecology*. John Wiley & Sons, New York, NY. 547 pp.
- Mullett, J. D. 1838. Field notes U.S. Survey. Ogemaw County. Located at: Ogemaw County Registry of Deeds Office, West Branch, MI.
- Nash, A. 1979a. The evolution of Oscoda County. In *The AuSable River Valley Historical Society* (ed.). Oscoda County. Futura Printing Company, Mio, MI. 96 p.
- Nash, A. 1979b. Logging railroads in Oscoda County 1884–1910. In *The AuSable River Valley Historical Society* (ed.). Oscoda County. Futura Printing Company, Mio, MI. 96 p.
- Newman, E. A. 1936. *Geology of Ogemaw County and West Branch Oil Field*. State of Michigan Department of Conservation, Geological Survey Division. Lansing, MI. 17 p.
- Parker, S. 1983. *Shanty Boys and Sawdust: the Lumbering History of Ogemaw County*. Located at the Rose City Library, Rose City, MI.
- Randall, J. 1979. The Michigan National Forest early history of the Mio Section. In *The AuSable River Valley Historical Society* (ed.). Oscoda County. Futura Printing Company, Mio, MI. 96 p.

- Rouse, C. 1986. Fire effects in northeastern forests: jack pine. USDA Forest Service General Technical Report NC-106. 8 p.
- Russell, E. W. B. 1997. People and the land through time: Linking ecology and history. Yale University Press, New Haven, CN. 306 p.
- Schallau, C. H. 1965. Fragmentation, absentee ownership, and turnover of forest land in northern lower Michigan. USDA Forest Service Research Paper, LS-17. 12 p.
- Sears, P. B. 1925. The natural vegetation of Ohio. *Ohio Journal of Science* 25:139–149.
- Siccama, T. G. 1971. Presettlement and present forest vegetation in northern Vermont with special reference to Chittenden County. *American Midland Naturalist* 85:153–172.
- Simard, A. J. and Blank, R. W. 1982. Fire history of a Michigan jack pine forest. *Michigan Academician*. 15:59–71.
- Simard, H. and Bouchard, A. 1996. The precolonial 19th century forest of the Upper St. Lawrence Region of Quebec: a record of its exploitation and transformation through notary deeds of wood sales. *Canadian Journal of Forest Research* 26:1670–1676.
- Steel, R. C. D., Torrie, J. H., & Dickey, D. A. 1997. Principles and procedures of statistics a biometrical approach. The McGraw-Hill Companies, Inc. New York, NY. 666 p.
- Strahler, A. H. 1978. Binary discriminant analysis: a new method for investigating species-environment relationships. *Ecology* 59:108–116.
- Symon, C. A. 1983. We Can Do It! A History of the Civilian Conservation Corps in Michigan—1933–1942. Richards Printing, Escanaba, MI. 192 p.
- Tanner, H. H. 1986. Atlas of Great Lakes Indian History. University of Oklahoma Press, Norman, OK. 224 p.
- Troyer, L. J. 1915. Oscoda County, Michigan—The Land of Opportunity. The Gregory Press, Bay City, MI. 23 p.
- Twining, C. E. 1983. The lumbering frontier. In S. F. Flader (ed.). *The Great Lakes Forest: An environmental and social history*. The University of Minnesota Press, Minneapolis, MN. 336 p.
- Veatch, J. O., Schoenmann, L. R., Millar, C. E. & Shearin, A. E. 1931. Soil Survey of Oscoda County, Michigan. USDA Bureau of Chemistry and Soils. Washington, D.C. Series 1931. Number 20. 42 p.
- Weaver, D. L. 1942. A study of grazing on certain northern Michigan cut-over lands. M.S. Thesis. Department of Soils and Conservation Institute. Michigan State College of Agriculture and Applied Science. 103 p.
- Whitney, G. G. 1986. Relation of Michigan's presettlement pine forests to substrate and disturbance history. *Ecology* 67:1548–1559.
- Whitney, G. G. 1987. An ecological history of the Great Lakes forest of Michigan. *Journal of Ecology* 75:667–684.
- Whitney, G. G. 1994. From Coastal Wilderness to Fruited Plain. Cambridge University Press. Cambridge, U. K. 451 p.
- Young, G. A. 1938. Michigan State Civilian Conservation Corps. Michigan State Department of Conservation. Lansing, MI.
- Zhang, Q. F., Pregitzer, K. S., & Reed, D. D. 2000. Historical changes in the forests of the Luce District of the Upper Peninsula of Michigan. *American Midland Naturalist* 143:94–110.

REVIEW

FLORA OF MAINE. A manual for identification of native and naturalized vascular plants of Maine. Arthur Haines and Thomas F. Vining. 1998. Paperback, 848 pp., ISBN 0-9664874-0-0. V. F. Thomas Co., P.O. Box 281, Bar Harbor, Maine 04069; \$51 including shipping and handling, and they accept credit cards; info@vfthomas.com for e-mail orders. Shipped with 15 pages of additions and corrections, these dated 26 April 2002.

For nearly five years, this has been a kind of ghost title to me. I knew it was out there, but it was just too darned much trouble to get my hands on it. For the longest time, it wasn't known at amazon.com, where just about everybody begins; it is listed there now, but "out of stock." So now its easily obtainable; I asked for an autographed copy, and darned if the two authors didn't sign the title page! That's no more than standard good manners from folks in Maine, but still

The book is based on the herbarium holdings at the University of Maine, Orono, and the herbaria of the University of New Hampshire and Harvard University. The authors don't make a big to-do about it, but it is clear they insist on proper vouchers, and they exclude unvouchered materials from their coverage. They make the point on p. 8 that reports of *Actinidia arguta* and *Aristolochia macrophylla* are unvouchered, but then on page 10 it says these two (and many others) have been added to Maine's flora based on the existence of a voucher specimen. Well, we cannot have it both ways, but it is not terribly important, given that the two species are only local escapes from cultivation.

The sequence of families is roughly Cronquistian; the genera within each family are simply alphabetical.

The keys are conventional and quite artificial. The species descriptions are very brief, but longer ones can be had in any of a dozen other books that cover New England. The status of each species in Maine is emphasized, with extralimital ranges also given, and they give common names. As an Appendix II, the authors put in a key to genera for use with vegetative, non-emergent, aquatic plant material. That could turn out to be most useful, and far outside Maine, too.

There are no illustrations, save for a cover illustration of a sprig of willow, *Salix arctophila*, rendered by the first author, Arthur Haines. This is explained on [unnumbered] page 2. But the cover illustration is initialed, m.m., in usual artist's fashion. The credit for the illustration can be left as one of the great unsolved mysteries in Maine botanical history, which is otherwise covered succinctly on p. 7.

What the book needs is an outline map that shows all the counties of Maine. That would have been really nice on Cover 2 or Cover 3, or even in both places. A work like this merits a happy future, and maybe in the next printing they could sneak in an outline map.

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