THE UNIVERSITY OF MICHIGAN
BIOLOGICAL STATION

THE NATURAL ECOLOGY AND CULTURAL HISTORY OF THE COLONIAL POINT RED OAK STANDS

TECHNICAL REPORT NO. 14

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INTRODUCTION

The Colonial Point Forest preserve provides a rare opportunity to study the forces affecting the composition and structure of Michigan's presettlement forest, by combining the investigation of natural ecological factors with specific historical data on land use and its impact on forest vegetation. Early documentary records, such as the original land surveys of northern Michigan, provide detailed historical information on the forests of the Colonial Point area. These documents record dynamic aspects of the forests which the surveyors encountered, including windthrows and natural burns, as well as the active role of Indians in modifying their environment for agricultural purposes.

In this study, we combine ecological and historic data to investigate the natural and cultural factors affecting the establishment and succession of the Colonial Point red oak stands. The red oak forests of Colonial Point occur as large, even-aged stands in an area typically dominated by a sugar maple and beech forest. Normally, red oaks do not establish beneath sugar maple and beech, as red oak requires higher light levels for establishment than is generally available under a beech-maple forest.

The successful establishment of red oak in mesic northern hardwood forests has been linked to fire. Mature oaks and seedlings can survive and resprout following fire. Beech and sugar maple, in contrast, are extremely sensitive to fire at all ages and are severely damaged or destroyed by even light burning. Fire therefore both creates an opening in the canopy for the establishment of red oak, and destroys competing sugar maple and beech seedlings and saplings.

Several natural causes of fire in mesic hardwood forests, including fire following windthrow and lightning strikes of large dominant trees (especially white pine and hemlock) can allow for the establishment of red oaks. Prior to European settlement, the Indian agricultural practice of burning to clear fields constituted another important source of fire disturbance.

In the mid-1800s, the presettlement land surveys report the presence of an Indian village on Colonial Point. The section lines of the surveys record both cultivated Indian fields as well as abandoned fields overgrown with bushes and small trees. In these "old fields", the predominant tree species noted by the surveyors were disturbance and fire-tolerant species, namely aspen, paper birch, and red oak. These areas of abandoned field currently support a forest dominated by mature red oak.

In this study, we investigate the natural and cultural factors responsible for the establishment of the red oak stands on Colonial Point. Specifically, we evaluate the role of site characteristics (such as soil texture and drainage class), natural disturbance (windthrow and fire), and cultural disturbance (fire resulting from Indian agriculture) in the successional history of the red oaks. The combined ecological and historical analyses were used to evaluate whether the establishment and succession of red oaks into the overstory could be attributed to natural ecological factors or whether human intervention in the form of agricultural disturbance significantly altered natural conditions, permitting the successful establishment of red oak.

This study was organized in four phases. Part I is concerned with identifying the major forest types of Colonial Point and with mapping the distribution of red oak stands relative to other forest types within the preserve. In Part II, we briefly discuss the composition and structure of these major forest types and their relationship to potential controlling factors such as topography and drainage. Beginning with Part III, we conduct a more detailed analysis of the relationship of red-oak stand composition, structure, and distribution to both physical site factors and disturbance history. Finally, in Part IV, we evaluate the fire history of Colonial Point as documented by historical records and direct evidence of burning, and its relationship to the location and timing of red oak establishment on Colonial Point.

PART I
DEFINITION AND MAPPING OF MAJOR OVERSTORY COMMUNITIES

A. Location and Definition of Study Area

The Colonial Point Forest comprises the central portion of the Colonial Point peninsula in Burt Lake, Cheboygan County (Township 36 N Range 3 W) (Fig. 1). The forest falls within the Presque Isle District of Michigan, typified by northern hardwood forests on the upland areas, while the lowlands characteristically contain hardwood-conifer swamps, cedar swamps, and hemlock-dominated seepages (Albert et al. 1986). Climatologically, the area is characterized by a fairly long average growing season (120 days) for its northern latitude due to its position near the Great Lakes. Local climatic conditions on the Point are further ameliorated (and growing season extended) by the proximity of Burt Lake.

The study area for this project includes the 283.5 acres of the Colonial Point Forest preserve with the addition of the contiguous 7.2 acre tract owned by Dale Cochran, which lies immediately south of the preserve (Fig. 2). The study area is bounded to the north by Brutus Road and is contained to the east and south within the curve of Indian Point Road. Lathers Road constitutes the major north-south axis for the study area and forms the western limit for the study area in the middle portion of the preserve. The northern portion of the tract and a small section at its southwest corner extend west of Lathers Road to the fenced boundary line of Monica Hippler's property. The study area totals 290.7 acres (1.2 sq. km.), with maximum dimensions of approximately 1.7 km. north-south and 0.9 km. east-west.

B. Goals of the Study

In order to determine the factors responsible for the establishment and distribution of red oak, it was necessary to first delimit the location of the red oak stands within the Colonial Point Forest and their position relative to possible controlling factors such as topography and disturbance.

Accordingly, the goals for this portion of the study were:

1. to sample, define, and map the major overstory vegetation communities;
2. to map the distribution of natural and human disturbance factors; and
3. to map the major topographic and drainage features of the peninsula.

C. Field Methods

To facilitate the mapping of vegetation and topography on Colonial Point, a reference grid was established on the ground for the study area. The major axes of this grid run east-west along the line between Sections 21 and 28 (the southern edge of Brutus Road), and north-south along the western edge of Lathers Road. For convenience, Brutus Road was designated as the 2000N line, while Lathers Road was designated 2000E. These primary axes were established with a surveyor's transit and tape, and points along these axes were staked and flagged at 100 m. intervals. Subsequent lines from these points were run using a Sunto MC-1 mirror compass while distances were taped.

The overstory vegetation of Colonial Point was sampled systematically using a series of transects running east-west across the peninsula following established grid lines. Continuous sampling units were utilized in order to map gradient changes in elevation and vegetation composition and to facilitate the identification of boundaries between vegetation units. However, sharp boundaries between vegetation types may have been blurred by the use of these arbitrary units.

Figure 1

Location of Colonial Point

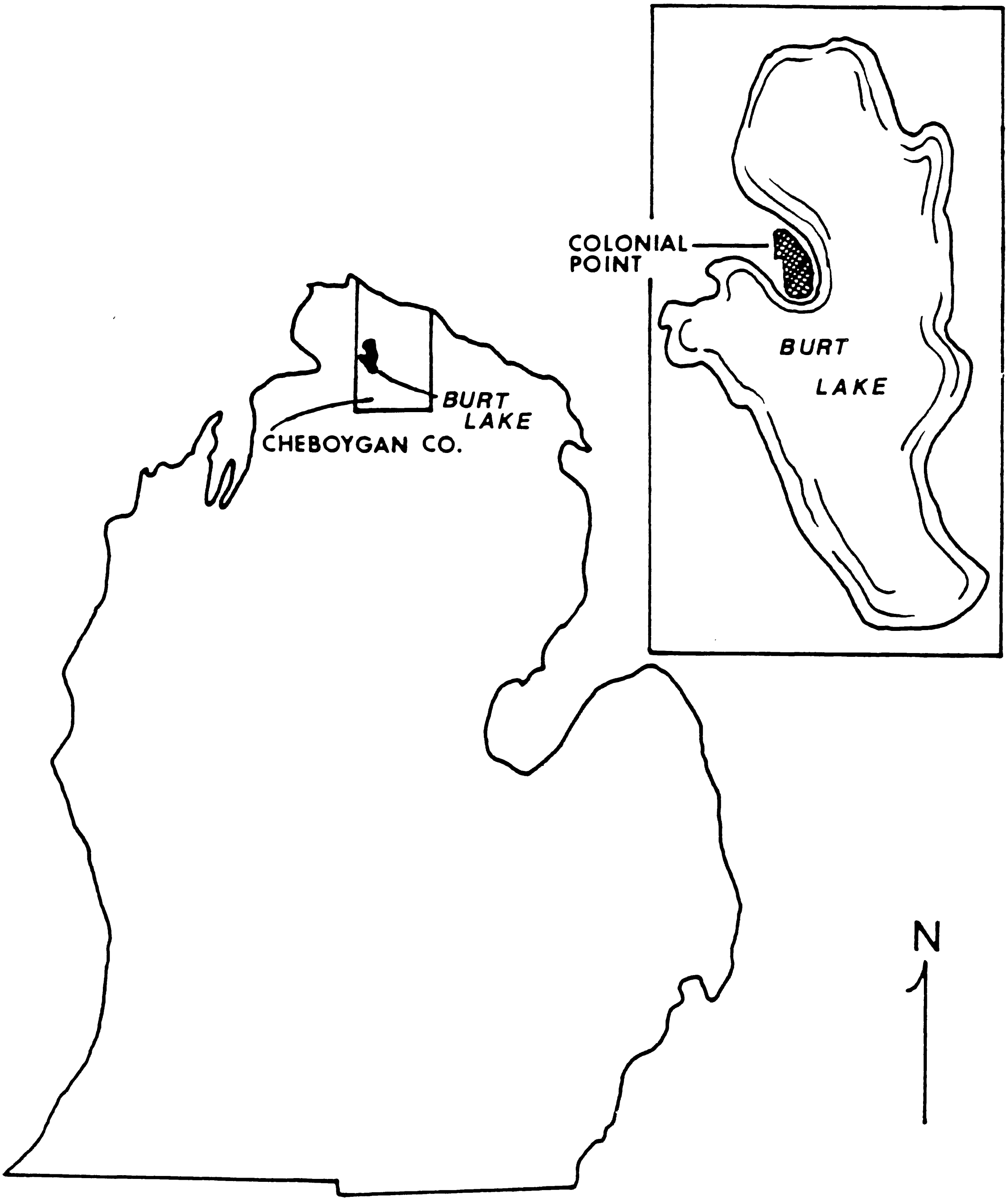
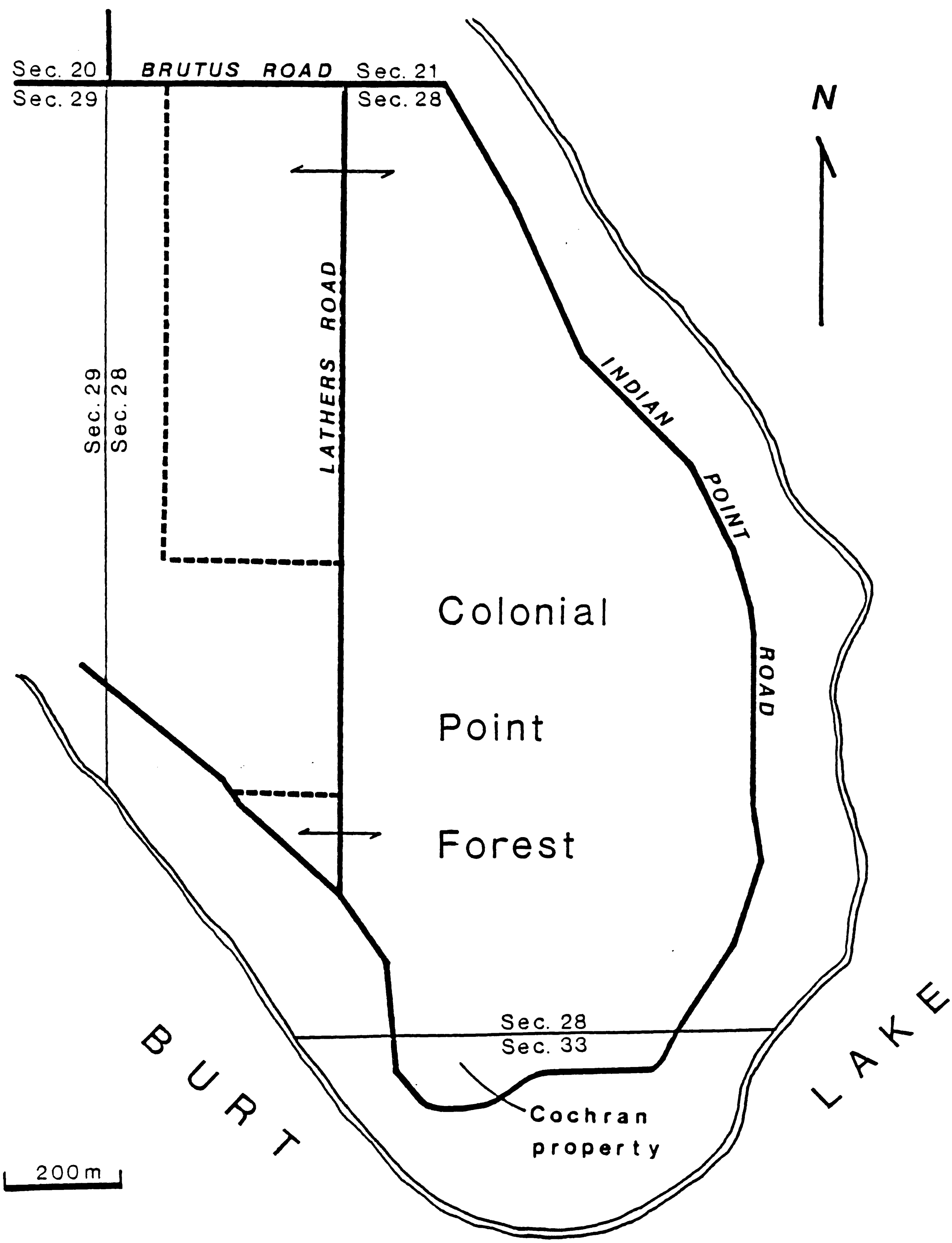


Figure 2



Sec. 20
BRUTUS ROAD
Sec. 21
Sec. 29
Sec. 28
N
LATHERS ROAD
Sec. 29
Sec. 28
INDIAN POINT ROAD
Colonial
Point
Forest
Sec. 28
Sec. 33
Cochran property
BURT
LAKE
200m

Nine transect lines were extended across the peninsula at 200 m. intervals on the north-south axis, i.e. on the 350N, 550N, 750N, 950N, 1150N, 1350N, 1550N, 1750N and 1950N lines (Fig. 3). Each transect consisted of a 10 m. wide strip which was subdivided along the east-west axis into 25 m. segments; thus, each transect unit constituted a 10 by 25 m. plot. The total of 5955 m. (3.7 miles) of transect line divided into 241 transect units provided the data base from which vegetation communities were identified and mapped. The total area investigated (59,550 sq. m. or 14.72 acres) constituted a 5.06% sample of the study area.

Recording Vegetation

Within each transect unit, understory and overstory vegetation were recorded by species as the number of stems in each of four size classes: (1) understory or .5" to 3.5" dbh; (2) 3.6" to 9.0" dbh; (3) 9.1" to 16.0", and (4) greater than 16.0" dbh. In addition, actual dbh measurements were taken for all red oak and for trees of all species with diameter greater than 16" (Table 1). Ground cover was not systematically recorded along the transects, although locations of red oak regeneration were noted.

Mapping Disturbance Factors

Evidence of both natural and man-induced disturbance factors was also noted along the vegetation transects. For each 25 m. transect unit, natural disturbance factors were quantified as the number of wind-broken trees, windthrown trees, and windthrow mounds. Human disturbance was recorded as the number of cut tree stumps by species per unit, the presence of roads or trails, and signs of habitation such as fences, clearings, or debris.

Recording Tree Ages

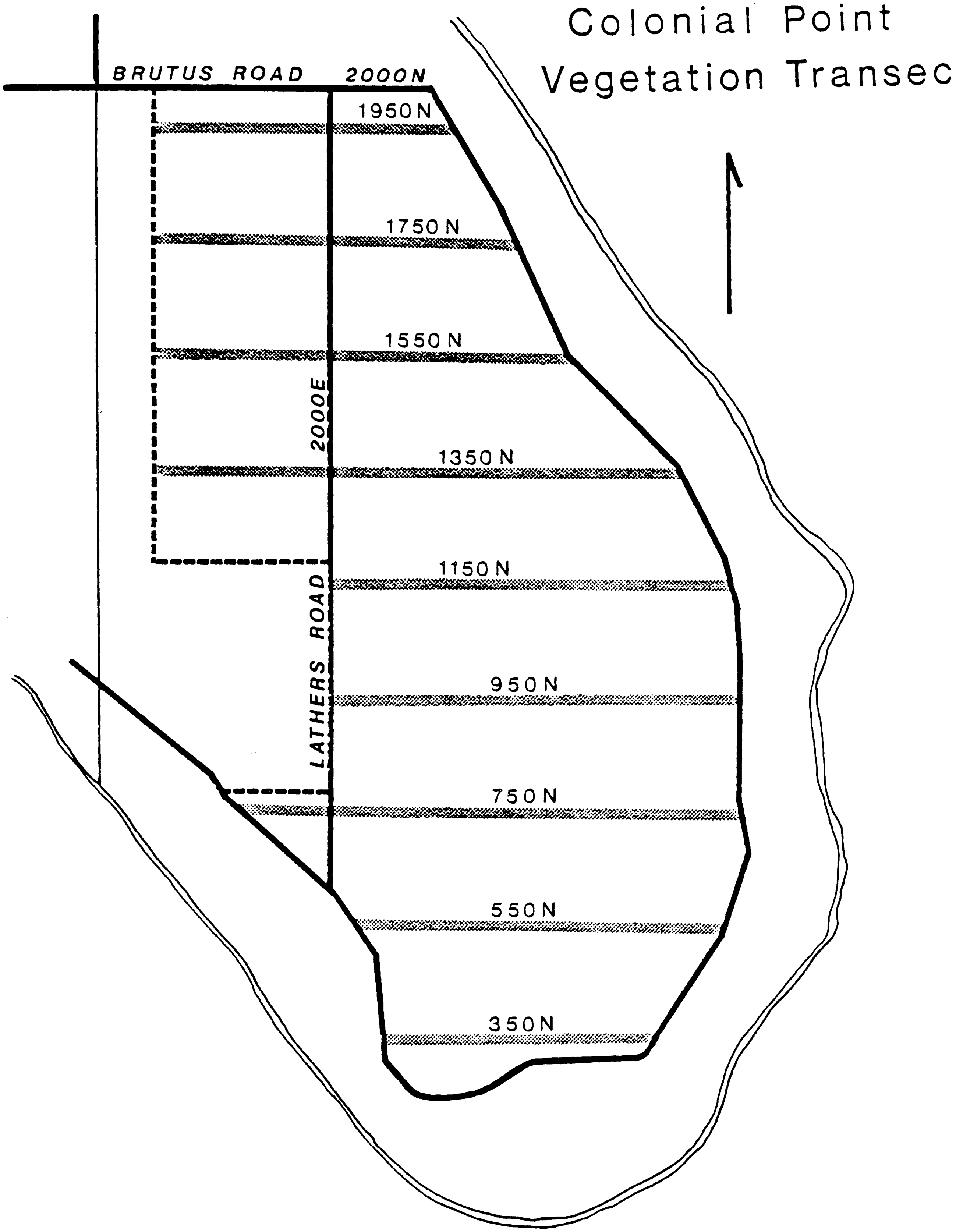
Investigations of stand age and date of establishment were additionally carried out along the vegetation transects and throughout the study area. Tree ages for individual red oak, white pine, and other species were determined where possible by examining annual growth rings obtained through increment cores or exposed in cut stumps.

Coring was limited to (a) recently windthrown [WT] trees, (b) dead standing [DS] trees which appeared to have died recently in that they still held their bark and small branches, and (c) live, but severely diseased [LD] trees. No apparently healthy trees were cored. This was to prevent the introduction of disease to these healthy individuals. Red oak wilt, a disease threatening red oak stands of the western Upper Peninsula and Wisconsin is readily transmitted through contamination from increment borers or through mechanical injury to the bark, such as the opening provided by the increment-core hole (Pirone 1978:442–43). The potential threat of this disease to the oaks of the upper Lower Peninsula has not yet been determined. Therefore, extreme care should be exercised in the future not to facilitate its spread within the Colonial Point stand through coring activities.

Tree ages determined from cut stumps came primarily from the adjacent Cochran and Hippler properties, which constitute continuations of the Colonial Point forest. The high level of recent cutting disturbance within these stands made it possible to determine the date of establishment for a large number of red oaks and white pines within a fairly localized area.

A total of 136 tree ages were obtained from cores and counts (Appendix I). Dates of establishment were then calculated by adding to each tree age the number of years since growth had terminated, plus an estimate of the number of years of growth required to attain the height of the core or cut. This latter estimate was based on examinations of growth rates of red oak seedlings and sprouts and white pine seedlings from old fields and roadsides near Colonial Point.

Figure 3



Colonial Point
Vegetation Transec
BRUTUS ROAD
2000N
1950N
1750N
1550N
1350N
1150N
950N
750N
550N
350N
2000E
LATHERS ROAD

Table 1
SUMMARY OF TRANSECT VEGETATION DATA:
RELATIVE DENSITY PER SPECIES BY SIZE CLASS

Species	DBH Size Class							
	0.5 – 3.5"		3.6 – 9.0"		9.1 – 16.0"		16.1" +	
	#	%	#	%	#	%	#	%
Abies balsamea	8	0.09	7	0.43				
Acer pensylvanicum	70	0.82						
Acer rubrum	216	2.53	247	15.29	177	19.73	41	7.93
Acer saccharum	3385	39.67	704	43.56	248	27.65	22	4.26
Amelanchier sp.	8	0.09						
Betula alleghaniensis	19	0.22	16	0.99	32	3.57	4	0.77
Betula papyrifera	3	0.04	7	0.43	10	1.12		
Fagus grandifolia	3009	35.27	246	15.22	117	13.04	62	11.99
Fraxinus americana	173	2.03	20	1.24	12	1.34	8	1.55
Fraxinus nigra	61	0.71	25	1.55	12	1.34	5	0.97
Fraxinus pennsylvanica			1	0.06				
Ostrya virginiana	1155	13.54	109	6.75	5	0.56		
Pinus strobus	13	0.15	31	1.92	36	4.01	86	16.63
Populus grandidentata	26	0.31	22	1.36	47	5.24	18	3.48
Prunus serotina	8	0.09	6	0.37	2	0.22		
Prunus virginiana	4	0.05						
Quercus rubra	39	0.46	26	1.61	151	16.83	226	43.71
Tilia americana	156	1.83	52	3.22	21	2.34	11	2.13
Tsuga canadensis	130	1.52	86	5.32	27	3.01	34	6.58
Ulmus americana	49	0.57	11	0.68				
Total	8532	100.00	1616	100.00	897	100.00	517	100.00

Mapping Topography

Changes in elevation along each transect line were recorded to the nearest .25 foot using a stadia rod and Sunto Clinometer sighting level. Absolute elevation values were then calculated from a baseline elevation of 650' above sea level recorded for the quarter-section corner on Brutus Road.

In general, elevation was recorded at 25 m. intervals along the transect; rapid changes in topography necessitated a closer spacing of measurements. Major topographic features not crossed by the transect lines were mapped later with reference to established grid points. In addition, drainage conditions were noted for all points along the vegetation transects, while drainages and wetland areas were later mapped in as individual units. The resulting topographic and drainage features are presented on Map I.

D. Analysis of Major Overstory Communities

For the purposes of this study, "overstory communities" were defined as the consistent co-occurrence or co-dominance of overstory species. In order to identify overstory communities from our transect data, it was necessary to first estimate the relative dominance of overstory species for each transect unit, and second, to quantitatively determine patterns of species co-occurrence within the study area as a whole.

For each transect unit, the stem counts per size class were utilized to calculate the Estimated Relative Dominance or ERD of major overstory species. Estimated Relative Dominance differs from actual relative dominance in that the calculations of basal area are based on estimates of stem diameter as opposed to measured stem diameter. Stem diameter was estimated from the average dbh of each species for each of the three overstory size classes (3.5–9.0", 9.1–16.0", >16") and this average was used as an approximate dbh for all stems of that species in that size class (see Table 2).

The average dbh per species for each overstory size class was estimated from three sources: (a) measured dbh's of all oaks and pines along the vegetation transects; (b) measured dbh's for all species with diameter greater than 16" (size class 4) in vegetation transect units; and (c) measured dbh's of all overstory trees in the vegetation plots (see Part II). These estimated means provided a more realistic estimate of dbh than the mid-point of a size class which tends on the average to under-estimate the true dbh of early successional species and over-estimate that of late successional species. However, for those species for which reliable estimates of dbh were not available, size-class mid-point values were used.

In calculating ERD's, the total basal area per species (as estimated from average dbh values) was then summed over all three size classes:

$$\text{Basal Area}_i = \sum_{i=2}^{4} n_{ij} \left[(\bar{X}_{ij}/2)^2 \times \pi\right]$$

where:

i = overstory tree species
j = overstory size classes 2 (3.5–9"), 3 (9–16"), and 4 (> 16")
n_{ij} = number of stems of species i in size class j
$\bar{X}_{ij}$ = average dbh for species i in size class j.

Table 2

MEAN DIAMETER (DBH) VALUES USED IN CALCULATING
ESTIMATED RELATIVE DOMINANCE FROM SIZE CLASS DATA FOR TRANSECT UNITS

Species	Size Class (DBH)		
	3.6 – 9.0"	9.1 – 16.0"	〉16.1"
Abies balsamea	——		
Acer saccharum	X = 5.7 s = 1.52 N = 90	X = 11.4 s = 1.78 N = 16	X = 19.9 s = 2.95 N = 21
Acer rubrum	X = 6.5 s = 1.35 N = 41	X = 12.7 s = 2.14 N = 33	X = 19.6 s = 2.96 N = 13
Betula alleghaniensis	X = 6.1 s = 0.42 N = 2	X = 12.0 s = 1.32 N = 8	X = 18.9 s = 1.50 N = 5
Betula papyrifera	——	X = 12.9 s = 0.64 N = 2	——
Fagus grandifolia	X = 5.8 s = 1.61 N = 32	X = 12.0 s = 2.16 N = 15	X = 20.9 s = 2.63 N = 12
Fraxinus americana	X = 6.1 N = 1	——	X = 21.2 s = 5.96 N = 8
Fraxinus nigra	——	——	X = 19.8 s = 2.49 N = 9
Fraxinus pennsylvanica		——	
Ostrya virginiana	X = 5.8 s = 1.20 N = 12	X = 11.7 s = 1.63 N = 2	
Pinus strobus	X = 6.4 s = 1.54 N = 27	X = 12.2 s = 1.96 N = 33	X = 23.3 s = 4.9 N = 104
Populus grandidentata	——	X = 13.0 s = 1.13 N = 4	X = 19.4 s = 2.26 N = 18
Prunus serotina	——	——	

Table 2
(continued)

Species	Size Class (DBH)		
	3.6 – 9.0"	9.1 – 16.0"	⟩ 16.1"
Quercus rubra	X = 7.5 s = 1.28 N = 24	X = 13.2 s = 1.93 N = 171	X = 20.8 s = 4.14 N = 263
Tilia americana	——	X = 11.7 s = 0.42 N = 2	X = 19.9 s = 2.12 N = 11
Tsuga canadensis	X = 4.1 N = 1	——	X = 21.2 s = 3.70 N = 32
Ulmus americana	——		

Patterns of species co-dominance indicative of overstory communities were identified quantitatively utilizing K-means cluster analysis. K-means performs a variance minimizing non-hierarchical divisive cluster analysis (Kintigh 1982). That is, for each cluster solution from 1 to K, the program finds the optimal division of the data into K clusters. The "optimal solution" is defined by the clustering algorithm as one which minimizes the variance or amount of variability (sum of squared error or SSE) within each cluster.

The advantages of the K-means program for the present case are twofold. First, the non-hierarchical nature of the program means that unusual or out-lying cases due to isolated disturbance or site factors will not constrain later cluster configurations as they would with a hierarchically-structured approach. Second, K-means provides a method whereby the degree of clustering in the data can be readily evaluated through comparison with the amount of clustering observed in a comparable but randomized data set. This facilitates determining the appropriate cluster solution or number of clusters in the data.

The input data for the K-means cluster analysis consisted of the ERD (Estimated Relative Dominance) for major species within each of the 241 transect units. Although the ERD was calculated over all overstory species, data for the K-means cluster analysis was limited to the following major species: *Abies balsamea*, *Acer rubrum*, *A. saccharum*, *Betula alleghaniensis*, *B. papyrifera*, *Fagus grandifolia*, *Fraxinus americana*, *F. nigra*, *F. pennsylvanica*, *Pinus strobus*, *Populus grandidentata*, *Quercus rubra*, *Tsuga canadensis*, and *Ulmus americana*.

Cluster solutions from 1 to 20 were run for the transect unit data. Cluster solution #15 was determined as the appropriate solution for this data set for two reasons. First, a substantial separation of the real from the randomized data occurs by Cluster 15, indicating that cluster divisions of this order generate a significant reduction in the SSE over than achieved from an equivalent number of divisions in the randomized data (Fig. 4). Second, a break of slope in the reduction of SSE occurs at the fifteenth cluster solution, indicating that further division of the data into more than fifteen clusters achieves very little further reduction in SSE.

E. Results: Major Overstory Communities of Colonial Point

The overstory composition for each of the fifteen clusters is defined in Table 3 as the average relative dominance of the major overstory species for transect units falling within that cluster. The spatial distribution of these clusters within the study area is mapped in Figure 5.

Cluster 1 (N = 67) represents a red-oak dominated community, in which red oak averages 63.3% relative dominance. This community is closely associated with that of Cluster 4 (N = 4), in which red oak predominates along with high percentages of red maple and paper birch – species also associated with high levels of disturbance. Cluster 1 predominates in the southern half of the peninsula. The occurrence of Cluster 4 primarily in the southwestern corner of the preserve suggests more recent disturbance in that area.

Clusters 2 (N = 2), 3 (N = 2), 5 (N = 7), 6 (N = 8) and 8 (N = 5), are represented by species associated with wet conditions. Average relative dominance is high for basswood, black ash, white ash, and balsam fir. Spatially, these cluster members are distributed along drainages and at the base of slopes. Cluster 3 is distinguished by the presence of American elm in addition to basswood and black ash. The cluster occurs only within the shallow poorly-drained swamp on clay soil located along Lathers Road.

Cluster 9 (N = 15) represents a hemlock-dominated community. The relative dominance of hemlock averages 54%; beech (22%) and red maple (10%) constitute the primary co-dominants. Low levels of sugar maple (7.7%) and yellow birch (3.8%) are also present. Cluster members occur to the west of Lathers Road, in an area where fine-textured soils are close to the surface,

Figure 4

COLONIAL POINT OVERSTORY COMMUNITIES:
COMPARISON OF ACTUAL AND RANDOMIZED DATA

LOG10(SSE) PLOT: * = DATA 1,2 = RANDOM # = MULTIPLE POINT

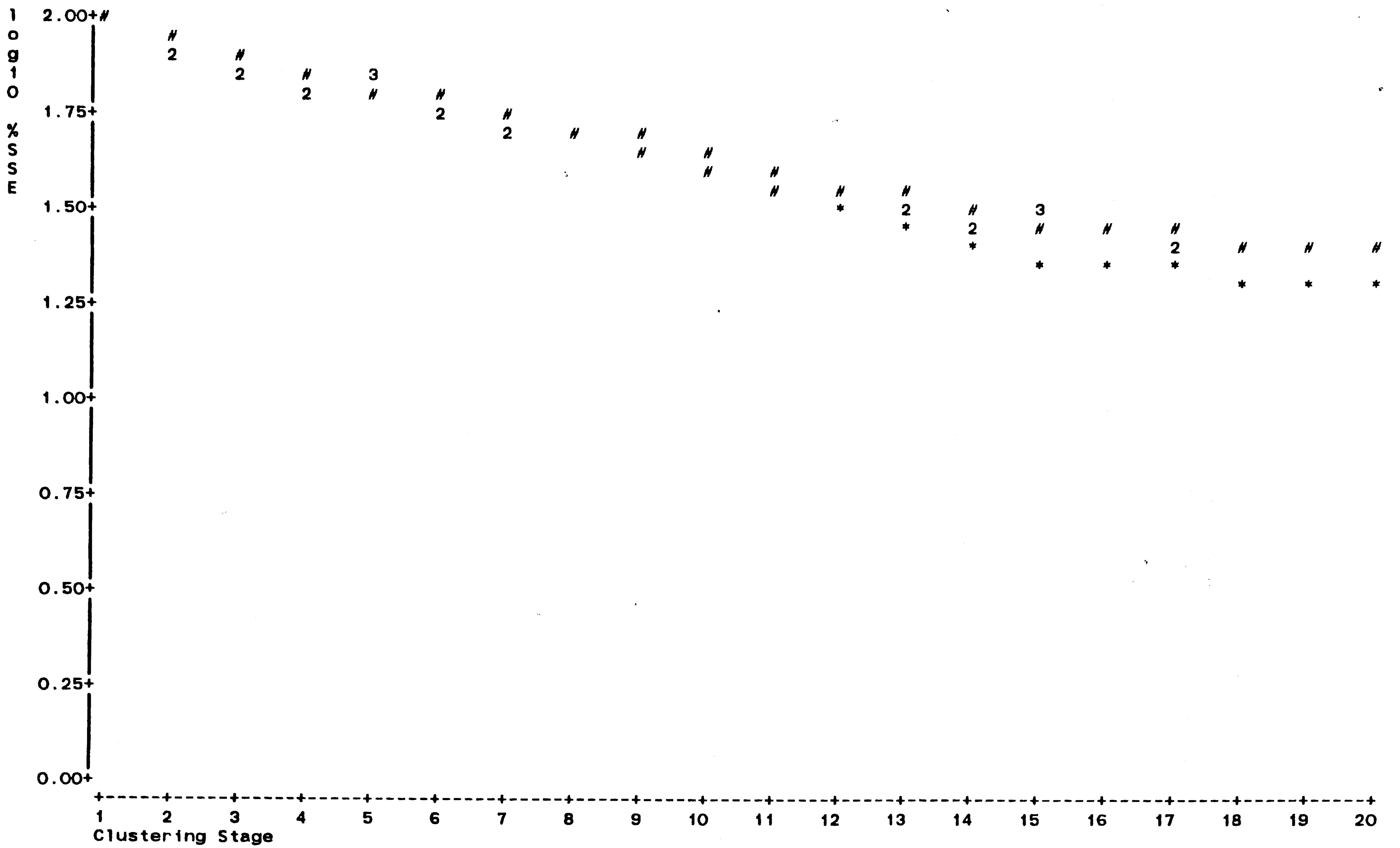


Table 3: Clusters Based on Estimated Relative Dominance of Major Overstory Species (Mean / Standard Deviation)

1	ABIES	0.0/ 0.0	ACER.SA	14.3/ 13.1	ACER.RU	8.4/ 7.9	BETU.AL	0.2/ 1.0	BETU.PA	0.3/ 1.4
	FAGU.GR	3.5/ 7.2	FRAX.AM	0.8/ 2.1	FRAX.NI	0.1/ 0.4	PINUS	4.1/ 9.7	POP.GR	0.5/ 2.2
	QUER.RU	63.3/ 18.5	TILI.AM	0.6/ 2.9	TSUG.CA	0.1/ 0.5	ULMUS.AM	0.0/ 0.0		
2	ABIES	15.4/ 3.9	ACER.SA	51.1/ 29.5	ACER.RU	1.6/ 1.6	BETU.AL	1.4/ 1.4	BETU.PA	0.0/ 0.0
	FAGU.GR	0.0/ 0.0	FRAX.AM	0.0/ 0.0	FRAX.NI	0.0/ 0.0	PINUS	0.0/ 0.0	POP.GR	0.0/ 0.0
	QUER.RU	22.3/ 22.3	TILI.AM	2.9/ 2.9	TSUG.CA	2.9/ 2.9	ULMUS.AM	0.0/ 0.0		
3	ABIES	0.0/ 0.0	ACER.SA	7.9/ 2.2	ACER.RU	0.0/ 0.0	BETU.AL	0.0/ 0.0	BETU.PA	0.0/ 0.0
	FAGU.GR	5.6/ 5.6	FRAX.AM	0.0/ 0.0	FRAX.NI	9.7/ 0.5	PINUS	0.0/ 0.0	POP.GR	0.0/ 0.0
	QUER.RU	12.6/ 12.6	TILI.AM	46.9/ 4.1	TSUG.CA	0.0/ 0.0	ULMUS.AM	14.3/ 4.1		
4	ABIES	0.0/ 0.0	ACER.SA	13.7/ 5.5	ACER.RU	21.2/ 5.0	BETU.AL	0.0/ 0.0	BETU.PA	18.9/ 5.9
	FAGU.GR	0.5/ 0.8	FRAX.AM	0.0/ 0.0	FRAX.NI	0.0/ 0.0	PINUS	4.9/ 8.5	POP.GR	0.0/ 0.0
	QUER.RU	39.7/ 14.8	TILI.AM	0.0/ 0.0	TSUG.CA	0.0/ 0.0	ULMUS.AM	0.0/ 0.0		
5	ABIES	0.0/ 0.0	ACER.SA	14.1/ 13.3	ACER.RU	6.8/ 9.9	BETU.AL	1.1/ 2.6	BETU.PA	0.0/ 0.0
	FAGU.GR	12.8/ 16.3	FRAX.AM	0.0/ 0.0	FRAX.NI	29.1/ 8.3	PINUS	0.0/ 0.0	POP.GR	0.0/ 0.0
	QUER.RU	17.7/ 22.2	TILI.AM	13.9/ 17.4	TSUG.CA	0.0/ 0.0	ULMUS.AM	0.6/ 1.4		
6	ABIES	0.2/ 0.6	ACER.SA	25.2/ 18.0	ACER.RU	9.3/ 17.1	BETU.AL	0.8/ 2.1	BETU.PA	0.0/ 0.0
	FAGU.GR	5.8/ 9.5	FRAX.AM	30.1/ 8.1	FRAX.NI	2.5/ 5.3	PINUS	0.0/ 0.0	POP.GR	0.0/ 0.0
	QUER.RU	9.4/ 18.6	TILI.AM	5.6/ 8.9	TSUG.CA	5.4/ 14.2	ULMUS.AM	0.0/ 0.0		
7	ABIES	0.0/ 0.0	ACER.SA	21.6/ 19.1	ACER.RU	11.0/ 10.8	BETU.AL	0.0/ 0.0	BETU.PA	0.2/ 0.8
	FAGU.GR	3.1/ 5.3	FRAX.AM	0.3/ 0.8	FRAX.NI	0.0/ 0.0	PINUS	16.3/ 17.8	POP.GR	26.4/ 7.9
	QUER.RU	17.5/ 19.9	TILI.AM	1.6/ 4.5	TSUG.CA	0.6/ 2.3	ULMUS.AM	0.0/ 0.0		
8	ABIES	0.0/ 0.0	ACER.SA	11.0/ 10.4	ACER.RU	4.5/ 9.1	BETU.AL	0.0/ 0.0	BETU.PA	0.0/ 0.0
	FAGU.GR	0.0/ 0.0	FRAX.AM	3.5/ 3.6	FRAX.NI	1.8/ 3.7	PINUS	7.6/ 15.1	POP.GR	0.0/ 0.0
	QUER.RU	26.0/ 22.6	TILI.AM	43.6/ 15.2	TSUG.CA	0.0/ 0.0	ULMUS.AM	0.0/ 0.0		
9	ABIES	0.1/ 0.4	ACER.SA	7.7/ 11.9	ACER.RU	10.1/ 12.1	BETU.AL	3.8/ 4.0	BETU.PA	0.0/ 0.0
	FAGU.GR	22.0/ 14.4	FRAX.AM	1.5/ 4.1	FRAX.NI	0.0/ 0.0	PINUS	0.0/ 0.0	POP.GR	0.0/ 0.0
	QUER.RU	0.8/ 2.9	TILI.AM	0.0/ 0.0	TSUG.CA	54.1/ 17.3	ULMUS.AM	0.0/ 0.0		
10	ABIES	0.0/ 0.0	ACER.SA	23.9/ 20.5	ACER.RU	15.1/ 17.0	BETU.AL	21.0/ 5.2	BETU.PA	0.0/ 0.0
	FAGU.GR	17.1/ 19.0	FRAX.AM	0.0/ 0.0	FRAX.NI	3.1/ 7.0	PINUS	1.3/ 4.3	POP.GR	0.0/ 0.0
	QUER.RU	11.0/ 14.5	TILI.AM	1.1/ 2.5	TSUG.CA	4.7/ 10.4	ULMUS.AM	0.0/ 0.0		
11	ABIES	0.0/ 0.0	ACER.SA	2.5/ 2.1	ACER.RU	14.6/ 11.8	BETU.AL	0.0/ 0.0	BETU.PA	0.0/ 0.0
	FAGU.GR	0.4/ 0.8	FRAX.AM	0.4/ 0.7	FRAX.NI	0.0/ 0.0	PINUS	4.4/ 6.8	POP.GR	67.0/ 7.6
	QUER.RU	1.5/ 2.7	TILI.AM	8.3/ 14.4	TSUG.CA	0.0/ 0.0	ULMUS.AM	0.0/ 0.0		
12	ABIES	0.0/ 0.0	ACER.SA	16.9/ 15.8	ACER.RU	7.5/ 9.7	BETU.AL	1.2/ 2.8	BETU.PA	0.1/ 0.5
	FAGU.GR	60.7/ 16.3	FRAX.AM	0.0/ 0.0	FRAX.NI	0.0/ 0.0	PINUS	0.3/ 1.4	POP.GR	0.0/ 0.0
	QUER.RU	7.3/ 13.6	TILI.AM	0.8/ 3.9	TSUG.CA	2.6/ 7.6	ULMUS.AM	0.0/ 0.0		
13	ABIES	0.0/ 0.0	ACER.SA	9.9/ 11.9	ACER.RU	39.2/ 12.3	BETU.AL	0.3/ 1.4	BETU.PA	0.6/ 1.8
	FAGU.GR	17.7/ 16.1	FRAX.AM	0.6/ 2.6	FRAX.NI	0.1/ 0.5	PINUS	11.3/ 17.3	POP.GR	0.3/ 1.8
	QUER.RU	17.8/ 20.3	TILI.AM	0.1/ 0.4	TSUG.CA	1.1/ 3.8	ULMUS.AM	0.0/ 0.0		
14	ABIES	0.0/ 0.0	ACER.SA	8.4/ 8.6	ACER.RU	2.9/ 4.6	BETU.AL	0.5/ 2.1	BETU.PA	0.0/ 0.0
	FAGU.GR	1.1/ 2.7	FRAX.AM	0.1/ 0.4	FRAX.NI	0.5/ 2.2	PINUS	77.3/ 15.7	POP.GR	0.6/ 2.4
	QUER.RU	5.2/ 10.2	TILI.AM	1.2/ 5.1	TSUG.CA	1.6/ 6.3	ULMUS.AM	0.0/ 0.0		
15	ABIES	0.0/ 0.0	ACER.SA	71.4/ 18.3	ACER.RU	3.9/ 7.1	BETU.AL	0.0/ 0.0	BETU.PA	0.0/ 0.0
	FAGU.GR	7.0/ 10.4	FRAX.AM	1.2/ 2.6	FRAX.NI	0.0/ 0.0	PINUS	3.8/ 11.1	POP.GR	0.4/ 1.8
	QUER.RU	7.8/ 13.2	TILI.AM	1.2/ 2.2	TSUG.CA	0.4/ 1.3	ULMUS.AM	0.0/ 0.0		

Figure 5

COLONIAL POINT OVERSTORY COMMUNITIES: 15 FINAL CLUSTERS

```
N      |    1A 11CC 41   E1CA 16DA D1
O 1900+
R      |
T      |
H      |
       |    DD 9CCD 9A9C CCF6 CCC1 CAAD CC
  1700+
       |
       |    C9 9999 99CC D91D 111DDDCA1 CD6F DC
  1500+
       |
       |    D6 99A9 9DE1 DBCF DCCD D555 11DE AA21 FEEF F
  1300+
       |
       |                55 517F D8F6 FFFC CA51 1111 EEFE7EF
  1100+
       |
       |                13 386D 1F1F AC11 1111 D11D D116 112
   900+
       |
       |           87B1 4111 D477 7B11 1171 DDD7 1111 111D 87B
   700+
       |
       |                   E111 E1D7 741B 7D1F 1117 77F6 81
   500+
       |
       |                     1E E1E1 EEEE EF7C F7C7
   300+
       +---------+---------+---------+---------+---------+---------+
      1600      1800      2000      2200      2400      2600      2800  EAST
```

1 = Cluster 1
2 = Cluster 2
3 = Cluster 3
4 = Cluster 4
5 = Cluster 5
6 = Cluster 6
7 = Cluster 7
8 = Cluster 8
9 = Cluster 9
A = Cluster 10
B = Cluster 11
C = Cluster 12
D = Cluster 13
E = Cluster 14
F = Cluster 15

creating poorly-drained conditions and associated high levels of windthrow.

Clusters 10 (N = 12), 12 (N = 28), 13 (N = 31), and 15 (N = 18) all represent northern hardwoods communities with high relative dominance of beech, sugar maple, red maple, and yellow birch. Red oak is present throughout these clusters, but in relatively low levels. Cluster 10, distinguished by higher levels of yellow birch (21%) and hemlock (5%), is located adjacent to drainages and in small pockets where fine-textured soil approaches the surface, causing moderately poor to poor drainage conditions. Cluster 12 is dominated by beech (61%) and may represent areas in which selective cutting has removed associated sugar maple. Conversely, Cluster 15, has high levels of sugar maple (71%), indicative of uncut areas. Cluster 13, with higher levels of red maple (39%) and red oak (18%), and variable levels of white pine, frequently occurs on the edge of red-oak and white-pine dominated areas, and may be transitional to the more heavily disturbed areas where these communities occur.

Cluster 14 (N = 18) represents a white-pine dominated community (77% relative dominance). This cluster is associated spatially with Cluster 7 (N = 18) and Cluster 11 (N = 4). Both of these latter clusters have high levels of bigtooth aspen (26% and 67%, respectively), which tends to occur in narrow bands around white pine stands. In addition to bigtooth aspen, Cluster 7 contains highly variable levels of white pine, sugar maple, red oak, and red maple. Cluster 7 occurs primarily as small patches in the more heavily disturbed southern half of the peninsula. The ecological significance of this cluster is not well understood and it may represent transitional conditions of both moisture and disturbance.

In summary, 15 clusters representing distinct patterns of overstory co-dominance were apparent in the transect vegetation data. These were combined on the basis of similar ecological conditions into six more general forest types. The structure and composition of these major forest types are discussed in the following section.

PART II
THE MAJOR FOREST TYPES OF COLONIAL POINT

Based on the preceding cluster analysis of vegetation communities, we defined six major forest types for the Colonial Point Forest. Upland forest types included Oak-dominated, Northern Hardwoods, and Pine-dominated, while poorly drained forest types consisted of Hemlock-dominated, Hardwood Swamp, and Swampy Drainages. Boundaries for these units were mapped utilizing the original transect data, further ground reconnaissance, and aerial photo interpretation. The distribution of these forest types within the study area is presented in Map II.

A. Field Investigations: Sampling the Major Forest Types

In order to delineate more specifically the composition and structure of upland forest types, 17 vegetation plots were placed in red oak, northern hardwoods, and pine-dominated areas (see Map III). Wetland types were not further sampled. Plot locations were arbitrarily selected to maximize the coverage of the upland forest types; actual field placement of plots deviated slightly from these arbitrary locations to avoid heavy local disturbance in the form of cutting or logging roads. Each vegetation plot consisted of a 15 by 30 m. unit, cardinally oriented.

Eight plots were placed in oak-dominated forest. Plots 1, 2, and 3 were located within a stand of young oak along the southwestern edge of the study area. Plots 8, 9, and 10 were set out in the broad band of mature oak which dominates the southern half of the peninsula. Plots 16 and 17 were located within a small stand of oak within the northern hardwoods dominated area. These last two plots were placed around the stumps of two large oaks cut and removed in 1985, in order to take advantage of the specific tree age and establishment date information obtained from these cut stumps.

Six plots (Plots 4, 5, 6, 7, 11, and 12) were placed in northern hardwoods areas and are accordingly concentrated in the northern portion of the study area. Finally, three plots (Plots 13, 14, and 15) were located within widely separated white pine stands.

Within each plot, dbh measurements were taken for all overstory trees, including both live and dead individuals. Understory trees were recorded for the entire plot as number of stems per species in each of three size classes (0.5 – 1.5", 1.6 – 2.5", 2.6 – 3.5" dbh). Trees and shrubs in the groundcover (< 0.5" dbh) were tallied in four 0.5 by 5 m. strips located along plot perimeters. Relative coverage values were recorded for herbaceous groundcover species. Overstory vegetation measurements were converted to relative dominance values for each species (Table 4), while counts of understory and groundcover species were transformed to measures of relative density (Tables 5 and 6).

B. Composition and Structure of Upland Forest Types

Both beech-sugar maple dominated and red-oak dominated forests are termed Northern Hardwoods Forest, and typically contain sugar maple, beech, red maple, yellow birch, hemlock, white pine, red oak, and hop-hornbeam. In more mature forests, beech and sugar maple become increasingly dominant, since they are very tolerant of low light conditions, while red oak needs high light levels for successful establishment. Red oak has been separated here from a more general northern hardwoods (beech-sugar maple) type, on the basis of its distinct early successional establishment pattern.

Oak-Dominated Forest

This upland forest type comprises the red-oak dominated (Cluster 1) and the oak-paper birch dominated (Cluster 4) overstory communities. Red oak is clearly the dominant overstory

Table 4

RELATIVE DOMINANCE OF OVERSTORY SPECIES BY VEGETATION PLOT

Species	Red-Oak Dominated Plots								Northern Hardwoods Plots						Pine Dominated Plots		
	1	2	3	8	9	10	16	17	4	5	6	7	11	12	13	14	15
Acer rubrum	5.10	27.06	45.29		11.68	23.14	15.22	13.84	22.73	57.84	44.29		52.54	23.51	5.46	1.03	0.88
Acer saccharum	16.29	3.37	4.20	14.48	2.99	14.25		8.73	21.27	11.47		34.62	0.52	1.63	4.61	13.27	8.02
Betula alleghaniensis									13.14	5.77	*	3.99	3.48	21.86			
Betula papyrifera	4.63	*	*			3.57			*						*	*	
Fagus grandifolia						4.55	16.14	4.69	42.86	12.72	41.21	16.19	25.26	41.25			0.78
Fraxinus americana																	3.40
Ostrya virginiana	0.91			0.42	*		0.63	3.57				13.48					*
Pinus strobus													*		89.93	78.10	66.44
Populus grandidentata		20.33														7.28	
Quercus rubra	73.07	49.24	50.51	85.10	71.78	54.49	68.00	69.16	*	12.20	14.50	31.72	18.20	11.75			*
Tilia americana					13.55												20.47
Tsuga canadensis																0.31	

* Present, but dead; not included in calculations of relative dominance.

Table 5

RELATIVE DENSITY OF UNDERSTORY SPECIES BY VEGETATION PLOT

Species	Red-Oak Dominated Plots								Northern Hardwoods Plots						Pine Dominated Plots		
	1	2	3	8	9	10	16	17	4	5	6	7	11	12	13	14	15
Acer pensylvanicum													3.23	*			
Acer rubrum	3.22	14.28				*	1.58						*	*		4.76	
Acer saccharum	90.32	57.14	92.10	100.00	68.52	78.05	23.81	43.55	33.96	4.62	46.43	49.18	4.84	11.54	90.74	61.90	53.85
Betula alleghaniensis																	
Betula papyrifera																	
Fagus grandifolia	6.45	28.57	7.89		31.48	21.95	71.43	56.45	60.38	95.38	53.57	45.90	90.32	88.46	1.85	4.76	46.15
Fraxinus americana															1.85		
Ostrya virginiana							1.59		5.66			1.64	1.61		3.71	28.57	
Pinus strobus																	
Populus grandidentata																	
Prunus serotina															1.85		
Quercus rubra																	
Tilia americana												3.28					
Tsuga canadensis							1.59										
Total Number of Stems	31	42	38	38	54	41	63	62	53	65	56	61	62	52	54	21	39

* Present, but dead; not included in calculations of relative density.

Table 6

RELATIVE DENSITY OF WOODY GROUNDCOVER SPECIES BY VEGETATION PLOT

Species	Red-Oak Dominated Plots								Northern Hardwoods Plots						Pine Dominated Plots		
	1	2	3	8	9	10	16	17	4	5	6	7	11	12	13	14	15
Acer pensylvanicum	*	19.35		*	*			*	*		*		2.78	0.49	*		
Acer rubrum		12.90	19.64		16.00	0.79	0.62		8.11	1.45	1.52		16.67	6.83		0.33	
Acer saccharum	94.05	62.90	76.79	97.86	68.00	84.92	29.01	40.39	37.16	61.84	50.00	85.88	5.56	10.73	88.32	98.33	70.79
Amelanchier sp.	*	1.61					0.62										
Fagus grandifolia	0.74	1.62	1.78	*	*	4.00	67.28	55.17	50.00	35.26	42.42	13.26	72.22	81.95			
Fraxinus americana	*	*		1.43	7.00	3.17				*	4.54	0.28			2.92	0.67	11.23
Lonicera canadensis	1.49	*	*	*	*	7.14			2.03		*				7.30		7.87
Ostrya virginiana	3.35	*	*	0.35	6.00	*	*				1.52						3.37
Pinus strobus	*	*		0.17	2.00		*						2.78				
Populus grandidentata		*	*													0.33	
Prunus serotina	0.37	*	0.89	0.17	1.00		0.62		0.67	1.45		0.58		*	1.46	0.33	1.12
Quercus rubra	*		0.89				1.85	3.94	2.03	*	*	*	*	*			*
Tilia americana	*	1.62		*							*	*					3.37
Tsuga canadensis							*	0.49									
Total Number of Stems	269	62	112	560	100	126	162	203	148	207	66	347	36	205	137	300	89

* Present in plot, but not in sampling strips; not included in calculations of relative density.

species, with a relative dominance of 49% to 85% (averaging 65%) for the plots within this forest type. Red maple (0 to 45%, mean 18%) was frequently a co-dominant, followed by sugar maple (0 to 16%, mean 8%). Other species typically occurring in the red oak stands of Colonial Point are white pine, bigtooth aspen, and paper birch – species also associated with disturbance. Most of the paper birch and many of the aspen have died or are dying, since both species are short lived relative to oak. Beech is present in the overstory in only three out of eight plots, two of which are immediately adjacent to beech-dominated northern hardwoods forest.

Sugar maple predominates in the groundcover (69%) and understory (69%), and is also relatively common in the small overstory size class. Beech is present in low levels in the understory (16%) and in somewhat higher levels in the groundcover (49%). The predominance of sugar maple and beech in the groundcover and understory indicate that the oak will eventually be replaced by these species.

The relatively low occurrence of beech in all structural levels is probably due to destruction of mature beech by fire and the resulting loss of seed source. While fire can destroy the local seed sources for both beech and sugar maple, sugar maple re-establishes rapidly due to the wide dispersal of its light wind-born seeds from adjacent stands. In contrast, the heavy beechnuts are largely dependent on mammals for dispersal and are accordingly distributed much less widely. The only two oak plots with high levels of beech saplings and seedlings (Plots 16 and 17) are situated immediately adjacent to existing mature beech stands.

Oak-dominated forest covers most of the southern half of the peninsula, while smaller isolated oak stands occur in the north portion within northern hardwoods forest. The structure and composition of individual oak stands are discussed in greater detail below.

<u>White Pine Stands</u>

Almost pure stands of white pine (Cluster 14) are found throughout the Colonial Point Forest in patches of varying size. The pine stands occur with greatest frequency along the margins of the peninsula, although stands are found in the interior as well. Within vegetation plots in pine-dominated areas, pine averages 78% relative dominance in the overstory, with sugar maple averaging 9%, red maple 2%, and beech less than 1%. These low levels of mature sugar maple, red maple, and beech may be due to the dense shade produced by the establishing white pine, droughty conditions in the leaf litter which hinder hardwood establishment, more severe disturbance, or a combination of these factors.

The white-pine dominated stands appear even-aged, and at present there is virtually no on-site regeneration of white pine. Groundcover and understory classes are dominated by sugar maple (86% and 69%, respectively), with lower levels of red maple, white ash, and beech.

Bigtooth aspen is common along the edges of and within many of the pine stands. Closely associated with and overlapping the pine units are communities containing bigtooth aspen (Cluster 11) and a mix of bigtooth aspen with red oak, red maple, and sugar maple (Cluster 7).

<u>Northern Hardwoods (Beech-Sugar Maple) Forest</u>

The northern hardwoods forest type of Colonial Point (represented by Clusters 10, 12, 13, and 15) is dominated by red maple (34% average relative dominance), beech (30%), sugar maple (15%), and red oak (15%) along with scattered mature hemlock, white pine, yellow birch, and other species, depending on local drainage and disturbance conditions. Advanced regeneration by sugar maple and beech is present throughout. Beech and sugar maple are equally common as seedlings in the groundcover; however, beech predominates in the understory (72%), due to high seedling and sapling survival rates for beech, possibly aided by the preferential browsing of sugar maple seedlings by deer (Curtis and Rushmore 1958; Curtis 1959). In addition, some of the understory beech are root sprouts from mature overstory trees, capable of surviving adverse conditions in the understory due to nutrients received from the parent tree (Curtis 1959).

Forest composition of the northern hardwoods type has changed due to heavy selective cutting of sugar maple, making beech and red maple the dominants in most portions of these stands. Red maple, although common in most of the forest types, was not commonly cut. Where cut, red maple often resprouted to form multi-stemmed trees. Sugar maple remains common as subdominant trees or large poorly formed trees left at the time of cutting in the mid-1940s.

Within the Colonial Point Forest, the northern hardwoods forest type is primarily restricted to the northern portion of the preserve. However, small areas of northern hardwoods are also present in moist microsites in the southern, oak-dominated sections of the peninsula.

C. Poorly Drained Forest Types

Forest communities found on poorly drained or very poorly drained sites within the tract include hardwood swamp located in shallow depressions on fine-textured soil, hardwood and hardwood-conifer dominated drainageways, and hardwood and hardwood-conifer dominated areas where fine-textured soils are near the surface. Although no vegetation plots were placed in these wetland forest types, the distinct communities and drainage conditions can be characterized from transect data.

Hardwood Swamp

A small, shallow basin in clay-loam soil is located just east of Lathers Road. The basin remains wet throughout the year, with some drainage occurring through an intermittent stream. Hardwood swamp also occurs to the west of the preserve on the adjacent Hippler property. The dominant species in the swamps are American elm, black ash, red ash, and basswood (Cluster 3). Windthrow is common, creating hummocky topography.

Hemlock-Dominated Seepages

Hemlock-dominated stands (Cluster 9) are found along both the east and west edges of the peninsula where fine-textured till underlies the sandy outwash deposits so prevalent at the surface. The fine-textured soil is within 2–4 feet of the surface. In lower-slope positions water is confined by the underlying fine-textured soil and appears at the surface as seeps. The soils in these areas are saturated to within a few inches of the surface throughout the growing season, causing tree rooting to be shallow. As a result windthrow is common, creating an irregular topography of shallow, often wet depressions and adjacent mounds. Hemlock, yellow birch, red ash, and sometimes red maple grow in the wetter depressions, while beech and sugar maple are common on the mounds. Shallow rooting causes the trees on these sites to blow over frequently. On the west edge of the study area, hemlock is especially prevalent; hemlock continues to be common in the swampy drainages further to the west. Cored windthrown hemlock from this area were among the oldest trees documented on Colonial Point, establishing around 1760. On the eastern side of the peninsula hemlock is locally dominant in seepages, but yellow birch is more common, with beech and sugar maple present on the drier mounds within the seepage areas.

Swampy Drainages

Swampy drainages (represented by Clusters 2, 5, 6, and 8) constitute localized areas of poor drainage associated with hardwood and coniferous swamp species. Forest composition varies with drainage conditions. In the northeastern portion of the preserve there are two shallow drainageways which support swamp-forest species. Near the upland ends of these drainageways sugar maple, beech, white ash, and red maple are common. As drainage conditions become poorer downslope, red ash, basswood, yellow birch, and finally black ash become more common. In some of the wettest portions of the drainageways, hemlock, balsam fir, yellow birch, and black ash are the dominants, although none grow to large size.

A steep wave-cut bluff is located near the southeastern edge of the peninsula. Locally, drainage is poor at the base of this bluff, probably in part due to the underlying clay-loam soils, which are found at or near the surface in several places near the base of the bluff. The poorly drained strip typically contains many of the species characteristic of the drainageways.

D. The Status and Structure of Red-Oak Dominated Areas Within the Colonial Point Forest

The red oak forest of Colonial Point can be characterized overall as even-aged. A histogram of red oak diameter measurements (Fig. 6) indicates that 80% of the 458 red oak encountered in the vegetation transects range between 12" and 24" in diameter. In a situation of active forest regeneration, a greater proportion of stems would be found in the smaller size classes, with a decline in the number of stems as stem size increased. In the Colonial Point red oak stands, however, there is no successful oak regeneration, thus the smaller size classes are under-represented. Only occasional understory red oak were encountered along road edges where there were large enough openings in the canopy to meet the light requirements of this species. Low frequencies of red oak seedlings were observed in the ground cover throughout the stand, but these appear unable to grow into the understory due to inadequate light.

The even-aged structure of the red oak indicates that many of the red oak established within a brief interval of time, apparently following a major disturbance or a series of closely-spaced disturbance events which opened the canopy and destroyed competing sugar maple and beech. Tree ages obtained from cores and cut stumps bracket establishment between the mid- to late 1800s.

Within the oak-dominated areas of Colonial Point, however, individual red oak stands can be distinguished on the basis of different age and stand composition. Two of these stands, termed the "young oak" and "oak plain" are discussed below, and their stand composition briefly compared with the distribution of red oak throughout the northern hardwoods forest.

Young Oak Stands

The youngest oak stands in Colonial Point Forest established between 1890–1900. Two areas of similar young stands were located: one centered in the northwestern corner of the preserve near 1900N/1700E and another centered in the southwestern corner near 900N/2050E.

The young oak stand in the northwestern corner of the study area extends west across the preserve property line into the recently cut stand on the adjacent Hippler property. Tree ages from this cut-over area indicate that many of the small oak established around 1900 after multiple burnings in the stand. The oldest tree dated in this area (Core #205) established ca. 1855, and shows a fire scar for the year 1890. A second tree (Core #204), which established in 1890 apparently as a consequence of the first burn, shows a fire scar in 1900. Establishment dates for four other young oak (Cores #200–203) immediately post-date this second burn.

The young age of the stand, with many trees establishing between 1890–1900, indicates an establishment date too late for Indian agriculture. Clearcutting would have been the alternative origin of the stand. Clearcutting would provide the necessary open conditions for successful oak establishment. There could also have been fires in 1890 and 1900 after logging, as at the turn of the century it was not uncommon to burn slash after logging. Later fires were often set in the cut-over stands to stimulate the growth of berries. A selective cut was probably not responsible

FIGURE 6

HISTOGRAM OF ALL RED OAK DBH MEASUREMENTS FROM VEGETATION TRANSECTS AND PLOTS

```
MIDPOINT        COUNT   (EACH X= 1)

 4.0000          2 +XX
 6.0000          3 +XXX
 8.0000         16 +XXXXXXXXXXXXXXXX
 10.000         29 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 12.000         49 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 14.000         51 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 16.000         63 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 18.000         84 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 20.000         57 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 22.000         39 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 24.000         18 +XXXXXXXXXXXXXXXXXX
 26.000         24 +XXXXXXXXXXXXXXXXXXXXXXXX
 28.000         11 +XXXXXXXXXXX
 30.000          4 +XXXX
 32.000          2 +XX
 34.000          3 +XXX
 36.000          0 +
 38.000          3 +XXX
 40.000          0 +

 TOTAL         458  (INTERVAL WIDTH= 2.0000)
```

for the establishment of the oak stands, as study of selective cuts near Colonial Point show that even a relatively heavy selective cut does not adequately reduce the competition to allow for successful red oak regeneration from either seed or sprouts.

Both of the young oak stands are characterized by stump sprouting (multiple stems), high levels of mortality, the presence of other early successional species (paper birch, bigtooth aspen, and red maple), the presence of numerous sugar maple in the understory and small overstory size classes, and the lack of oak regeneration in the groundcover or understory.

Within vegetation plots placed in the young oak stand, densities of red oak are relatively high (13 to 21 standing stems per plot), and bole diameter corresponding small (generally 10" to 14"). Up to 33% of the standing red oak stems in these plots are from multiple-stemmed trees. This high level of multi-stem trees suggests that a major disturbance (such as a fire or clearcut) occurred after oak establishment, causing the damaged oaks to stump sprout.

Red oak mortality is high (up to 66%) in the young oak stands. These mortality rates probably reflect the natural thinning of the stand with maturity, although disease cannot be ruled out as a contributing factor. Paper birch mortality is also high and fallen paper birch are common. Red maple and bigtooth aspen, both species which appear to have established at the same time as the red oak, are not yet overmature or dead.

Oak regeneration is absent from all of the young oak stands. Instead, sugar maple predominates as small overstory or understory trees. In the young oak stands, sugar maple assumes only 3–16% relative dominance in the overstory, but makes up 57–92% of the understory. Beech is also present in the understory, but in lesser amounts than sugar maple (6–28%).

Sugar maples were not cored for ages, but it is likely that the sugar maple established either at the same time or after the red oak. Since sugar maple is highly intolerant of fire, it is assumed that it did not establish before the fire event which led to the establishment of the oak. Further, its prior presence in large numbers would have precluded the establishment of oak, which cannot compete with sugar maple for light. As will also be seen in older oak areas, sugar maple and beech appear to be slowly replacing the oak and other early successional species.

The Oak Plain

The name "oak plain" was coined for a broad band of oak-dominated forest, located in the southeastern quarter of the study area between 500N and 1100N, and 2300E and 2550E. The oaks of this area appear to be somewhat older than the young oak stand, with dates of establishment between approximately 1830 and 1860. Single-stemmed trees are much more common on the oak plain, possibly indicating that the area was only disturbed once, at the time the red oak established. The trees are also larger on the oak plain, with an average dbh of 18–19". The largest oaks are 22–23" in diameter.

Oak regeneration is absent on the oak plain, and beech and sugar maple predominate in the groundcover and understory. The average relative dominance of sugar maple is higher on the oak plain than in the area of young oak (20% vs. 8%). Beech is also a much more important component of the oak plain. In the young oak stand, sugar maple outnumbers beech 10 to 1 in the overstory and 6 to 1 in the understory. On the oak plain, in contrast, beech is equally as common as sugar maple in both the overstory and understory. Beech may be less common in the young oak area due to either the sensitivity of beech to high light levels present in the young stand or its destruction by fire. Fire occurred more recently and possibly was more severe in the young-oak area. Beechnuts also do not distribute as widely as the light, wind-dispersed samaras of sugar maple, thus the re-establishment of beech after its destruction by fire would be slower.

Oak in Northern Hardwoods (Beech-Sugar Maple) Forests

Red oak is present in small numbers throughout the beech-sugar maple dominated portions of the forest, with relative dominance along the vegetation transects of 7–15%. These oak are found as isolated individual trees or in small clusters, and are typically large mature or overmature trees, with diameters of 24–36". Some of the individual trees may have established when windstorms caused multiple windthrows, opening up the canopy. Areas susceptible to windthrow are common on the northern half of the peninsula, especially along the eastern and western slopes, where drainage is moderately poor to poor due to underlying fine-textured soils. The patches of red oak may also have established as the result of localized fires. Fire scars are common at the bases of beech trees located adjacent to the oak patches. It is not clear whether these small patches were the result of natural lightning-caused fires or human-caused fires.

Many of the large oak within the northern hardwoods are dead or dying. Cores show most of the dead trees to be 130–150 years old. It is not certain whether this is the typical life span for red oak growing under the climatic conditions prevalent on Colonial Point, or whether these individual trees are short lived due to intense competition with neighboring beech and sugar maple for light, water, and nutrients.

Oak Regeneration

It has previously been mentioned that successful oak regeneration has been limited in the forests on Colonial Point. Successful regeneration has only been seen in two locations on the tract: on the road edges and in the old field at the southern end of the peninsula. The high light levels along Lathers Road and Indian Point Road have allowed many red oak to reach understory size. Similarly, understory and small overstory yellow birch, paper birch, basswood, and white ash were common along the road edges. Smaller logging roads, made during the 1940s, did not typically provide enough light for red oak to survive.

The old field just north of the line between Sections 28 and 33, as identified from the 1938 aerial photos, was apparently used for pasture. Parts of the farm were cleared of trees, whereas other portions had enough of the trees removed to allow grazing. Where the land had been completely cleared, red oak and white pine regenerated successfully and are presently dominant overstory species. Where clearing had been only partial, white pine and oak regenerated along with sugar maple. Unable to adequately compete for light, many of the red oak and pine are presently dying. Examination of a recently dead 3" dbh red oak showed rapid growth for 32 years, followed by 10–12 years of slow growth, and death in 1985, at the age of 42–44 years. Similarly, the white pine had grown rapidly for 31 years, followed by very slow growth for 16 years.

Red oak is found as seedlings in the groundcover in many areas on the peninsula where there has been a local disturbance, such as the windthrow of a dominant tree. It is also present in moist, seepy areas at the base of the wave-cut bluff. These seepages are very windthrow prone, as indicated by common windthrow mounds and small overstory-tree diameters. The oak seedlings probably established when trees blew over, and the small seedlings may actually be several years old. Even in these areas, however, red oak rarely succeeds into the understory.

In summary, the red oak stands of Colonial Point are, as a whole, even-aged and contain early successional species such as paper birch, bigtooth aspen, and white pine. Based on stand composition, it is probable that fire played an important role in red oak establishment. Further, red oak is not reproducing, except locally along road edges. This indicates that the red oak will be eventually replaced over large areas by beech and sugar maple, unless a major disturbance allows it to re-establish. The resulting forest will be a mature stand of northern hardwoods, in which red oak will occur as scattered large individuals.

PART III
FACTORS AFFECTING RED OAK ESTABLISHMENT AND DISTRIBUTION

The second stage of this study was aimed at determining those factors responsible for the distribution and establishment of red oak. Those factors investigated included physical site factors (soils and drainage conditions), natural disturbance (windthrow), cutting disturbance, and fire history, whether of natural or human origin.

A. Field and Lab Methods

Data on windthrow, cutting disturbance, and land-form were drawn largely from the vegetation transects. These data were supplemented by site-specific analyses of soil texture, drainage conditions, and fire history from the vegetation plots sampling upland forest types.

Soil Sampling and Analysis

Soils were sampled at the center of each vegetation plot. A shallow soil pit was dug to facilitate study of the litter layers and the surface mineral horizons. An auger was used to collect samples to at least six foot depth. The thickness of each litter layer and soil horizon was recorded. The soil texture for each horizon was field-estimated and a sample of the B and C horizons was collected for laboratory textural analysis. Drainage conditions were estimated by recording depth to mottling, gleying, and saturation. The pH was recorded for each horizon, using a Hellige-Truog Soil Testers kit.

Soil samples were also taken along transect lines using a bucket auger. Samples were taken to at least 6' deep, except in a few cases where gravelly subsoil restricted augering. Soil texture was field-estimated and the depth to mottling, gleying, and saturation was recorded.

Textural analysis was conducted on the soil samples from the plots, using the methods described by Day (1965). The size fractions (sand, silt, and clay) for each sample were recorded as percent of sample weight and the textural class was computed. The sand fraction was dry-sieved to separate it into 5 sub-fractions: very coarse, coarse, medium, fine, and very fine sand.

Charcoal Sampling, Recovery, and Analysis

The fire history of the upland forest types was investigated by examining the relative abundance of charcoal in the surface organic and upper mineral soils. Five surface soil samples of standard size (50 cm. square by 10 cm. deep) totalling 0.125 cubic meter were taken from each vegetation plot. Multiple samples were taken to increase the probability of recovering charcoal. The samples were consistently taken from the four plot corners and from an approximately central location. The soils were bagged in the field and removed for further processing. A total of 85 soil samples were taken from the 17 vegetation plots.

The surface soil samples were first dry-sieved through nested screens of 1/4" over 1/8" mesh, to facilitate the removal of larger roots and pebbles. Material on the 1/4" screen was hand-sorted and any charcoal found was removed and bagged. Charcoal from this fraction was later rinsed to remove adhering mineral soil and then oven dried at 100 degrees F. for 24 hours. Material from the 1/8" screen was reserved for flotation, while material less than 1/8" was discarded due to difficulties in recovery and identification.

Charcoal was removed from the 1/8" – 1/4" soil fraction by standard flotation procedures (Shackley 1981). The small charcoal pieces along with other floating low-density organic materials were then oven-dried at 100 degrees F. for 24 hours. Finally, the dried low-density material was hand-sorted and the charcoal was separated out with tweezers and great patience.

Once the total charcoal from each plot corner had been recovered and dried, each charcoal sample was gently dry sieved through nested screens of 1/2", 1/4", and 1/8" mesh to separate it into four size classes (less than 1/8", 1/8 – 1/4", 1/4 – 1/2", and greater than 1/2"). Each of the four size fractions of each plot sample was then weighed to the nearest .001 gr. using a Mettler PE-160 digital read-out scale.

Charcoal from the three largest size classes (material greater than 1/8") was further identified to genus through microscopic analysis of wood structure. Charcoalized wood retains the distinctive arrangement of rays and pores in its structure indicative of individual genera (Panshin and de Zeeuw 1970). It is often difficult, however, to distinguish the separate species of a given genus on the basis of structure. For many genera this was not a problem, in that the genera are represented by a single species in the Colonial Point Forest. The primary problem areas were the inability to separate sugar maple from red maple and paper birch from yellow birch on the basis of structure, although these species represent different ecological and disturbance factors.

In small samples (less than 30 pieces per size class per corner), all pieces of charcoal were examined for genus identification. For larger samples, however, time constraints made it necessary to select a sub-sample of pieces for examination. Each size class of charcoal from each plot corner was sampled separately by pouring the charcoal onto a gridded surface of 4 by 5 squares and selecting from each square the charcoal piece closest to the upper right corner. The charcoal was then agitated and redistributed on the grid, and a second pass was made, for a sample size of 30 to 40 pieces, depending on the size of the sample and the degree of species diversity so far encountered.

The counts of identified pieces were then converted to estimates of the relative dominance of each genus by weight. For each size class of each corner sample, genera counts were first converted to percentages and these multiplied by the total weight of that size fraction, to estimate the weight of charcoal for each genus. The estimated weights per genus were then summed across all three size classes, and the relative dominance of each genus determined for that corner sample as the percent of total weight. The relative dominances were then averaged across all five corner samples to determine the relative predominance of each genus for the plot as a whole.

Because the volume of charcoal recovered was so much greater than that anticipated, genus identification is still in progress. To date, however, identifications have been completed for all of the northern hardwoods plots and all of the red oak plots.

B. Analysis of Possible Determining Factors for Red Oak Establishment

Soils and Drainage Conditions

Most of Colonial Point has sandy soil at the surface (Table 7). Sandy-loam to sandy-clay-loam till underlies the sand at variable depth. The depth to this underlying fine-textured soil is important in determining the drainage class of the soil and to some degree, the forest vegetation. Most of the wetlands on the peninsula are located where fine-textured soils are located at or near the surface, inhibiting drainage. East of Lathers Road is a hardwood swamp where clay-loam soils are at the surface. In lower and midslope positions along the eastern and western edges of the tract, fine-textured subsoils are within 2–3 feet of the surface, causing seepage areas dominated by trees tolerant of poorly-drained conditions. Windthrown trees are common in these areas due to shallow rooting. Sugar maple and beech are common on the drier hummocks within these seepage areas and at the drier margins.

Relative dominance of oak in these seepage areas is low. Red oak establishment is probably limited in these areas for several reasons. First, the moist conditions probably reduce the occurrence of fire, an important form of disturbance for red oak establishment. Second, many of

Table 7

SOIL TEXTURE DATA FOR VEGETATION PLOTS

Plot	Soil Horizon	Particle Size Fraction			Sand Size Fraction					Textural Class
		Sand	Silt	Clay	Very Coarse	Coarse	Medium	Fine	Very Fine	
Red-Oak Dominated Plots										
1	B2	92.4	7.6	0.0	2.0	5.4	65.6	18.2	1.2	sand
	C	95.8	2.2	2.0	4.4	24.4	49.8	15.6	1.6	sand
	IIC	65.0	25.0	10.0	0.2	1.4	14.4	29.8	19.2	sandy loam
2	B2	96.8	1.2	2.0	1.4	13.0	66.2	14.8	1.4	sand
	C	97.0	3.0	0.0	0.2	10.4	73.4	9.6	3.4	sand
3	B2	91.0	3.0	6.0	2.0	22.6	50.6	12.6	3.2	sand
	C	66.6	22.4	11.0	1.0	7.0	20.6	25.8	12.2	sandy loam
	C4	25.6	50.4	24.0	0.0	0.2	0.8	5.4	18.2	silt loam
8	B2	87.4	8.6	4.0	3.0	10.0	49.4	20.8	4.2	loamy sand
	IIC	86.8	7.2	6.0	1.2	8.6	50.2	22.2	4.6	loamy sand
9	B2	52.4	15.6	32.0	0.4	3.6	40.8	5.6	2.0	sandy clay loam
	C	62.6	15.4	22.0	1.4	5.8	30.0	19.6	5.8	sandy clay loam
10	B2	86.6	15.4	2.0	1.4	5.4	42.4	25.6	7.6	loamy sand
	C	80.4	11.6	8.0	1.2	6.2	43.4	23.4	6.2	loamy sand
16	B21	89.0	6.0	5.0	1.4	7.4	49.6	25.8	4.8	sand
	IIC	80.6	6.4	13.0	0.6	4.8	40.8	27.6	6.8	sandy loam
Northern Hardwoods Dominated Plots										
4	B2	84.4	11.6	4.0	1.2	14.2	50.0	15.0	4.0	loamy sand
	IIC	60.6	19.4	20.0	2.4	13.0	28.0	6.8	10.4	sandy loam
5	B2	85.2	12.8	2.0	0.6	5.4	66.4	10.8	2.0	loamy sand
	IIIC	99.0	1.0	0.0	0.4	2.4	69.8	25.8	0.6	sand
6	B21r	92.2	5.8	2.0	1.0	6.0	46.0	33.6	5.6	sand
	IIC	72.6	15.4	12.0	1.2	5.8	39.2	21.2	5.2	sandy loam
7	B2	79.4	12.6	8.0	4.2	19.2	45.0	8.4	2.6	loamy sand
	B22	84.4	11.6	4.0	5.6	25.2	43.6	7.6	2.4	loamy sand
11	B2	96.4	3.6	0.0	0.8	13.6	73.4	8.0	0.6	sand
	C	93.4	4.6	2.0	0.8	10.6	72.4	9.2	0.4	sand
	IIC	53.6	28.4	18.0	0.2	0.8	5.4	27.8	19.4	loam
12	B2	92.0	8.0	0.0	0.6	7.6	65.4	16.2	2.2	sand
	C	95.0	3.0	2.0	0.8	14.2	64.2	13.2	2.6	sand

Table 7
(continued)

Plot	Soil Horizon	Particle Size Fraction			Sand Size Fraction					Textural Class
		Sand	Silt	Clay	Very Coarse	Coarse	Medium	Fine	Very Fine	
Pine Dominated Plots										
13	A'B'X	57.8	35.2	7.0	0.2	1.4	16.4	26.8	18.0	sandy loam
	IIC	25.0	37.0	38.0	1.0	1.0	5.2	10.0	8.8	clay loam
	IIIC	93.4	4.6	2.0	0.2	1.0	13.8	70.8	7.6	sand
14	B2	71.0	25.0	4.0	0.2	1.4	42.0	24.2	3.2	sandy loam
	C	95.8	4.2	0.0	0.4	3.6	75.2	15.8	0.8	sand
15	B2	33.2	26.8	40.0	0.0	1.0	22.4	8.4	1.4	clay loam - clay
	C	35.4	26.6	38.0	0.0	1.2	24.8	8.0	1.4	clay loam

the seepage areas are patchy enough that windthrows within them will not produce openings in the canopy sufficiently large for red oak to establish and survive. Several areas were seen in our study where red oak seedlings had established in windthrown seepage areas, but where the canopy closed in before the seedling could reach the understory. Third, some of the larger seepage areas are adjacent to hardwood-conifer swamps. After major windstorms, which can provide large openings in the canopy, wind-dispersed seed from yellow birch, hemlock, balsam fir, and white pine establish quickly in the openings. Red oak is not common enough in these poorly drained areas to rapidly colonize them after disturbance.

Red oak is the dominant tree in many areas of the peninsula (Map II), but is especially common on the southern half of the peninsula. Differences in soil conditions appear insufficient to have excluded a northern hardwoods forest from this area. Although drier than the northern hardwoods area to the north, the soils of the oak-dominated areas cannot be considered especially droughty or fire-prone. Two-storied soils, with fine-textured subsoils within 3–4 feet of the surface are relatively common on the southern half of the peninsula. These fine-textured subsoils effectively slow downward perculation of moisture and increase moisture availability at the surface. In addition, fine-textured soils are exposed at the surface locally at the southern end of the peninsula in upper slope positions, although there are few locations where the fine-textured subsoils cause wet seepages. Finally, the presence of sugar maple and beech in the understory and overstory of the red-oak dominated stands indicate that these sandy soils do meet the moisture requirements of a beech-sugar maple forest.

However, drier soil conditions of the southern peninsula may have contributed indirectly to the dominance of oak and pine. A greater proportion of the soils on the southern half of the peninsula have a thicker sandy surface layer, which is both drier and warmer in the spring and more easily worked – features attractive to Indian agriculturalists (Krakker 1983). Further, this area would be easier to manage with fire, as it is not broken up by wetlands or wet seepages.

A preliminary soil survey (Map IV and Appendix II) has been conducted for Colonial Point and the rest of Cheboygan County by the Soil Conservation Service (SCS 1986). Comparison with the soil sampling results of this study (Appendix III) shows agreement with the survey results in the wetland areas and where beech-sugar maple is dominant at the north end of the peninsula. Our results differ greatly at the south end of the peninsula, which they map as primarily deep, sandy soils, probably based on aerial photo interpretation of the vegetation. In this study, over 50% of the soils sampled at the south end of the peninsula had fine-textured subsoils near the surface. It appears that aerial-photograph interpretation is not adequate for areas where disturbance (either natural or human) has significantly modified forest composition.

Windthrow and Red Oak Establishment

Based on the distribution of the Colonial Point red oak relative to the distribution and frequency of windthrow mounds, windthrow does not appear to be responsible for the establishment of red oak on most of the peninsula. The northern half of the peninsula (Fig. 7) is characterized by large numbers of windthrow mounds in those areas where soil drainage is impeded by underlying fine-textured soils. In these areas, a 250 sq. m. transect unit (10 m. by 25 m.) typically contained many (11–20) windthrow mounds. Red oak dominance is typically less than 20% on these windthrow-prone sites, with red oak dominance decreasing as the number of windthrow mounds increases. On the southern half of the peninsula, where red oak predominates, the average number of windthrow mounds per transect unit typically ranges between 0 and 10 (97% of the units), with 0 to 5 windthrow mounds per 25 m. section being most common (82% of the units).

The importance of windthrow is probably low because the windthrow-prone areas are either too small to produce canopy gaps large enough for successful red oak establishment, or the

FIGURE 7: DENSITY AND DISTRIBUTION OF WINDTHROW MOUNDS WITHIN VEGETATION TRANSECTS

```
NORTH
1950  +          23 2321 11   0010 2201 01          KEY:
                                                    0 = 0
      +                                             1 =  1 -  5
                                                    2 =  6 - 10
                                                    3 = 11 - 15
1750  +          13 3333 3222 0122 1211 1111 11    4 = 16 - 20

      +

1550  +          44 3403 3231 1310 1123 2111 0122 00

      +

1350  +          34 3231 1011 1201 2133 2433 1111 2320 1110 0

      +

1150  +                         23 3011 1110 2410 1331 1112 1111 10

      +

 950  +                         23 4432 3222 3222 1112 2333 3222 121

      +

 750  +                    1111 1111 1111 1113 2211 2211 1311 1111 110

      +

 550  +                              011 1000 0111 1011 2221 1121 10

      +

 350  +                               00 0000 1011 1222 2111

      +

      +
      +----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
    1400      1600      1800      2000      2200      2400      2600      2800      EAST
```

resulting large gaps are colonized by nearby wetland species with abundant wind-dispersed seed.

Cutting History and its Impact on Red Oak Distribution

The cutting history of the Colonial Point forest has been reconstructed from information obtained from former owners of the property, from aerial photos of stand height and density, and from direct evidence of cutting activities in the stand in the form of cut stumps and slash. Information on cutting history is summarized below for the major economic species.

White Pine: Only limited cutting of white pine has occurred within the Colonial Point stand. A total of 29 white pine stumps were recorded in the vegetation transects (Table 8, Fig. 8); most of these were very large trees with dbh's greater than 30". Although it is difficult to determine the precise date of cutting, the date can be bracketed between the late 1800s and early 1900s. White pine had become a focus of the timber industry in northern Michigan by the 1880s. Legal titles to cutting rights for white pine indicate that white pine was actively cut as late as the 1920s. Mr. Dau of Michigan Maple Block Company who owned the property since the 1940s had never cut for pine, as these "shore" pines were not as desirable as those inland (pers. comm. to Bob Vande Kopple, Spring, 1986).

Hemlock: Hemlock cutting was also limited in the Colonial Point Forest, although 35 stumps were encountered within the present hemlock-dominated area west of Lathers Road. In each case, remains of the tree bole were still evident, suggesting that the tree had been left where it fell beside the stump. It is probable that these hemlocks were cut and stripped of bark 75–100 years ago, when tanneries in the area were still utilizing the natural tanning agents of hemlock bark (John Dau, pers. comm. to Bob Vande Kopple, Spring, 1986).

Sugar Maple: In contrast with pine and hemlock, sugar maple has been fairly intensively cut out of the Colonial Point stand. In 1946 and 1947, Michigan Maple Block took out up to 100,000 board feet of maple from the central part of Section 28 (pers. comm. from John Dau to Bob Vande Kopple of UMBS, Spring, 1986). The cutting was concentrated in a 40 acre area to the east side of the old logging road recently renamed Colonial Point Forest Trail. Mr. Dau specifically noted that this cut took out only mature sugar maple, no red oak.

A large number of highly decomposed maple stumps were encountered in the vegetation transects (Table 8). By extrapolation from the area covered by the transects to the Colonial Point property as a whole, these density figures suggest that upwards of 1600 sugar maple were removed from the stand in the 1940s cut. In accordance with Mr. Dau's recollections, these stumps are concentrated in the northern third of the property, east of Lathers Road (Fig. 9).

Sugar maples were cut from areas currently dominated by northern hardwoods (Map II). These areas now have higher proportions of beech and red maple as a result of the near absence of large sugar maples.

Red Oak: Although Mr. Dau specifically states that no red oaks were taken from the Colonial Point stand, a large number of cut red oak stumps were encountered on the property in the course of field investigations. The majority of these stumps were located in the southern half of the peninsula, in areas currently dominated by red oak (Fig. 10). The degree of decomposition of these red oak stumps is similar to that of the sugar maple stumps, suggesting that the red oak were cut at approximately the same time as the maple, i.e. in the mid-1940s. The aerial photos of the peninsula confirm this general date, bracketing the cut between 1938 and 1952. The 1938 photographs show only restricted cutting in the far south end of the peninsula (see Map II), while the 1952 fly-over records frequent openings in the crown cover throughout the peninsula, including the southern half of the peninsula where red oak stumps are prevalent.

Table 8

CUTTING DISTURBANCE ON COLONIAL POINT:
NUMBER AND DENSITY OF CUT STUMPS BY SPECIES ENCOUNTERED IN VEGETATION TRANSECTS

Species	Stumps on Colonial Point Transects	Stumps on Cochran Property Transect	Total Cut Stumps in Transects	Density per Acre of Transect (Colonial Point)	Density per Acre of Transect (Study Area)	Percent of Total Cut Stumps
Acer saccharum	80	2	82	5.87	5.57	29.60
Betula alleghaniensis	2	0	2	0.15	0.14	0.72
Fagus grandifolia	6	1	7	0.44	0.48	2.53
Pinus strobus	29	7	36	2.13	2.45	13.00
Populus grandidentata	3	0	3	0.22	0.20	1.08
Quercus rubra	105	7	112	7.70	7.61	40.43
Tsuga canadensis	35	0	35	2.57	2.38	12.64
Total	260	17	277	19.08	18.82	100.00

FIGURE 8: DENSITY AND DISTRIBUTION OF CUT PINE STUMPS WITHIN VEGETATION TRANSECTS

```
NORTH
1950   +              00 0000 00   0000 0000 00
       +
1750   +              00 0000 0000 0000 0000 0000 00
       +
1550   +              00 0000 0000 1000 0000 0000 0000 00
       +
1350   +              00 0010 0201 1000 0000 0000 0010 0002 0110 0
       +
1150   +                             00 0000 1000 0000 0000 0000 0000 00
       +
 950   +                             00 0000 0000 0000 0000 0000 0000 000
       +
 750   +                    1000 0001 0013 1000 0010 0022 0000 0000 000
       +
 550   +                                010 0000 0010 0000 0000 0101 00
       +
 350   +                                 00 0011 2011 1000 0010
       +
       +
       +----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
           1600      1800      2000      2200      2400      2600      2800     EAST
```

FIGURE 9: DENSITY AND DISTRIBUTION OF CUT SUGAR MAPLE STUMPS WITHIN VEGETATION TRANSECTS

```
NORTH
1950   +                00 0001 00   0002 0000 00

       +

1750   +                02 1111 2012 0040 0120 2102 23

       +

1550   +                02 0110 0111 0000 0011 0000 0010 13

       +

1350   +                01 0000 1001 1000 0000 0100 0000 0102 0000 0

       +

1150   +                             00 1000 0020 0000 0000 0000 0100 00

       +

950    +                             00 0000 0101 1100 0000 0000 0000 100

       +

750    +                       0000 0000 0000 0000 0000 0000 0000 0000 000

       +

550    +                                000 0000 0001 0000 0000 0080 00

       +

350    +                                 00 0000 0001 0010 0000

       +

       +
       +----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
     1400      1600      1800      2000      2200      2400      2600      2800    EAST
```

FIGURE 10: DENSITY AND DISTRIBUTION OF CUT RED OAK STUMPS WITHIN VEGETATION TRANSECTS

```
NORTH
1950   +          10 2301 00   0010 0000 00

       +

1750   +          00 0000 0100 0000 0000 0001 00

       +

1550   +          00 0000 0010 0000 0000 0001 0001 11

       +

1350   +          00 0000 0000 0200 0001 1010 0101 0011 1000 0

       +

1150   +                         01 1232 0130 1011 1002 4001 0000 00

       +

 950   +                         00 0010 0001 1001 1110 0000 1020 101

       +

 750   +               0400 0112 0100 0120 0100 0121 0220 0012 000

       +

 550   +                            100 0000 0100 2204 2140 0030 00

       +

 350   +                             10 0003 0000 0000 0201

       +

       +
        +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
       1400    1600    1800    2000    2200    2400    2600    2800   EAST
```

A total of 105 red oak stumps were recorded in the vegetation transects crossing the Colonial Point Forest property, for a density of 7.7 per acre of transect (Table 8). These density figures suggest that more than 2100 red oaks were removed from the stand in the mid-1940s. This represents a fairly intensive selective cut, focusing on the greater than 12.0" dbh size class.

In addition to the 1940s red oak cut on the Colonial Point property, the red oaks (as well as the white pines) on the Cochran property were cut in recent years. This cut took place during the fall months of 1982 and 1983 (pers. comm. Dale Cochran (Columbus, Ohio) and Gene Gillon (Burt Lake Store), October, 1986). The cut was fairly intensive, leaving a concentrated area of red oak and white pine stumps in the southern tip of the study area.

Finally, Devereaux Sawmill removed three large red oaks from the Colonial Point property in the early spring of 1985 (Jim Devereaux, pers. comm., October, 1986). All three oaks were located along the north-south logging road (Colonial Point Forest Trail) near the center of the peninsula.

In summary, two main episodes of cutting can be documented for the Colonial Point stand: (1) the limited harvesting of white pines and hemlocks in the late 1800s and early 1900s; and (2) the wide spread and fairly intensive selective cut of sugar maple and red oak in the 1940s. Both were selective cuts which post-date the establishment of red oak. The primary impact of these selective cuts on associated vegetation would have been increased growth rates of understory and small overstory trees resulting from a more open canopy and increased establishment and survival rates for tolerant species, primarily sugar maple and beech. No clear evidence of successful stump sprouting from cut red oak was observed, although it is possible that the small multiple-stem red oaks on the 550N transect line in the area of the pre-1938 cut result from those cutting activities. However, no tree ages were obtained for red oaks in this area to verify establishment date.

The impact of cutting on the distribution of red oak also appears to have been limited. Red oaks were cut primarily from areas still dominated by red oak, such that the apparent distribution of red oak within the Colonial Point Forest remains unaffected.

Fire Ecology of Red Oak

Fire has been recognized to be instrumental in red oak establishment on sites previously dominated by sugar maple (Curtis 1959). Fire not only opens up the canopy for red oak establishment, it also kills competing beech and sugar maple in all structural levels of the forest stand. Oak, in contrast to beech and sugar maple, is well adapted to fire. Multiple burnings over a several year period may kill the above-ground red oak seedling or sapling, but new sprouts are sent up from the base at or near ground level. Windthrow and disease can likewise open up the canopy, but in the absence of fire, already existing beech and sugar maple seedlings and saplings immediately begin accelerated growth, reducing light levels in the groundcover and understory structural layers before red oak seedlings can successfully establish and grow into the understory.

Fire can be separated into naturally occurring fires and fires of human origin. Natural fires occur in many forest ecosystems. They are not common in mesic northern hardwoods, such as those at Colonial Point, but occur frequently enough to maintain low levels of white pine throughout the region (Barnes and Wagner 1981). Fires probably occurred naturally at Colonial Point along the margins of Burt Lake, where desiccating winds and direct exposure to sunlight dried out the leaf litter and dead groundcover vegetation. Highly flammable species such as white pine and red pine were probably present along the lake edge because of high light levels. A lightning strike could easily set the flammable vegetation and leaf litter on fire. Such fire-prone areas were often limited to narrow bands along the margins of lakes. It is questionable whether such lake-margin fires could be responsible for the establishment of red oak (and white pine) over the entire southern half of the peninsula. If lake-margin fires were frequent, a mosaic of burned and unburned areas would be expected, creating a patchy distribution of oak/pine within a beech-sugar maple forest.

Fire also occurs naturally after large areas of forest are windthrown. After the windthrown trees dry for several months, a lightning strike can easily cause fire and the resulting fires can be quite intense (Komarek 1968). In the General Land Office surveys of the 1800s, mention of such burnt-over areas was common in some regions of the state. However, fire following windthrow is probably not a reasonable explanation for the fire-related stands on the southern portion of Colonial Point, as windthrow has not been heavy in this area in the past.

An alternative source of fire is human-induced fire, either accidental or intentional. Before European settlement, fire was often used by indigenous populations as an intentional management tool, primarily in the clearing of agricultural fields (Day 1953; Russell 1983; Cronon 1983). Following European settlement, fires were frequently set after clearcutting, to remove accumulated slash. While the timing of burn events at Colonial Point indicates that both Indian-set and post-logging fires contributed to the establishment of red oak stands within this forest, the impact of post-logging fires was spatially limited. The following section evaluates the history and extent of Indian-set fires on Colonial Point, and their role in red oak establishment.

PART IV
TRADITIONAL INDIAN AGRICULTURE AND RED OAK ESTABLISHMENT

A. Traditional Land-Clearing and Agricultural Practices

Prior to European settlement, fire constituted an important management tool for Indian groups throughout the Great Lakes region and northeastern North America. Fire was used for a range of purposes, including game drives, to increase deer browse, and to promote the establishment of berry patches (Day 1953; Russell 1983). The primary use, however, was to clear the forest in the preparation of agricultural fields.

Traditional Indian agricultural practices in the Great Lakes region involved girdling and burning large trees to create an opening in the forest for field crops (Russell 1980; Cronon 1983). First, smaller cut trees and brush were piled at the base of standing large trees. This brush was then burned to destroy the bark and kill the trees. Crops could then be planted in the openings between the still standing but lifeless trees. Over the next several years, many of the dead trees would blow down and could be removed entirely by burning. Fire was further utilized to clear the fields of weedy growth and reduce crop pests. The resultant coating of wood ashes, rich in phosphates, lime, and potash, provided a natural fertilizer to increase productivity of corn and other crops (Russell 1980:140).

Field sites were utilized for a relatively short period (generally less than 10 years). With declining soil fertility and increased weed growth, fields were abandoned to return to forest and a new field site was selected. This traditional pattern of shifting agriculture created a mosaic of small-scale fire disturbance, permitting the establishment of patches of fire-tolerant species, including oak.

Colonial Point appears to have a long history of agricultural use prior to the period of European settlement. The presence of large numbers of corn caching pits in association with occupation sites dating to the Late Prehistoric period, indicate that the peninsula was used for agricultural purposes as early as AD 1300. The best documented period of traditional Indian agriculture on the Point, however, is that which immediate predates the arrival of European settlement in the Burt Lake area in the early to mid-1800s.

B. Late Prehistoric Occupation and Land Use

Although this study was not specifically oriented toward the recovery of prehistoric sites, remains of late prehistoric occupation were discovered during field investigations. Six prehistoric sites have been registered with the office of the State Archaeologist. These sites were of two types: concentrations of prehistoric ceramics and groups of caching pits.

Two concentrations of late prehistoric pottery were recovered from bare mineral soil exposed in windthrow mounds. Both were of Late Woodland date. The first concentration, designated site 20-CN-43, contained one rim and two neck sherds representing a single vessel of early Juntunen ware, plus 56 badly exfoliated body sherds. The sherds from this site apparently represent a single vessel of early Juntunen Ware, with an incipient collar and flattened, undecorated lip. The collar is decorated with two lines of drag-and-jab technique, while large triangular punctates appear below the collar. The body of the vessel appears to have been cord-marked at the neck, although most of the associated body sherds are unmarked.

The vessel bears strong stylistic and technical similarities to early Juntunen Wares as defined at the Juntunen type site on Bois Blanc Island. Similar ceramics at that site have been radiocarbon dated between AD 1300 and 1500 (McPherron 1967; Fitting 1975).

The second concentration of sherds, bearing site designation 20-CN-44, contained three rims plus 30 unmarked body sherds representing one or two collared vessels of Juntunen Ware. The well-developed collars are decorated with three parallel lines of drag-and-jab technique, with larger triangular impressions occurring on the lower edge of the collar. The lip of the vessel(s) is flattened and decorated with oblique cord-wrapped stick impressions. All the associated body sherds appear to be unmarked. As with the first concentrations of sherds, these vessels can be dated to the general period between AD 1300 and 1500, although stylistical differences suggest they are of slightly more recent date than the 20-CN-43 vessels.

The second type of prehistoric site encountered was that of cache pits, occurring in concentrations of two to greater than thirty. Four of these concentrations with more than seven pits were designated as sites (20-CN-40, −41, −42, and −45). Scattered occurrences of two to three pits are common on the peninsula, but were not given site numbers.

Caching pits appear on the surface as shallow depressions, approximately 3' in diameter and 1–2' deep. They are distinguished from windthrow-generated depressions by their regular shape and the absence of an associated windthrow mound. They tend to be located in well-drained areas and are arranged in fairly regular clusters. None of the Colonial Point caching pits were tested or excavated. However, test excavations in similar pits along the Black River in Presque Isle County, revealed that these storage facilities were up to five feet deep and roughly conical in form (O'Shea n.d.).

Caching pits are associated with the storage of agricultural produce. In Alcona County, caching pits were found arranged in rows around abandoned Indians corn fields (Hinsdale 1931:14). The pits were apparently lined with bark, reed mats, or skins and filled with corn. One early travel account described the use of caching pits as follows: "They put [their corn] into bags, and bury it in holes dug in the ground, for their use in spring and summer" (Morse 1822:127).

Caching pits generally contain little in the way of associated artifactual material and are therefore difficult to date (O'Shea n.d.). At the earliest, however, they are coeval with the period of dependence on agriculture, which in northern Michigan occurs during the Late Woodland period or sometime after AD 1000 (Fitting 1975). At Colonial Point, it is probable that the pits are temporally associated with the Juntunen Ware ceramics dated to AD 1300–1500. However, it is not impossible that they date to the early historic period as well. Several tribes of Michigan Indians, who had been displaced to Illinois and Indiana, were still utilizing cache pits to store corn as late as the 1820s (Morse 1822).

The Late Woodland occupations of Colonial Point, although indicating the long-term use of the area as agricultural land, are too early to have a direct bearing on the composition and structure of the current forest vegetation. No later prehistoric remains were encountered on Colonial Point. In general, village sites in northern Michigan post-dating AD 1500 were located on the shores of the Great Lakes, while the interior appears to have been largely abandoned (Feest and Feest 1978). During the early historic period, however, extensive movements of groups along the Inland Water Way (of which Burt Lake was a component) brought indigenous populations through the Colonial Point vicinity on at least a seasonal basis, although their occupation and use of the area remains undocumented.

C. Contact and Historic Period Occupation

Early Occupation of Colonial Point

During the period immediately preceding white settlement in the Burt Lake area, Colonial Point was the focus for the Cheboygan Band of Chippewa and Ottawa Indians. Occupation of Colonial Point by this band began ca. the mid-1830s and ended abruptly in October, 1900.

The earliest legal reference to the Cheboygan Band of Chippewa and Ottawa Indians comes from the Treaty of Washington, March 28, 1836. In this treaty, the Ottawa and Chippewa nations of Indians ceded to the United States a large tract of Michigan's Lower Peninsula extending north of the Grand River to Thunder Bay and the Straits, as well as most of the Upper Peninsula east of the Escanaba River (Royce 1899:756; Kappler 1972:450–56). From this cession, certain tracts were excepted and reserved for the use of specific tribes, including "One tract of 1,000 acres to be located by Chingassanoo or the Big Sail, on the Cheboigan [River]". At the time of the treaty, the village of Chingassanoo [alternately Chingassamo or Chingassamoo] was reported to be situated at the fork of the Cheboygan River (McDonell and Clark 1837), a reference presumably to the juncture of the Black River with the Cheboygan, just north of its outlet from Mullett Lake (Hinsdale 1931:9, 18), and the proposed reservation was to be located along the western bank of the Cheboygan River below the fork (Schoolcraft 1837). However, the actual location of Chingassanoo's village remains somewhat in doubt. Cartographic knowledge of the interior was limited, as evidenced by the near featureless maps of that era (cf. Schoolcraft 1837), and the earliest government land surveys of 1840 make no mention of a village currently or recently located in the vicinity of Mullett Lake or anywhere along the Cheboygan River (GLO 1840).

At the time of the 1836 Treaty of Washington, members of the Cheboygan band of Chippewa Indians were reported to be living "by the chase", that is, primarily dependent on hunting for their subsistence needs (Schoolcraft 1847-51, Vol. III:621-22). Yet, an earlier appraisal of Indian improvements deserving monetary compensation under the 1836 treaty had reported that the band "on the forks of the Chaboigan" had 30 acres of land under cultivation and an additional 25 acres of "improved" (i.e. cleared) land in fallow (McDonell and Clark 1837). These reports indicate that in the late 1830s, the Cheboygan band was following fairly traditional economic patterns combining hunting with a limited reliance on corn agriculture:

> "The Chippewa cultivate corn and potatoes to a limited extent, but devote most of their time in quest of food in the chase, or in fishing. They also manufacture sugar from the rock maple... This tribe exhibits no general improvement or advance in civilization [i.e. permanent field agriculture]....with few exceptions living in mat or bark lodges which are transported in their migrations" (ARCIA 1838, Senate (25–2) Document 1, p. 531).

Agricultural fields were frequently located at a considerable distance from the village. As a result, the coordination of hunting and agricultural activities led to a very mobile existence, structured by seasonal movements between sugaring sites in early spring, fields locations for planting in late spring and again in fall for the harvest, and favored summer and winter hunting territories (for contemporary accounts see Tanner 1956; Henry 1921).

The decade following the 1836 Treaty of Washington was one of major change for the Cheboygan band, as traditional and highly mobile economic patterns were replaced by more sedentary, agricultural pursuits. By 1840, the Cheboygan band, consisting of 13 families with a total population of 52 individuals under the leadership of a new chief, Ke-Shig-o-wa (Schoolcraft 1847-51, Vol. III:621-22), was clearly established at Colonial Point. Government land surveys report the presence of an Indian village on the western edge of the peninsula (in Section 29), as well as the locations of cleared fields planted in corn (GLO 1840). Other portions of the peninsula, however, were considered "old fields", that is, areas previously under cultivation which had been abandoned to return to forest. These recently abandoned fields indicate that the Cheboygan band had been utilizing Colonial Point for agricultural purposes for a period of at least 5 to 10 years prior to the survey date, or as early as 1830, even though their village may have been located elsewhere at the time.

By 1847, census returns indicate that the band had increased to 14 families and 61 members (Schoolcraft 1847–51, Vol. I:478–87), and that as of that date, all family heads were subsisting their families entirely by agriculture. A total of 350 acres were under cultivation (or approximately 25 acres per family), which yielded 1600 bushels of corn and 1000 bushels of potatoes. In addition, the band produced 18,000 pounds of maple sugar, and may have been involved in logging and carpentry activities, as well.

Between 1848 and 1850, deeds recorded with the Cheboygan County Register of Deeds indicate that the band of Chief Kie-She-go-way had purchased land on Colonial Point. Those lands purchased first included the southern half of Section 28 (containing the southern portion of the Colonial Point Forest) and the northwest quarter of adjacent Section 29 to the west, an area totalling approximately 375 acres. The land was purchased for cash and at the statutory price from the United States government under its general land laws; however, titles for the land were issued to the Governor of Michigan who was to hold these lands in trust for the Cheboygan band.

By 1855, the Cheboygan band had a well-established village on the peninsula, at that time called Indian Point, on the land which they had purchased in Section 29 (Fig. 11). The village contained about 20 dwellings and a church, under the guidance of a missionary preacher (GLO 1855, Vol. 83:150–151). An area roughly 95 acres in extent around the village was under cultivation, with additional outlying fields raising the total of cultivated lands to approximately 135 acres. However, most of the peninsular lands which had been under cultivation at the time of the 1840 survey, were by this date "old fields".

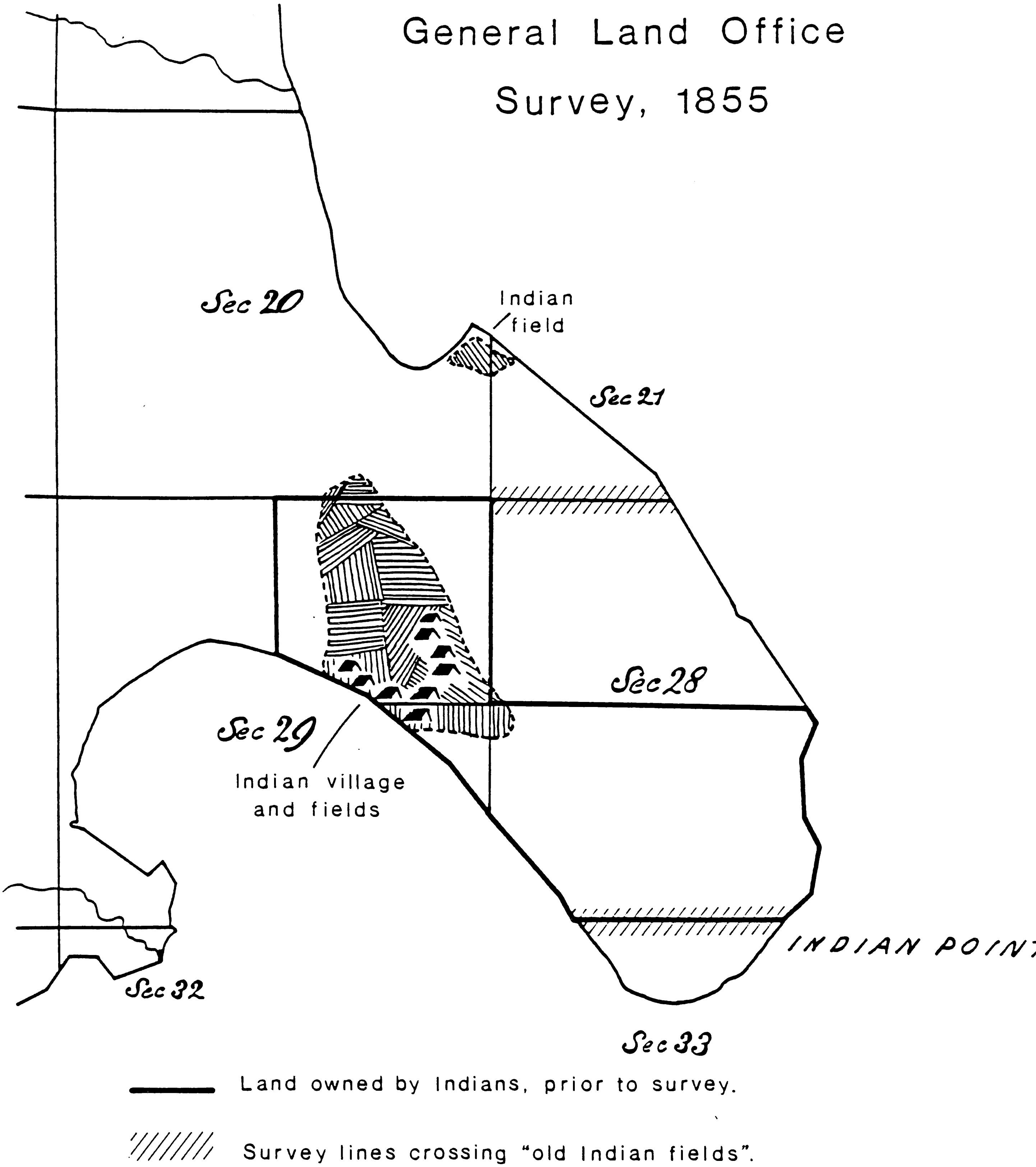
In 1855, the Treaty of Detroit granted additional lands to the Cheboygan band in final fulfillment of obligations set out in the 1836 Treaty. The two townships which encompass Burt Lake (Ts. 35 and 36 N., R. 3 W.) were set apart for the band as a reservation. From this area, each Indian family head was to select eighty acres of land, and each single person over twenty-one years of age, forty acres of land. These lands were granted in severality and were to be held in fee simple; that is, they were taxable, and could be bought and sold. The treaty was concluded and put into effect on September 10, 1856.

The Treaty of 1855 also specifically dissolved the tribal organization of the Ottawa and Chippewa, and, as an apparently unspecified consequence, voided the trusteeship of the Governor of Michigan for the Cheboygan band (United States of America vs. Shepard and Ramsey, Sept. 10, 1917). As a result, lands formerly held in trust by the Governor of Michigan for the band were considered to be held in severality by the Indians and thus were taxable.

Beginning in 1860, these lands were assessed for taxes; however, none of the assessed taxes were paid by the Indians, who were apparently unaware in the change in trusteeship or in the tax status of these lands. Ownership reverted to the state and the lands were made available for sale to Euroamerican settlers in the area. During the early 1880s, the lands belonging to the Cheboygan band were sold to a number of individuals, including Robert Patterson (Lots 3 and 4, Sec. 28), E. Z. Perkins (Lots 1 and 2, Sec. 29), and Charles H. Nuite (E 1/2 of NE 1/4, Sec. 29). However, the Cheboygan band continued to occupy their lands until 1900; it is therefore unlikely that these new owners actually took possession of the property, and in several cases, tax payments again lagged.

Between 1895 and 1899, John W. McGinn obtained the record title to much of the lands formerly held in trust for the Cheboygan band, and in 1898 he petitioned the Circuit Court for Cheboygan County for assistance in removing the Indians and in placing him in full possession of his lands. As a result of this petition, the Circuit Court commanded the Sheriff of Cheboygan County that:

Figure 11


General Land Office
Survey, 1855
Sec 20
Indian
field
Sec 21
Sec 28
Sec 29
Indian village
and fields
INDIAN POINT
Sec 32
Sec 33
Land owned by Indians, prior to survey.
Survey lines crossing "old Indian fields".

> "immediately after receiving this writ you go to and enter upon the lands and premises and that you eject and move therefrom all and every person or persons holding and detaining the same or any part thereof against the said petitioner and that you put the said petitioner or his assigns in the full peaceable and quiet possession of the lands and premises without delay..."

On the evening of October 15, 1900, Sheriff Fred Ming and John W. McGinn set fire to the Indians' village and church, and the Indians were forcibly removed.

Traditional and Early Historic Land Use

Given the rapid pace of acculturation during the contact period, it is difficult to determine precisely how late traditional agricultural practices continued to be employed by individual groups in northern Michigan. In 1820, L'Abre Croche, the primary Ottawa settlement at Cross Village and a model of Indian acculturation, was still using fairly traditional methods of cultivation: "They use the hoe only, in cultivating their lands, having no ploughs, oxen, cows, nor, but in a single instance, horses" (Morse 1822:24). However, plows became increasingly available after the 1820s with grants from the federal government and encouragement from missionaries, both of whom equated agricultural acculturation with progress toward true civilized life, and by 1838, the Superintendent of Indian Affairs reported that "Cattle, ploughs, axes, carts, etc. have been distributed to as great an extent as was thought they would be properly used" among the tribes of Michigan (ARCIA 1838, Senate (25-2) Document 1, p. 485).

In response to these external pressures, during the early 1840s the Ottawa of L'Abre Croche and Mackinac were among the first groups to practice permanent field agriculture and to subsist chiefly on the produce of their fields (Feest and Feest 1978:781). According to the report of the Superintendent of Indian Affairs for Michigan, "The Ottawas of Mackinac and its environs have advanced more in agriculture than any of the lake tribes; [they] cultivate corn, beans, pumpkins to some extent, annually; have fenced fields, and generally live in comfortable log houses. They make a considerable quantity of maple sugar, which, together with a limited crop of corn, is sold in the Mackinac market...In proportion as they have assumed the character of pseudo agriculturalists, they have neglected the chase..." (ARCIA 1838, Senate (25-2) Document 1, p. 531).

Other groups, including the Chippewa (among whom the Cheboygan Band were classed as of 1840), continued to pursue traditional economic patterns of mixed hunting and agriculture with a high degree of seasonal mobility. By the 1847 census, however, all members of the Cheboygan band were recorded as subsisting entirely by agriculture (with the connotation of permanent field agriculture), were growing introduced crops (including potatoes, oats, and turnips) in addition to corn, and had been provided with a large supply of agricultural implements, including one plow. Yet as late as 1855, government surveyor's notes for the Colonial Point area make it abundantly clear that the "Indian mode of Cultivation" had been employed within recent years of the survey date, indicating that traditional landing clearing and cultivation practices had not at that time been entirely replaced by plow agriculture (GLO 1855, Vol. 83:150–151).

The period after the 1855 survey brought accelerated change, as adjacent lands were put up for public sale and the Indians came into consistent contact with white settlers. By the 1860s, members of the Cheboygan Band were actively involved in township politics and were characterized as having "adopted the habits and customs of the civilized white people with whom they associated", including those of permanent field agriculture (United States vs. Shepard and Ramsey, June 1, 1917 and Sept. 17, 1917). It is therefore probable that the 1855 survey dates the terminus of traditional Indian agricultural practices in the vicinity of Colonial Point.

The Impact of Traditional Land Use Patterns

Our primary information source on the impact of land use on local vegetation during the early historic occupation comes from the General Land Office Surveys of the peninsula. Two surveys were made of the area. The first survey, conducted by James H. Mullett during the second quarter of 1840, laid out the townships and subdivided these into sections one square mile in size. The area was resurveyed by Harvey Mellen in the second quarter of 1855. At that time, previous section lines were checked and corrected if necessary, and the sections were further subdivided into quarter sections and lots, the units for public land sales.

In both surveys, the section lines were marked by blazing trees standing on the line and by setting section and quarter-section corner posts. At each corner, the surveyors further blazed two "bearing trees" to mark the location of the post, which were recorded in the survey notes by species, diameter, and location relative to the corner post.

In addition to laying out the sections and their subdivisions, the 1840 and 1855 surveys recorded detailed information on the quality of land surveyed along each line. Major vegetation types, whether upland forest or wetland, were noted and the major forest species were recorded in order of their prevalency (Bourdo 1956:758). Areas of disturbance, including tracts of windthrow, burnt land, beaver dam ponds, or cultivated fields were also noted and frequently mapped. These detailed notes provide an invaluable record of both the nature of disturbance events and their impact on forested stands by referencing the resultant vegetation.

The 1840 and 1855 surveys record the impact of traditional Indian agriculture on forest composition for several areas within the Colonial Point peninsula as these areas were crossed in the course of laying out section lines (Table 9). For example, the 1840 survey records that the north-south line between Sections 28 and 29 first passed through a mature stand of sugar maple and beech, before encountering Indian corn fields along the southern half of the line (GLO 1840). The quarter section post was set just within the field, and the line continued south through "improved fields" to the edge of the lake.

Fifteen years later, the survey along this section line crossed old fields "grown up to bushes". The quarter section post was re-set in a portion of the old field, using as bearing trees two 8" aspen. South of the quarter section post, no blazed trees were found and the old line could not be traced – a logical consequence of the fact that since the area had already been cleared and was under cultivation at the time of the 1840 survey, there were no trees still standing along the line which could have been blazed. In 1855, vegetation along this southern portion of the line consisted of "a small growth of Aspen, W. Birch, [Red] Maple, W. Pine, etc." (GLO 1855, Vol. 83: 142–43). In contrast, the vegetation along the line north of the old fields was described as "a large growth of Beech, Hemlock, Sugar [Maple], W. Pine, Lynn [i.e. basswood], [and] Elm", indicating a mature northern hardwoods forest.

Other portions of the peninsula had been cleared, cultivated, and then abandoned prior to the 1840 survey. For example, the east-west line between Sections 21 and 28 was characterized as recently abandoned "old fields" in 1840. In 1855, the succession of forest vegetation in these old fields was described as follows: "Timber mostly a small growth of Beech, Aspen, [Red] Maple, W. [Paper] Birch, etc. Some large Sugar [Maple] and Beech. Much of the Surface on this line has been cultivated by the Indians who have suffered it to become overgrown with bushes" (GLO 1855, Vol. 83:142).

Similarly, the east-west line between Sections 28 and 33 at the southern tip of the peninsula consisted entirely of fields which in 1840 had already been abandoned (GLO 1840). By 1855, these old fields had become "over run with bushes", and timber along the line consisted of "a small growth of Aspen, [Red] Maple, Beech, [and] Birch" (GLO 1855, Vol. 83:143). Bearing

Table 9

Colonial Point as Described by the General Land Office Surveys

Area Surveyed	Comments from 1840 Survey Field Notes (James H. Mullett)	Comments from 1855 Survey Field Notes (Harvey Mellen)
East-West Line Between Sections 20 and 29:	"Land except swamp rolling good 2nd rate - Beech, Sugar, Lynn, Hemlock, etc."	"Indian fields on East 1/2 mostly South of line."
North-South Line Between Sections 28 and 29:	Southern half of line in "Indian corn fields". "Set quarter section post in field." "Land mostly improved fields, good soil."	At mid-point enter "Old field grown up to bushes." "Set qr. Section Post in old field." "No old qr. Section Cor. to be found." Timber "a small growth of Aspen, W. Birch, Maple, W. Pine, etc."
East-West Line Between Sections 28 and 33:	"Land all old Fields, good soil."	"Timber mostly a small growth of Aspen, Maple, Beech, Birch. The land on this line has formerly been cultivated by the Indians who have suffered it to become over run with bushes."
East-West Line Between Sections 21 and 28:	"Land all old Fields, good soil."	"Timber mostly a small growth of Beech, Aspen, Maple, W. Birch, etc. Some large Sugar and Beech. Much of the Surface on this line has been cultivated by the Indians who have suffered it to become overgrown with bushes."
North-South Line Between Sections 20 and 21:	"Land etc. same." [follows preceeding entry]	"Traced old line." "Indian field" at northern end of line.
Section 29:	"Indian Village" approximately 40 chains (1/4 mile) west of eastern section line.	"The Indian Village is located on Section 29 and contains about 20 dwellings. They have a church and missionary preaching a part of the time."
General Description of Township:	"This Township is gently rolling. Soil is particularly good in the neighborhood of the Indian Village."	"The soil of Indian Point though formerly of good quality is at this time poor being nearly worn out by the Indian mode of Cultivation and the old fields have lately been suffered by them to become covered with bushes."

trees were early successional species, including two white pines, an aspen, a red maple, and a 6" red oak. This section line runs at approximately 400N on our reference grid, through an area dominated today by red oaks and large white pines.

In summarizing the quality of land in Burt Township in 1840, Mullett characterized the topography as gently rolling and the soil as good, especially in the neighborhood of the Indian Village. At the time of the second survey fifteen years later, Mellen described the condition of Colonial Point in rather more severe terms: "The Soil of Indian Point though formerly of good quality is at this time poor being nearly worn out by the Indian mode of Cultivation and the old fields have lately been suffered by them to become covered with bushes" (GLO 1855, Vol. 83:150–151).

The 1840 and 1855 surveys make several clear statements concerning the extent, timing, and impact of traditional Indian agricultural activities on Colonial Point. First, they indicate that much of the peninsula had been utilized for agriculture by 1855, although specific field locations were recorded only along section lines. The earliest field locations appear to have been along the eastern half of the peninsula, with field locations moving progressively further west through time. Fields cultivated and then abandoned prior to 1840 were encountered at the northeastern edge of the peninsula as well as along the southern tip, while fields under cultivation in 1840 were noted along the Section 28–29 line, which had in turn been abandoned in favor of new field locations adjacent to the village in Section 29 by 1855.

The surveys further temporally bracket the period of active field clearing and use between ca. 1830 and 1855. Fields abandoned just prior to the 1840 survey date were most likely cultivated for a period of less than ten years, suggesting an initial clearing date of ca. 1830. Similarly, all "old field" locations noted in 1855 had been abandoned sufficiently prior to that date for a bushy growth of early successional species to have become established. In old fields in the Colonial Point vicinity today, red oak obtains a brushy height in 10 years, while heights of 8–10' are attained in 20 years. These growth rates would suggest an establishment date 10 to 20 years prior to the 1855 survey.

Finally, the survey notes support the conclusion that fire was a major component of field preparation. The characterization of the soils as "worn out" is consistent with the release and subsequent loss of nutrients following fire, while the succession of "fire-related" species (aspen, paper birch, red maple, white pine, and red oak) in old field areas reflects disturbance in that form.

In summary, the years between the mid-1830s and 1855 comprise the period of settlement and active land clearing on Colonial Point using traditional Indian methods of slash-and-burn agriculture. Clearing activities apparently affected much of the peninsula, although specific field locations have been documented for only a small portion of this larger area. In these specific locations, the sequence of burning, cultivation, and then abandonment permitted the healthy establishment of early successional species, including paper birch, aspen, white pine and red oak.

For many of the areas currently dominated by red oak, the documentary evidence linking successful red oak establishment to traditional Indian agriculture is somewhat circumstantial. Two additional lines of evidence, however, support the documentary record. These are: (1) the fire history of red oak stands as determined from the abundance and genera of charcoal in the surface soils of these areas; and (2) the timing of red oak establishment relative to burning and historically documented episodes of land clearing and field use.

D. The Fire History of Red Oak Stands: The Charcoal Evidence

Five surface soil samples were collected from each vegetation plot located in red-oak dominated and northern hardwoods dominated areas to determine the fire history of these areas from the abundance of charcoal. All charcoal samples recovered were weighed and a sub-sample of each was identified to genus in order to determine the composition of the forest which had been burned prior to the establishment of the present forest stand.

Severity of Fire History

Charcoal was present in every corner sample of every plot in both the red-oak dominated areas and those in northern hardwoods. This background-level of charcoal throughout the peninsula suggests that the area has a long history of fire, consistent with its long history of occupation and agricultural land use. Some of the burning events represented probably occurred too far in the past to have had a direct effect on the establishment and distribution of existing forest types. If areas of the peninsula had been cleared with fire during the late prehistoric occupation (AD 1300–1500), disturbance species establishing after field abandonment would have been long since replaced by a beech-sugar maple forest through natural succession.

On the other hand, it is unlikely that the presence of charcoal on Colonial Point results from extensive recent fires, such as fire following cutting. All cutting within the Colonial Point Forest since the late 1800s (with the possible exception of the young oak stands in the northwestern and southwestern corners of the tract) appears to have been selective cutting which would not generate sufficient slash to spark natural burns. Nor would the slash have been intentionally burned, as the fire would damage younger and commercially valuable trees in the stand. Further, no evidence of burning was apparent on any of the cut stumps encountered within the stand.

Although some charcoal was recovered in all locations sampled, red-oak dominated areas yielded greater quantities of charcoal than did northern hardwoods areas (Table 10), indicating a more severe fire history in areas currently dominated by red oak. Red oak plots averaged a total weight of 88 grams of charcoal, while northern hardwoods plots averaged only 19 grams. Further, charcoal samples from red oak plots significantly out-weigh those from northern hardwoods plots for each size class of charcoal as well as in total weight (Table 11a). Differences in charcoal weight between red oak and northern hardwoods plots are significant at the .05 level.

Red oak plots also yielded more larger pieces of charcoal. Larger piece size would suggest a more recent burn, in that the charcoal has had less time to decompose or to be broken down by roots, freezing/thawing, or the activities of ground-burrowing rodents. On the average, in oak plots, half of the charcoal by weight falls in the size classes greater than 1/4" (Table 11b). In contrast, most of the charcoal from northern hardwoods plots is small, with an average of only 25% of the charcoal occurring in the larger size classes.

Within the oak-dominated areas, the greatest volume of charcoal was recovered from Plots 1 and 2 in the young oak stand. The late date of establishment for the young oak stand (ca. 1890–1900), suggests that the burn occurred at a time after traditional Indian agricultural practices had been replaced by plow agriculture, and can more probably be attributed to a slash fire following clearcutting of the stand.

Reconstructing Prior Forest Composition

Based on the genera of trees represented in the charcoal samples, it is possible to reconstruct the general composition of the forest at the time of the burn. In this study, the relative predominance of genera as represented in charcoal was utilized as a coarse measure of the relative dominance of forest species prior to burning (Table 12). This approach was based on the logic that since calculations of relative dominance are based on measures of basal area, they provide some crude volumetric measure of the amount of wood of any given species available to be

Table 10

WEIGHT AND SIZE DISTRIBUTION OF CHARCOAL
RECOVERED FROM RED OAK AND NORTHERN HARDWOODS PLOTS

Plot	< 1/8"		1/8 - 1/4"		1/4 - 1/2"		> 1/2"		Total Weight
	g.	%	g.	%	g.	%	g.	%	
Red-Oak Dominated Plots									
1	5.856	4.57	25.630	20.02	24.748	19.33	71.795	56.08	128.029
2	18.679	10.30	69.505	38.33	58.012	31.99	35.149	19.38	181.345
3	8.973	8.65	29.275	28.21	39.720	38.27	25.809	24.87	103.777
8	5.200	10.37	23.602	47.08	12.147	24.23	9.188	18.33	50.137
9	1.356	12.95	5.378	51.35	3.396	32.43	0.343	3.28	10.473
10	14.722	12.55	55.967	47.69	36.464	31.07	10.202	8.69	117.355
16	3.116	8.60	20.144	55.59	12.568	34.68	0.410	1.13	36.238
17	8.717	7.88	35.771	32.34	32.054	28.98	34.061	30.80	110.603
Mean	8.327	10.32	33.009	43.02	26.510	30.00	20.292	16.61	88.139

Table 10
(continued)

Plot	< 1/8"		1/8 – 1/4"		1/4 – 1/2"		> 1/2"		Total Weight
	g.	%	g.	%	g.	%	g.	%	
Northern Hardwoods Plots									
4	1.801	13.51	8.477	63.57	1.924	14.43	1.132	8.49	13.334
5	1.822	20.45	5.765	64.72	1.321	14.83	0.000	0.00	8.908
6	3.561	10.41	19.693	57.56	9.672	28.27	1.286	3.76	34.212
7	1.604	10.71	8.882	59.28	3.478	23.21	1.020	6.81	14.984
11	2.468	21.60	6.821	59.70	2.137	18.70	0.000	0.00	11.426
12	4.115	14.04	16.632	56.74	8.567	29.23	0.000	0.00	29.314
Mean	2.562	15.12	11.045	60.26	4.517	21.45	0.573	3.18	18.696

Table 11a

TWO-SAMPLE T-TESTS COMPARING CHARCOAL WEIGHT BY SIZE CLASS
FOR RED OAK AND NORTHERN HARDWOODS PLOTS

VARIABLE		OAK	HARDWOOD	TEST STATISTIC	DF	SIGNIF
CHAR.1	MEAN	8.3274	2.5618	T= 2.3592	12	.0361
< 1/8"	VAR	34.323	1.0926	F= 31.414	7,5	.0008
(TOTAL= 14)	N	8	6	PROB(1ST MEAN>2ND |DATA)=		.9851
CHAR.2	MEAN	33.009	11.045	T= 2.5158	12	.0271
1/8 - 1/4"	VAR	424.73	32.599	F= 13.029	7,5	.0061
(TOTAL= 14)	N	8	6	PROB(1ST MEAN>2ND |DATA)=		.9878
CHAR.3	MEAN	26.510	4.5165	T= 2.9110	12	.0131
1/4 - 1/2"	VAR	326.01	13.332	F= 24.453	7,5	.0014
(TOTAL= 14)	N	8	6	PROB(1ST MEAN>2ND |DATA)=		.9939
CHAR.4	MEAN	20.292	.57300	T= 1.9560	12	.0742
> 1/2"	VAR	597.08	.40113	F= 1488.5	7,5	.0000
(TOTAL= 14)	N	8	6	PROB(1ST MEAN>2ND |DATA)=		.9717
TOTAL	MEAN	88.139	18.696	T= 2.9281	12	.0126
WEIGHT	VAR	3228.1	108.94	F= 29.633	7,5	.0009
(TOTAL= 14)	N	8	6	PROB(1ST MEAN>2ND |DATA)=		.9942

Table 11b

TWO-SAMPLE T-TESTS COMPARING PERCENT CHARCOAL WEIGHT PER SIZE CLASS
FOR RED OAK AND NORTHERN HARDWOODS PLOTS

VARIABLE		OAK	HARDWOOD	TEST STATISTIC	DF	SIGNIF
CHAR.1%	MEAN	10.317	15.119	T=-2.2314	12	.0455
< 1/8"	VAR	10.661	23.180	F= 2.1742	5,7	.1699
(TOTAL= 14)	N	8	6	PROB(1ST MEAN<2ND |DATA)=		.9568
CHAR.2%	MEAN	43.022	60.261	T=-2.9347	12	.0125
1/8 - 1/4"	VAR	195.41	10.365	F= 18.853	7,5	.0026
(TOTAL= 14)	N	8	6	PROB(1ST MEAN<2ND |DATA)=		.9941
CHAR.3%	MEAN	30.001	21.445	T= 2.6240	12	.0222
1/4 - 1/2"	VAR	32.383	42.149	F= 1.3016	5,7	.3617
(TOTAL= 14)	N	8	6	PROB(1ST MEAN>2ND |DATA)=		.9772
CHAR.4%	MEAN	16.661	3.1760	T= 1.7391	12	.1076
> 1/2"	VAR	343.07	14.404	F= 23.818	7,5	.0015
(TOTAL= 14)	N	8	6	PROB(1ST MEAN>2ND |DATA)=		.9566
STANDARD	MEAN	25.919	4.0177	T= 2.7592	12	.0173
DEVIATION	VAR	366.06	5.9806	F= 61.209	7,5	.0002
(TOTAL= 14)	N	8	6	PROB(1ST MEAN>2ND |DATA)=		.9925

burned. Thus, we expect that, other things being equal, the relative dominance of a species should be reflected in the relative abundance of charcoal resulting from a burn.

There are a number of factors which may distort this proposed relationship, however, including possible differences in the rate and completeness of burning and the rate of charcoal disintegration due to differences in the structure and density of wood. For example, the major hardwood species of a northern hardwoods forest (beech, sugar maple, yellow birch, red oak and white ash) have similar weight densities, ranging between 42 and 45 lb. per cubic foot, and similar high ratings for hardness and shock resistance (Panshin and de Zeeuw 1970, Tables 12–1 and 12–2). We would therefore expect these species as a group to exhibit similar properties of both charcoal generation and charcoal decomposition. In contrast, the appropriately termed "softwoods", including red (soft) maple, the aspens, basswood, paper birch and pine, have substantially lower weight densities (25 to 38 lb. per cubic foot), and lower values for hardness and shock resistance. These structural properties are confirmed at the subjective level, in that beech, red oak, and (presumably sugar) maple charcoal generally occur as very hard pieces with well-defined surfaces and edges, while softer woods such as aspen and pine have rounded edges and are more fragile and hence more likely to disintegrate during analysis. It remains uncertain, however, whether and to what extent these structural differences have significantly altered the relative proportions of species represented in the charcoal record.

In addition to natural factors, the relationship between prior forest composition and charcoal may have been altered substantially by cultural factors if the fire was set through human actions. Human intervention potentially functioned as a "cultural filter" which selected for or against certain species of wood entering the charcoal record in direct proportion to their predominance in the forest stand according to their use value for other contexts. Thus, site selection of a burn was probably conditioned by considerations of the economic value of trees in their healthy, growing state, and may have avoided areas with high densities of sugar maple, for example, which were valued for the production of maple syrup. The relative proportions of species left to become charcoalized may also have been modified through the removal of some types of wood for other uses, such as for firewood and house construction, prior to burning the stand. As noted above, the major hardwood species have similar weight densities and thus similar fuel values (Panshin and de Zeeuw 1970:215). We would therefore not expect preferential removal of any one of these species, although as a group, they may be under-represented in charcoal samples. White pine was a preferred species for both lumber (in the historic period) and for kindling and may be similarly under-represented in *in situ* charcoalized remains of a forest stand.

Finally, any direct relationship between relative dominance of the prior stand and the relative predominance of species in the charcoal record may be obscured by a history of multiple burns. That is, if the charcoal record represents a composite record of multiple burns at different times and of forest stands of differing composition, then no clear relationship will be observed between the composition of the charcoal record and that of the immediately preceding forest stand. However, we suggest that such multiple burns may be evident from the dominance of difference species in different size classes of a charcoal sample (reflecting the greater degree of disintegration of the charcoal of one species due to the greater age of the charcoal) and from the apparent co-presence of species of distinctly different successional or ecological contexts.

In spite of these possible distorting factors, we assume that a sufficiently strong relationship exists between the relative dominance of a species and the relative abundance of its charcoal following a burn, that general statements concerning prior forest composition based on charcoal analyses are justified. Table 13 documents the *prevalence* (defined as the percent of corner samples containing a genus) and *predominance* (the percent of plot sample by weight) of charcoalized genera from plots in areas currently dominated by red-oak and northern hardwoods forest types.

Table 12
Relative Abundance (%) of Tree Genera by Weight in Charcoal Samples from Vegetation Plots

Plot	*Acer*	*Betula*	*Fagus*	*Fraxinus*	*Ostrya*	*Pinus*	*Populus*	*Prunus*	*Quercus*
Red-Oak Dominated Plots									
1	23.14	0.00	24.98	0.00	0.00	20.95	0.20	0.00	21.11
2	3.15	0.00	12.58	0.00	0.00	26.31	0.42	0.37	42.68
3	8.24	1.82	12.16	0.00	0.00	39.52	15.19	0.00	16.02
8	1.44	0.00	59.72	16.60	0.28	0.00	3.03	0.00	18.04
9	0.00	0.00	55.02	11.11	0.58	4.00	20.16	0.00	0.00
10	4.22	0.37	21.14	0.00	0.78	50.96	3.52	0.00	13.26
16	24.82	0.86	40.26	0.00	0.89	5.69	5.39	0.00	5.76
17	1.86	0.71	27.65	0.00	0.27	45.66	0.00	0.00	17.42
Northern Hardwoods Plots									
4	0.72	0.00	43.65	0.00	3.16	0.00	9.70	0.00	27.90
5	6.41	1.12	68.98	0.00	0.00	0.94	2.70	0.00	3.88
6	23.39	0.00	56.34	0.00	0.00	0.00	0.51	0.00	17.89
7	17.66	3.08	41.85	3.08	6.05	0.00	13.20	0.00	0.00
11	0.56	0.48	45.45	0.00	0.00	6.82	8.31	7.81	23.38
12	0.00	0.45	85.51	0.00	0.00	3.92	2.39	0.00	0.64

Table 13

Prevalence and Predominance of Tree Genera in Charcoal Samples
From Red-Oak Dominated and Northern Hardwoods Plots

Genera:	PREVALENCE (Percent of Corner Samples Containing Genus)			PREDOMINANCE (Average Percent of Plot Sample by Weight)		
	Red Oak Samples (N=40)	N. Hardwoods Samples (N=30)	All Samples (N=70)	Red Oak Plots (N=8)	N. Hardwoods Plots (N=6)	All Plots (N=14)
Acer	45.00	36.67	41.43	8.36	8.12	8.26
Betula	10.00	13.33	11.43	0.47	0.85	0.63
Fagus	85.00	96.67	90.00	31.69	56.96	42.52
Fraxinus	5.00	3.33	4.29	3.46	0.51	2.20
Ostrya	17.50	10.00	14.29	0.35	1.54	0.86
Pinus	65.00	26.67	48.57	24.14	1.95	14.63
Populus	27.50	40.00	32.86	5.99	6.14	6.05
Prunus	2.50	3.33	2.86	0.05	1.30	0.58
Quercus	50.00	43.33	47.14	16.79	12.28	14.86

The predominant genera encountered in the charcoal samples were *Fagus*, *Quercus*, *Pinus*, and *Acer*, with lesser quantities of *Betula*, *Fraxinus*, *Ostrya*, *Populus*, and *Prunus*. Of these, *Fagus*, *Quercus*, and *Pinus* were employed as the primary indicators of prior forest composition due to their unambiguous species identification. Less emphasis was placed on *Acer* and *Betula*, as these genera are not readily distinguished to species, and the constituent species represent distinct ecological and successional conditions (*Acer saccharum* vs. *Acer rubrum*, and *Betula alleghaniensis* vs. *Betula papyrifera*).

Fagus grandifolia was the most prevalent and the predominant species encountered in charcoal samples. Beech charcoal was present in 90% of the plot corner samples, with a relative abundance averaging 42% of all plots. Beech charcoal was slightly less prevalent in oak plots than in northern hardwoods plots (85% vs. 97%), as well as less abundant (32% vs. 57%). Beech charcoal was the most abundant genera in ten out of fourteen plots, including all of those plots currently dominated by northern hardwoods forest and three of those currently in the red oak stands. In these beech-dominated charcoal samples, the average relative abundance of *Fagus* charcoal (55%) is substantially higher than the relative dominance of beech trees in the overstory of the present northern hardwoods forest (12% to 43%, with an average of 30%).

Oak and pine were the next most prevalent and predominant species. Red oak charcoal is represented in 50% of the oak stand charcoal samples and in 43% of the northern hardwoods samples. Within the oak-dominated forests, plots within the young oak stand (#1, 2 and 3) show higher prevalence of red oak charcoal (present in 67% of the samples) than do samples from the oak plain (40%). The higher levels of oak charcoal in the young oak stand support the interpretation of this area as having stump-sprouted after clearcutting and/or burning a pre-existing oak stand. Overall, oak averaged 15% dominance of the charcoal samples (range 0–43%), with similar percentages for both oak dominated and northern hardwoods dominated plots (17% and 12%, respectively). Living overstory red oak in northern hardwoods plots averages 15% relative dominance, suggesting that prior to the wide-spread burning which occurred on the southern half of the peninsula, the prevalence of red oak was not substantially different than that in northern hardwoods at present.

Pine charcoal, ranging from 0 to 51% (mean 15%), dominated the samples from three plots, while oak predominated in only one. However, pine charcoal constituted a less consistent component of the charcoal samples. White pine is represented in 65% of samples from the oak plots, but in only 27% of those from northern hardwoods plots. This non-uniform distribution of pine charcoal throughout the peninsula is consistent with the present patchy distribution of pine in small, concentrated stands.

Acer charcoal occurs in less than half of the corner samples of both red-oak dominated and northern hardwoods plots, and averages only 8% of plot samples by weight. These low levels of *Acer* charcoal do not reflect the current levels of either sugar maple or red maple in the existing overstory. In the present forests, red maple and sugar maple combined represent an average overstory dominance of 26% in the oak plots and 49% in the northern hardwoods plots. The apparent under-representation of maple in the charcoal samples may indicate either a higher dominance of beech in the prior stand, or an avoidance of sugar-maple dominated areas in the selection of agricultural field sites. Neither explanation seems entirely adequate.

In contrast with *Acer*, *Populus* appears to be more prevalent in the charcoal samples than in the current forest stands. *Populus* (probably *P. grandidentata*), occurs in 27% of oak plot charcoal samples and in 40% of those from northern hardwoods, and averages 6% of plot samples by weight. In the present overstory vegetation, however, bigtooth aspen was encountered in only one plot, for an average relative dominance of 1.45%. The wide-spread occurrence of aspen charcoal, as well as that of pine, in areas with little or no overstory representation of these fire-related species, may indicate earlier episodes of fire-disturbance.

Based on the relative abundance of genera in the charcoal samples, beech was the predominant overstory species for much of the upland forests of Colonial Point prior to burning. Red oak were present throughout the area in low numbers, while white pine occurred, as today, with a more patchy distribution. Other prevalent genera included maple, poplar, and birch. All of those areas sampled which currently support a northern hardwoods forest were formerly dominated by beech, as were four of the red oak plots. In contrast, the remaining four oak plots (including those from the young oak stand) indicated previous dominance by pine and red oak.

In summary, the areas currently dominated by red oak appear to have had a more severe and more recent fire history than the northern hardwoods dominated areas. Red oak stands yielded both larger volumes and generally larger pieces of charcoal than did plots in the northern hardwoods. Within the oak plain, the prevalence of beech charcoal indicates that at the time of the burn, this area was dominated by a northern hardwoods forest and that the current stand of red oak established after the burn. In contrast, the young oak stand shows a higher prevalence of oak charcoal, indicating that the most recent burn affected an existing red oak stand, and that the burned oak stump-sprouted, generating the high levels of multiple-stems present in the stand today.

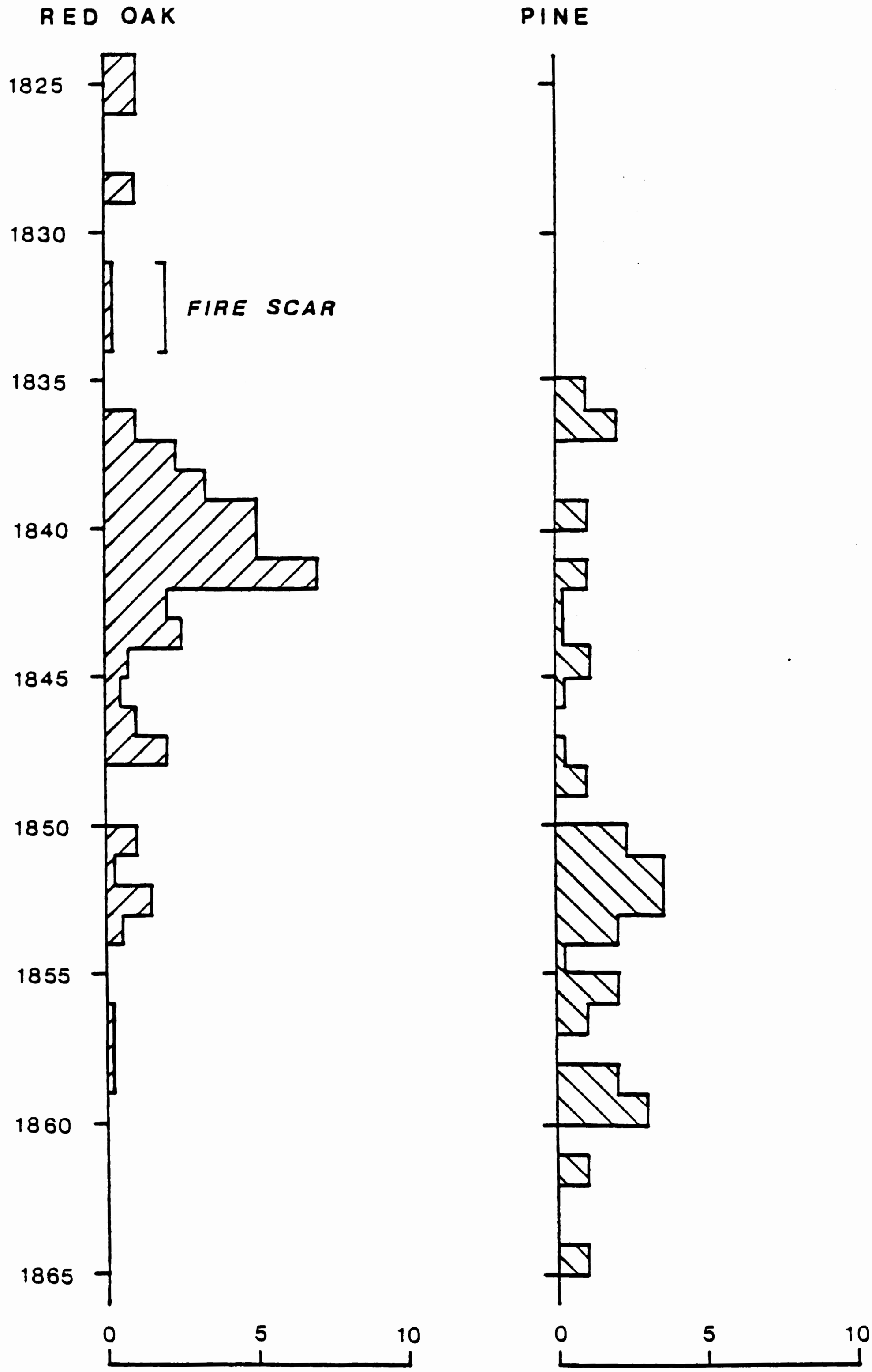
E. Fire History and Dates of Establishment for Red Oak

One of the specific "old field" locations recorded by the early land surveys occurs along the line between Sections 28 and 33 at the southern tip of the peninsula. In 1840, the land along this line consisted of recently abandoned corn fields, which by 1855 had become overrun with bushes and a small growth of early successional species. Today this section line marks the property boundary between the Colonial Point Forest and the Cochran property to the south. Fairly intensive recent cutting on the Cochran property enabled us to determine establishment dates for 46 red oak and 26 pine within the historically documented "old Indian field" (Cores #42–122).

Tree ages within this area bracket a very brief period of establishment following a burn (Fig. 12). The oldest tree dated (Core #61) established ca. 1817 and shows a fire scar at age 16. This burn event dates to the year 1833 and corresponds to the period in which traditional agricultural practices of land-clearing and cultivation were still utilized by the Cheboygan band. Immediately following the date of the burn, there was no red oak establishment and little white pine establishment for several years. Most of the red oaks established around 1840, while white pine appears to have seeded in later, generally after 1850.

The preceding sequence of events indicates that this area was originally cleared and burned in the early 1830s. Following the burn, the area appears to have been cultivated and tree seedling establishment (including that of red oak) discouraged as weedy growth for a period of several years. By the time of the initial land survey in 1840, the field had been abandoned. Red oak and white pine establishment was rapid following this date, and by the time the section line was re-surveyed in 1855, these early successional species had established a healthy stand of brushy height. When the area was cut in 1982, the stand was one of mature red oak with patches of white pine, similar in size, age, and stand composition to those red oak and white pine stands still existing in the southern portion of the Colonial Point Forest.

Figure 12



Establishment Dates for Red Oak and White Pine on the Cochran Property.

CONCLUSIONS

The physical characteristics, stand composition, and disturbance history of Colonial Point were investigated to determine those factors responsible for the establishment and distribution of the Colonial Point red oak stands. Drainage conditions only partially explain red oak distribution. Red oak does not become a dominant species where drainage conditions are poor to somewhat poor. On the other hand, red oak does predominate on sites with drainage class ranging from moderately well drained to well drained. However, red oak is also found on a broad range of soil textures, from sand to sandy clay loam. Thus, it appears that soil texture in itself is not important in determining the location of sites dominated by red oak.

Red oak requires disturbance for establishment. Within Colonial Point Forest, red oak is not presently regenerating except on open sites, such as in old fields and along road edges. In the past, similar large openings in the canopy could have been created by a major windthrow. However, windthrow disturbance does not appear to be responsible for the past widespread establishment of red oak. Mature red oak predominates in areas with low to medium windthrow, and no signs of widespread recent windthrow (within the past 150 years) are visible in red-oak dominated areas.

Fire appears to have been the major factor which created openings for red oak establishment. Plots located in red-oak dominated areas were characterized by high levels of charcoal. Much of the charcoal was that of beech and sugar maple, indicating a conversion of northern hardwoods to forests dominated by red oak after fire.

Two main episodes of burning can be documented for Colonial Point. Clearcutting of existing red oak stands by European settlers in the late 1800s to early 1900s resulted in the successful stump sprouting of the oak forests, generating the small multi-stemmed red-oak dominated stands in the southwestern and northwestern corners of the tract. However, historical documents on land use in the 1840s and 1850s, verified by the timing of red oak establishment, indicate that the traditional Indian agricultural practice of burning to clear fields gave rise to the red oak stands which dominate much of Colonial Point today.

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Appendices

Appendix I

DATES OF ESTABLISHMENT FROM INCREMENT CORES AND CUT STUMPS

#	Species[1]	Location	Source[2]	Diameter	Last Year of Growth	Age at Termination	Est. Age at Core/Cut Ht.	Probable Date of Establishment	Fire Scar
1	Oak	1750N/1800E	DS core	32.5" @ 4.0′	ca. 1985	ca. 120	8	1858	
2	Hemlock	1750N/1775E	WT core	26.0" @ 4.0′	1985	167	ca. 10	1808	
3	Hemlock	1750N/1725E	CS count	32.0"	ca. 1978	ca. 210	ca. 5	1763	
4	Oak	1590N/2066E	CS count	51.5" @ 1.0′	1984	143	2	1839	
5	Oak	1552N/2238E	LD core	24.8" @ 4.0′	1985	ca. 143	8	1834	
6	Oak D	1342N/2480E	LD core	22.4" @ 4.0′	1985	ca. 142	8	1835	
7	Oak	1350N/2287E	CS count	23.0" @ 1.5′	ca. 1976-81	135	2	1839-44	
8	Pine	1204N/2102E	WT core	22.8" @ 4.0′	1985	ca. 133	6	1846	
10	Pine	1184N/2182E	WT core	29.0" @ 4.0′	1985	126-130	6	1853-57	
12	Oak	1182N/1987E	CS count		ca. 1975-81	126	2	1850	
15	Pine	1145N/2666E	WT core	22.5" @ 4.0′	1985	ca. 140	6	1839	
17	Oak	804N/2703E	CS count	20.0" @ 1.0′	1984	128	2	1854	
18	Pine	399N/2590E	WT/CS count	31.5" @ 2.0′	1985	125	4	1856	
19	Pine	402N/2590E	WT/CS count	26.0" @ 1.0′	1985	118	3	1864	
20	Pine	398N/2571E	WT/CS core	31.5" @ 14′	1985	132	ca. 14	1839	
21	Pine	399N/2551E	WT/CS count	43.0" @ 4.0′	1985	137	ca. 12	1836	
22	Pine	368N/2527E	WT/CS count	23.0" @ 2.0′	1985	122	4	1859	
23	Pine	369N/2535E	CS core	34.0" @ 2.0′	1985	133	4	1848	
24	Oak	1020N/2225E	WT core	18.0" @ 4.0′	ca. 1980-85	ca. 108	8	1864-69	
25	Oak	1010N/2275E	WT core	24.2" @ 4.0′	1985	120	8	1857	
26	Oak	1607N/2038E	CS count	37.5" @ 1.0′	1984	143	2	1839	
27	Oak	1496N/2054E	CS count	40.0" @ 1.0′	1984	139-140	2	1843-44	
28	Oak	944N/2159E	LD core	40.0" @ 1.0′	1985	122	2	1861	
29	Pine	928N/2136E	WT/LD core	21.0" @ 4.0′	1985	122	6	1857	
30	S. Maple	940N/2191E	CS count	15.0" @ 1.5′	1984	ca. 120	4	1860	

Appendix I
(continued)

#	Species[1]	Location	Source[2]	Diameter	Last Year of Growth	Age at Termination	Est. Age at Core/Cut Ht.	Probable Date of Establishment	Fire Scar
31	Oak	1040N/2285E	CS count	24.0" @ 1.5′	1980-85	102	3	1875-1880	
32	Oak	1030N/2287E	CS count	26.5" @ 1.5′	1984	140	3	1841	
33	Oak	934N/2334E	LD core	19.0" @ 4.0′	1985	131	8	1846	
36	Oak	951N/2157E	LD core	4.0′	1985	132	8	1845	
39	Oak	747N/2547E	LD core	26.0" @ 4.0′	1985	ca. 150	8	1827	
40	Oak	547N/2427E	DS core	24.0" @ 4.0′	ca. 1980-84	136	8	1836-40	
42	Pine	347N/2373E	CS core	28.0" @ 2.0′	1982	135	4	1842-45	1875-78
43	Pine	383N/2380E	CS count	25.0" @ 1.0′	1982	126-129	3	1853-56	
44	Pine	383N/2378E	CS count	27.0" @ 1.0′	1982	127	3	1852	
45	Pine	371N/2347E	CS core	29.0" @ 1.5′	1982	135	3	1844	
46	Pine	370N/2335E	CS count	27.0" @ 1.0′	1982	126	3	1853	
47	Pine	380N/2321E	CS core	30.0" @ 2.0′	1982	135	4	1841	
48	Ash	335N/2350E	CS count	24.0" @ 5.5′	1982	128	7	1847	
49	Pine	376N/2388E	CS count	31.0" @ 1.5′	1982	ca. 124	3	1855	
50	Pine	381N/2400E	CS core	25.5" @ 1.5′	1982	144	3	1835	
51	S. Maple	394N/2394E	CS core	22.0" @ 4.0′	1982	ca. 90	10	1882	
52	Ash	391N/2381E	CS count	30.0" @ 1.5′	1982	138-140	3	1841-1843	
53	Pine	380N/2420E	CS count	40.0" @ 2.0′	1982	128-130	4	1850-1852	
54	Pine	390N/2429E	CS count	33.0" @ 1.0′	1982	127	3	1852	
55	Oak	397N/2455E	CS count	39.0" @ 1.0′	1982	ca. 150	4	1828	
56	Oak D	355N/2475E	CS count	29.5" @ 1.5′	1982	136-140	3	1843-47	
57	Ash	371N/2464E	CS count	23.0" @ 1.0′	1982	143	2	1837	
58	Oak	333N/2475E	CS count	28.0" @ 1.5′	1982	135-138	3	1844-47	
59	Oak	334N/2482E	CS count	53.0" @ 1.5′	1982				1883
60	Oak	349N/2482E	CS count	34.0" @ 1.5′	1982	142	3	1837	
61	Oak	373N/2499E	CS count	44.0" @ 2.5′	1982	162-164	5	1815-17	1831-33

Appendix I
(continued)

#	Species[1]	Location	Source[2]	Diameter	Last Year of Growth	Age at Termination	Est. Age at Core/Cut Ht.	Probable Date of Establishment	Fire Scar
62	Oak D	392N/2474E	CS count	32.0" @ 2.5′	1982	136	5	1841	
63	Oak	384N/2484E	CS count	33.0" @ 2.0′	1982	139	4	1839	
64	Oak	387N/2488E	CS count	31.0" @ 2.0′	1982	141	4	1837	
65	Oak	382N/2493E	CS count	27.0" @ 1.0′	1982	142	2	1839	
66	Oak	377N/2496E	CS count	40.0" @ 1.5′	1982	138	3	1841	
67	Oak	378N/2500E	CS count	26.0" @ 1.5′	1982	143	3	1836	
68	Oak D	370N/2518E	CS count	57.0" @ 1.0′	1982	149-151	2	1831-33	
69	Oak	346N/2478E	CS count	24.0" @ 1.0′	1982	140	2	1840	
71	Pine	391N/2411E	LD core	28.5" @ 4.0′	1985	ca. 127	6	1852	
76	Pine	402N/2571E	CS core	12.0" @ 1.0′	1982	124	3	1855	
77	Pine	346N/2321E	CS core	26.0" @ 1.0′	1982	128	3	1851	
78	Pine	382N/2316E	CS core	24.0" @ 1.0′	1982	128	3	1851	
79	Pine	393N/2316E	CS core	30.0" @ 1.5′	1982	129	3	1850	
80	Pine	391N/2310E	CS core	27.5" @ 1.0′	1982	120	3	1859	
82a	Oak D	377N/2243E	CS count	31.0" @ 20′	1982	135	4	1843	
82b					1982	139	4	1847	
83	Oak	379N/2243E	CS count	22.0" @ 1.0′	1982	134-135	2	1846-47	
85	Oak	365N/2230E	CS count	30.0" @ 1.0′	1982	143-145	2	1837-39	
86	Oak	339N/2257E	CS count	1.0′	1982	139	2	1841	
87	Oak	339N/2256E	CS count	1.0′	1982	139-140	2	1841-42	
88	Red Pine	362N/2256E	CS core	23.5" @ 1.0′	1982	121	2	1861	
89	Oak T	355N/2245E	CS count	43.0" @ 1.5′	1982	141-142	3	1838-39	
90a	Oak T	350N/2231E	CS count	38.0" @ 1.0′	1982	140	2	1840	
90b					1982	139	2	1841	
90c					1982	124-126	2	1856-58	
91a	Oak T	343N/2232E	CS count	44.0" @ 1.0′	1982	141	3	1838	
91b					1982	128-31	3	1851-54	
91c					1982	139-140	3	1840-41	

Appendix I
(continued)

#	Species[1]	Location	Source[2]	Diameter	Last Year of Growth	Age at Termination	Est. Age at Core/Cut Ht.	Probable Date of Establishment	Fire Scar
92	Oak D	338N/2242E	CS count	40.0" @ 2.0'	1982	153	4	1825	
94	Oak	385N/2226E	CS count	20.0" @ 1.0'	1982	128-130	2	1852-54	
95	Oak D	383N/2218E	CS count	48.0" @ 1.5'	1982	155	3	1824	
96	Oak	398N/2215E	CS count	23.0" @ 1.0'	1982	136	3	1843	
97	Oak	389N/2237E	CS count	21.0" @ 1.0'	1982	130	2	1850	
99	Oak	317N/2256E	CS count	34.0" @ 1.0'	1982	137	2	1843	
100a 100b	Oak D	311N/2256E	CS count	31.0" @ 1.0'	1982 1982	139 140-141	2 2	1841 1839-40	
101	Oak	306N/2252E	CS count	28.0" @ 1.0'	1982	141	2	1839	
103	Oak	282N/2253E	CS count	24.0" @ 1.0'	1982	139	2	1841	
104	Oak	302N/2234E	CS count	33.0" @ 1.5'	1982	141	3	1838	
105a 105b	Oak D	288N/2233E	CS count	29.0" @ 1.0'	1982 1982	138 128	2 2	1842 1852	
106	Oak	286N/2230E	CS count	23.0" @ 1.0'	1982	127	2	1853	
107	Oak	286N/2224E	CS count	31.0" @ 2.0'	1982	140-141	4	1838-39	
108	Oak	303N/2281E	CS count	20.0" @ 4.0'	1982	135	7	1840	
109	Oak	300N/2277E	CS count	27.0" @ 1.0'	1982	138-140	2	1842-44	
110	Pine	339N/2255E	CS core	10.5" @ .75'	1982	129	2	1851	
113	Pine	278N/2192E	CS core	28.0" @ 1.5'	1982	128	4	1850	
114	Pine	303N/2180E	CS core	26.0" @ 1.5'	1982	120	3	1859	
115	Pine	295N/2164E	CS core	25.0" @ 1.0'	1982	121	3	1858	
116	Oak	305N/2201E	CS count	25.0" @ 1.0'	1982	97	2	1883	
117	Pine	313N/2193E	WT/CS core	25.0" @ 1.5'	1982	101	3	1878	
118	Pine	315N/2185E	CS core	21.0" @ 1.0'	1982	101	3	1878	
119	Oak	310N/2142E	CS count	32.0" @ 1.0'	1982	140	2	1840	
120	Pine	321N/2140E	CS core	27.0" @ 1.5'	1982	143	3	1836	
121	Red Pine	319N/2139E	CS core	18.0" @ 1.0'	1982	126	3	1853	

Appendix I
(continued)

#	Species[1]	Location	Source[2]	Diameter	Last Year of Growth	Age at Termination	Est. Age at Core/Cut Ht.	Probable Date of Establishment	Fire Scar
122	Pine	317N/2128E	CS core	25.0" @ 1.5'	1982	121	3	1858	
123	Oak	1626N/1652E	CS count	26.0" @ 2.0'	ca. 1978	87-88	4	1887-88	
124	Oak	1355N/1975E	DS core	15.5" @ 4.0'	1984-85	114	8	1862-63	
125	Pine	1348N/1921E	LD core	16.1" @ 4.0'	1985	134	6	1845	
126	Pine	1345N/1921E	LD core	12.0" @ 4.0'	1985	113	6	1866	
127	Oak	756N/1953E	DS core	9.1" @ 4.0'	ca. 1983-84	86	8	1889-90	
128	Oak	762N/1920E	DS core	24.2" @ 4.0'	ca. 1983-84	135	8	1840-41	
130a	Oak Q	742N/1875E	CS count	11.0" @ 1.0'	1978	75-76	2	1901-02	
130b					1978	75	2	1901	
131	Oak	940N/1895E	CS count	22.0" @ 1.0'	1978	78	2	1898	
132	Oak	940N/1970E	CS count	31.0" @ 1.0'	1978	135	2	1841	
133	Oak	940N/1990E	CS count	23.0" @ 1.0'	1978	ca. 93	3	1882	
134	Oak D	952N/1990E	CS count	22.0" @ 1.0'	1978	133	2	1843	
135	Oak	666N/2462E	DS core	19.2" @ 4.0'	1984-85	143	8	1833-34	
136	Oak	865N/2476E	DS core	20.9" @ 4.0'	1984-85	120	8	1856-57	
137	Oak	1449N/2232E	DS core	18.5" @ 4.0'	ca. 1983-85	130	8	1845-47	
138	Pine	1207N/2525E	WT core	19.9" @ 4.0'	1985	ca. 141	6	ca. 1838	
140	Pine	1279N/2483E	WT core	14.5" @ 4.0'	1985	106	6	1873	
142	Oak	1207N/2181E	DS core	26.2" @ 4.0'	1984-85	127	8	1847	
143	Oak	1504N/2059E	CS count	10.0" @ 4.0'	ca. 1980	126	8	1846	
144	Oak	1440N/2410E	DS core	33.7" @ 4.0'	ca. 1983	127	8	1848	
145	Oak	1950N/2180E	DS core	35.7" @ 4.0'	ca. 1984	128	8	1848	
146	Oak	1970N/2150E	DS core	28.5" @ 4.0'	1984-85	ca. 145	8	1832	
148	Oak	1985N/2135E	DS core	21.3" @ 4.0'	ca. 1984	138-142	8	1834-38	
200	Oak	1850N/1683E	CS count	2.0'" @ 1.0'	1978	73-76	2	1900-03	
201	Oak	1860N/1675E	CS count	18.0" @ 1.0'	1978	76	2	1900	

Appendix I
(continued)

#	Species[1]	Location	Source[2]	Diameter	Last Year of Growth	Age at Termination	Est. Age at Core/Cut Ht.	Probable Date of Establishment	Fire Scar
202	Oak	1822N/1666E	CS count	22.0" @ 1.0′	1978	106	2	1890	
203	Oak	1808N/1678E	CS count	20.0" @ 1.5′	1978	76	3	1899	
204	Oak	1968N/1710E	CS count	22.0" @ 1.0′	1978	106-108	2	1888-90	1900-02
205	Oak	1875N/1717E	CS count	24.0" @ 2.5′	1978	118	5	1855	1890

(1) D = double-trunk; T = triple-trunk; Q = quintuple-trunk

(2) CS - Cut Stump
DS - Dead Standing
LD - Live, but Diseased
core - count of annual rings from increment core
count - count of annual rings from stump

Appendix II. Index of Map Units for Advance Copy of Cheboygan Co. Soil Survey.

Mapping Symbol	Soil Name
2	Lupton muck
5	Loxley peat
6	Cathro muck
7	Rondeau muck
8	Tawas muck
9	Greenwood peat
10	Dawson peat
11B	Kalkaska sand, 0 to 6 percent slopes
11C	Kalkaska sand, 6 to 12 percent slopes
11D	Kalkaska sand, 12 to 30 percent slopes
11F	Kalkaska sand, 30 to 50 percent slopes
12B	Grayling sand, 0 to 8 percent slopes
13B	Rubicon sand, 0 to 6 percent slopes
13C	Rubicon sand, 6 to 12 percent slopes
13D	Rubicon sand, 12 to 30 percent slopes
13F	Rubicon sand, 30 to 60 percent slopes
14B	Melita sand, 0 to 6 percent slopes
15C	Alpena gravelly loamy sand, 3 to 12 percent slopes
15D	Alpena gravelly loamy sand, 12 to 30 percent slopes
16B	East Lake sand, 0 to 6 percent slopes
16C	East Lake sand, 6 to 12 percent slopes
16D	East Lake sand, 12 to 30 percent slopes
16F	East Lake sand, 30 to 50 percent slopes
17B	Wallace sand, 0 to 6 percent slopes
17D	Wallace sand, 6 to 18 percent slopes

Mapping Symbol	Soil Name
17E	Wallace sand, 18 to 30 percent slopes
18B	Blue Lake loamy sand, 0 to 6 percent slopes
18C	Blue Lake loamy sand, 6 to 12 percent slopes
18D	Blue Lake loamy sand, 12 to 30 percent slopes
18F	Blue Lake loamy sand, 30 to 50 percent slopes
20B	Mancelona sand, 0 to 6 percent slopes
20C	Mancelona sand, 6 to 12 percent slopes
20D	Mancelona sand, 12 to 30 percent slopes
20F	Mancelona sand, 30 to 50 percent slopes
21B	Zimmerman fine sand, 0 to 6 percent slopes
21C	Zimmerman fine sand, 6 to 12 percent slopes
21D	Zimmerman fine sand, 12 to 30 percent slopes
22B	Leelanau loamy sand, 0 to 6 percent slopes
22C	Leelanau loamy sand, 6 to 12 percent slopes
22D	Leelanau loamy sand, 12 to 30 percent slopes
23B	Menominee loamy sand, 0 to 6 percent slopes
23C	Menominee loamy sand, 6 to 12 percent slopes
24B	Ocqueoc fine sand, 0 to 6 percent slopes
24C	Ocqueoc fine sand, 6 to 12 percent slopes
24D	Ocqueoc fine sand, 12 to 30 percent slopes
25B	Eastport sand, 0 to 6 percent slopes
25D	Eastport sand, 12 to 25 percent slopes
26B	Rubicon sand, dark subsoil, 0 to 6 percent slopes
26C	Rubicon sand, dark subsoil, 6 to 12 percent slopes
26D	Rubicon sand, dark subsoil, 12 to 30 percent slopes

Mapping Symbol	Soil Name
27B	Cheboygan loamy sand, 0 to 6 percent slopes
27C	Cheboygan loamy sand, 6 to 12 percent slopes
27D	Cheboygan loamy sand, 12 to 30 percent slopes
27F	Cheboygan loamy sand, 30 to 50 percent slopes
29B	Fairport fine sandy loam, 1 to 8 percent slopes
29C	Fairport fine sandy loam, 8 to 25 percent slopes
30B	Rousseau fine sand, 0 to 6 percent slopes
30C	Rousseau fine sand, 6 to 12 percent slopes
30D	Rousseau fine sand, 12 to 30 percent slopes
31B	Nadeau very gravelly loam sand, 1 to 9 percent slopes
32B	Rubicon sand, banded substratum, 0 to 6 percent slopes
32C	Rubicon sand, banded substratum, 6 to 12 percent slopes
32D	Rubicon sand, banded substratum, 12 to 30 percent slopes
33B2	Nunica silt loam, 2 to 6 percent slopes, eroded
33C2	Nunica silt loam, 6 to 18 percent slopes, eroded
34B	Bohemian Variant loamy very fine sand, 0 to 6 percent slopes
34C	Bohemian Variant loamy very fine sand, 6 to 12 percent slopes
34D	Bohemian Variant loamy very fine sand, 12 to 20 percent slopes
34E	Bohemian Variant loamy very fine sand, 20 to 50 percent slopes
37B	Emmet sandy loam, 0 to 6 percent slopes

Mapping Symbol	Soil Name
36B	Dryburg fine sandy loam, 0 to 6 percent slopes
36C	Dryburg fine sandy loam, 6 to 12 percent slopes
37C	Emmet sandy loam, 6 to 12 percent slopes
37D	Emmet sandy loam, 12 to 18 percent slopes
37E	Emmet sandy loam, 18 to 25 percent slopes
38B	Onaway loam, 1 to 6 percent slopes
38C	Onaway loam, 6 to 12 percent slopes
38D	Onaway loam, 12 to 18 percent slopes
38E	Onaway loam, 18 to 25 percent slopes
38F	Onaway loam, 25 to 50 percent slopes
39B	Nester loam, 2 to 6 percent slopes
39C	Nester loam, 6 to 15 percent slopes
39E	Nester loam, 15 to 35 percent slopes
40B	Ontonagon silt loam, 0 to 4 percent slopes
40C	Ontonagon silt loam, 4 to 12 percent slopes
40D2	Ontonagon silt loam, 12 to 25 percent slopes, eroded
41A	AuGres sand, 0 to 3 percent slopes
43A	Gladwin Variant sand, 0 to 3 percent slopes
44A	Wainola fine sand, 0 to 3 percent slopes
45B	Croswell sand, 1 to 4 percent slopes
46A	Iosco sand, 0 to 3 perecent slopes
47A	Ingalls loamy sand, 0 to 3 percent slopes
48A	Allendale sand, 0 to 3 percent slopes
49A	Finch sand, 0 to 3 percent slopes

Appendix II, Continued

Mapping Symbol	Soil Name
50A	Sundell loamy fine sand, 0 to 3 percent slopes
51A	Otisco sand, 0 to 3 percent slopes
53A	Bowers silt loam, 0 to 3 percent slopes
55A	Solona sandy loam, 0 to 3 percent slopes
56A	Charlevoix loamy sand, 0 to 3 percent slopes
57A	Brimley very fine sandy loam, 0 to 3 percent slopes
60A	Rudyard loam, 0 to 3 percent slopes
61	Roscommon muck
63	Brevort mucky loamy sand
64	Burleigh mucky sand
65	Pinconning mucky loamy sand
66	Pinconning mucky loamy sand
67	Kinross mucky sand
70B	AuGres-Roscommon complex, 1 to 4 percent slopes
71	Bowstring muck
72	Aquents, ponded
73	Fluvaqents and Histosols, frequently flooded
74	Munuscong fine sandy loam
75	Hettinger silt loam
76	Ensley sandy loam
77	Bruce Variant fine sandy loam
78	Angelica mucky sandy loam
79	Charity loam
80	Charity loam
81	Udipsamments, nearly level to hilly

Mapping Symbol	Soil Name
82	Udorthents
83	Pits, gravel
84	Pits, quarry
85	Histosols and Aquents, ponded
87	Beaches
88	Dumps,sawdust
141A	Finch cobbly sand, 0 to 3 percent slopes
158A	Detour cobbly loam, 0 to 3 percent slopes
163	Brevort cobbly mucky loamy sand
178	Hessel mucky loam

Appendix III

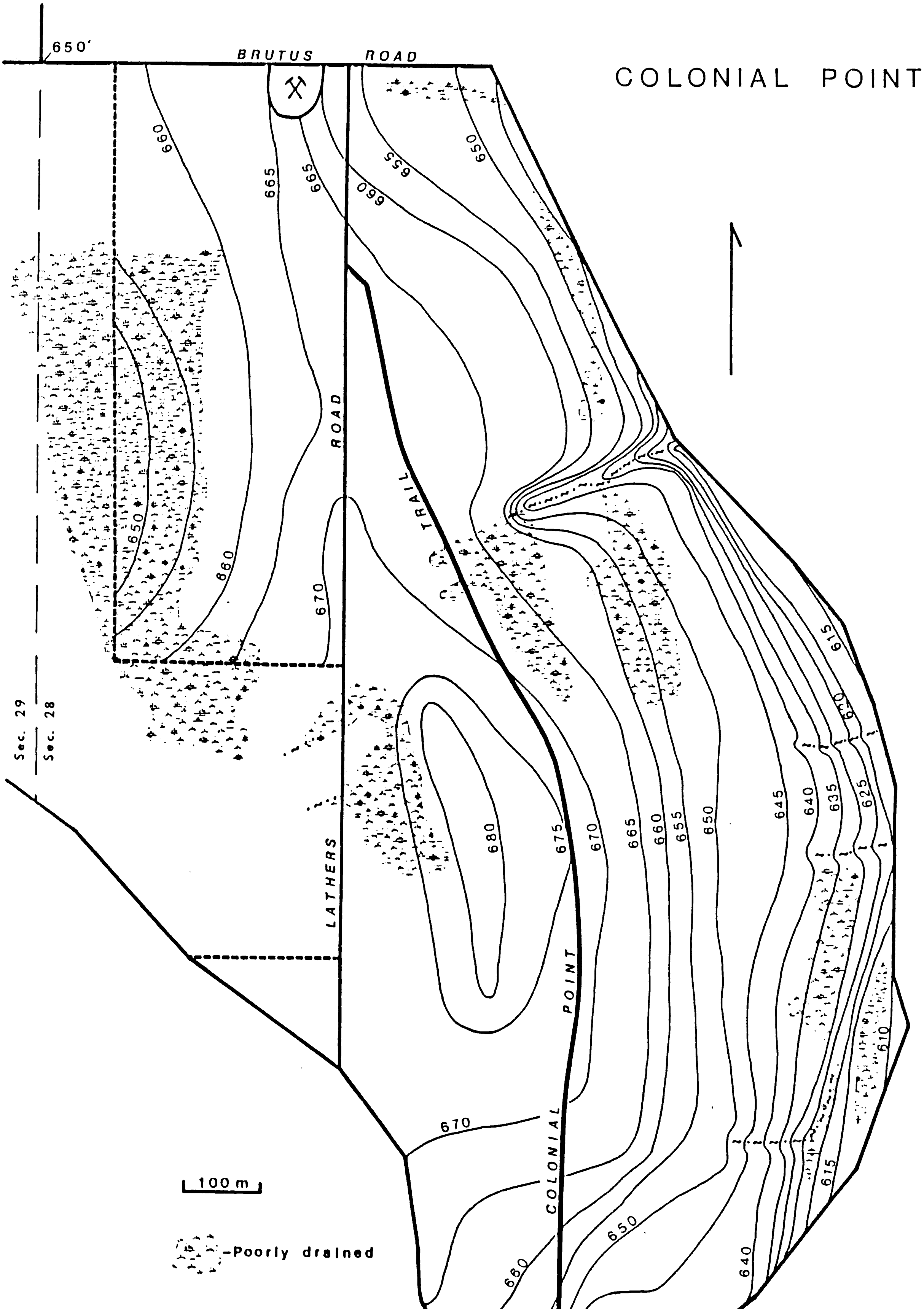
Colonial Point Soil Samples:
Location and Textural Classes

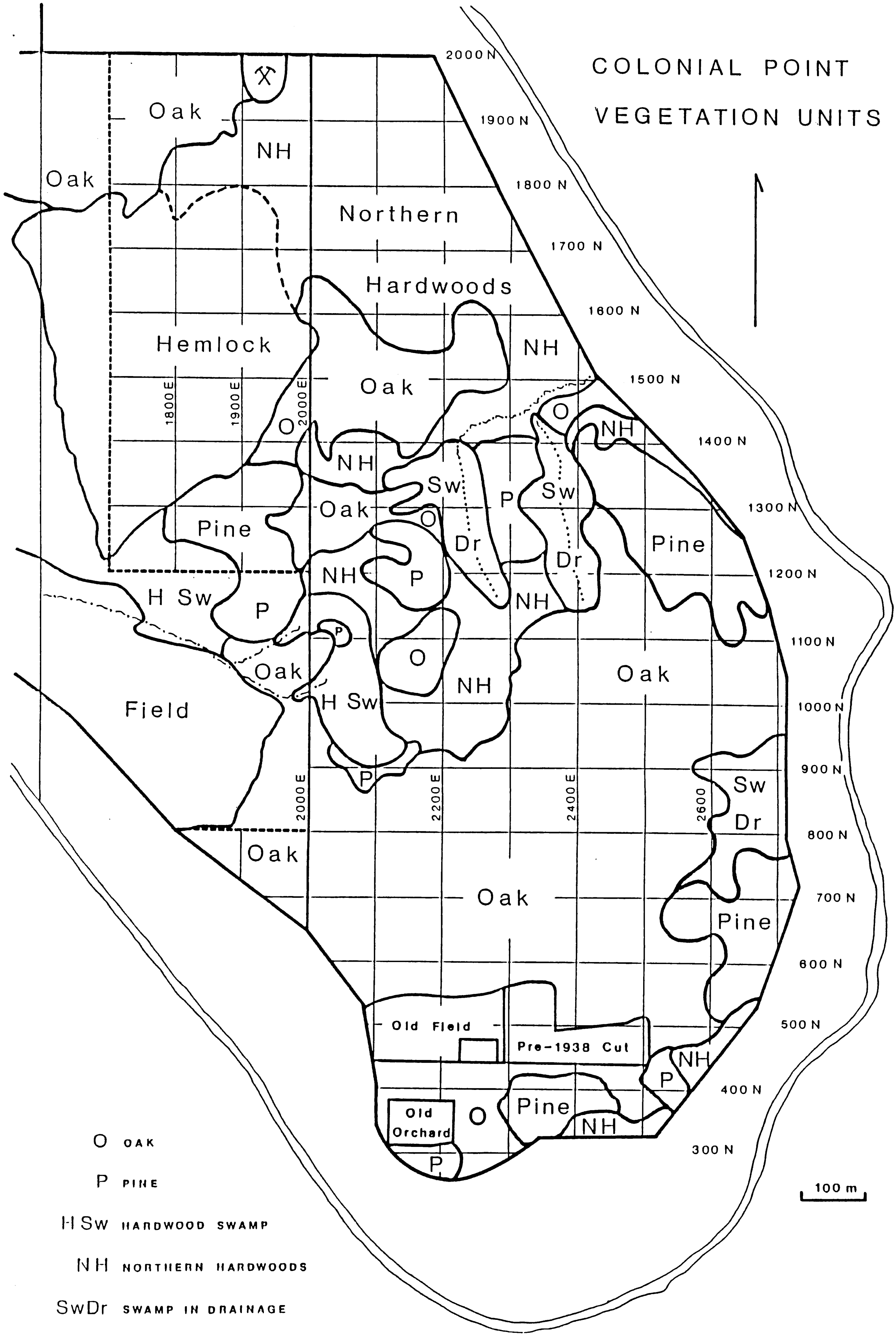
#	Sample Type	Location	Forest Type	Soil Texture and Depth (inches)				Y/N[1]
1	Plot 5	1842N/2150E	Beech	loamy sand 0-41	sandy loam 41-47	sand 47-70	sandy clay loam 70-73+	Y
2	Auger	1750N/1750E	Hemlock	sand 0-20	sandy loam 20-30	sand 30-38	sandy clay loam 38-48+	N
3	Auger	1750N/1850E	Hemlock	sand 0-14	sandy loam 14-28	sandy clay loam 28-46+		N
4	Auger	1750N/1950E	Hemlock	sand 0-24	sandy loam 24-35	sandy clay loam 35-43	sandy loam 43-80+	N
5	Auger	1750N/2050E	Beech	sand 0-28	sandy clay loam 28-60+			Y
6	Auger	1750N/2150E	Beech	sand 0-49	sandy clay loam 49-55+			Y
7	Plot 12	1743N/2200E	Beech	sand 0-71	sandy loam 71-80+			N
8	Auger	1750N/2250E	Beech	sand 0-36	sandy clay loam 36-42+			N
9	Plot 6	1658N/2120E	Beech	sand 0-37	sandy loam 37-51+			Y
10	Plot 16	1585N/2068E	Oak	sand 0-45	sandy loam 45-55+			Y
11	Auger	1550N/2050E	Oak	sand 0-52	sandy loam 52-68+			Y?
12	Auger	1550N/2150E	Oak/Beech	sand 0-42	sandy loam 42-48	sand 48-68+		Y
13	Auger	1550N/2250E	Oak	sand 0-66	sandy clay loam 66-78+			N
14	Plot 11	1465N/2223E	Beech	sand 0-55	loam 55-67+			Y?
15	Plot 4	1408N/2065E	Beech	loamy sand 0-41	sandy loam 41-53+			Y?
16	Auger	1350N/1950E	W. Pine	sand 0-80+				Y
17	Plot 14	1250N/2543E	W. Pine	sandy loam 0-35	sand 35-77	sandy clay loam 77-80+		N
18	Plot 15	1210N/2182E	W. Pine	clay loam 0-28+				Y
19	Auger	1150N/2150E	W. Pine	sand 0-18	sandy clay loam 18-25	sand 25-32	sandy clay loam 32-40+	Y
20	Auger	1150N/2250E	Beech	loamy sand 0-18	sandy clay loam 18-60+			Y
21	Auger	1150N/2350E	Beech	sand 0-46	sandy clay loam 46-52	sand 52-60	clay 60-72+	N
22	Auger	1150N/2450E	Oak	loamy sand 0-16	sandy clay loam 16-36+			N
23	Auger	1120N/2150E	Oak	sand 0-8	sandy clay loam 8-12+			Y
24	Plot 10	1065N/2493E	Oak	loamy sand 0-41+				Y
25	Auger	950N/2250E	Beech	loamy sand 0-14	sandy clay loam 14-30	sand 30-49	clay loam 49-60+	Y

Appendix III
(continued)

#	Sample Type	Location	Forest Type	Soil Texture and Depth (inches)				Y/N[1]
26	Auger	950N/2450E	Oak	sand 0-44	sandy clay loam 44-48	sand 48-54	sandy clay loam 54-66+	N
27	Plot 9	882N/2485E	Oak	sandy clay loam 0-34+				N
28	Plot 3	792N/2065E	Oak	sand 0-30	sandy loam 30-49	sand 49-53	silt loam 53-65+	N
29	Plot 1	768N/1950E	Oak	sand 0-49	sandy loam 49-57	sand 57-65+		Y?
30	Plot 2	658N/2085E	Oak	sand 0-80+				Y
31	Plot 8	665N/2458E	Oak	loamy sand 0-55+				Y
32	Plot 13	350N/2350E	W. Pine	sandy loam 0-22	clay loam 22-30	sand 30-35	sandy clay loam 35-43+	N

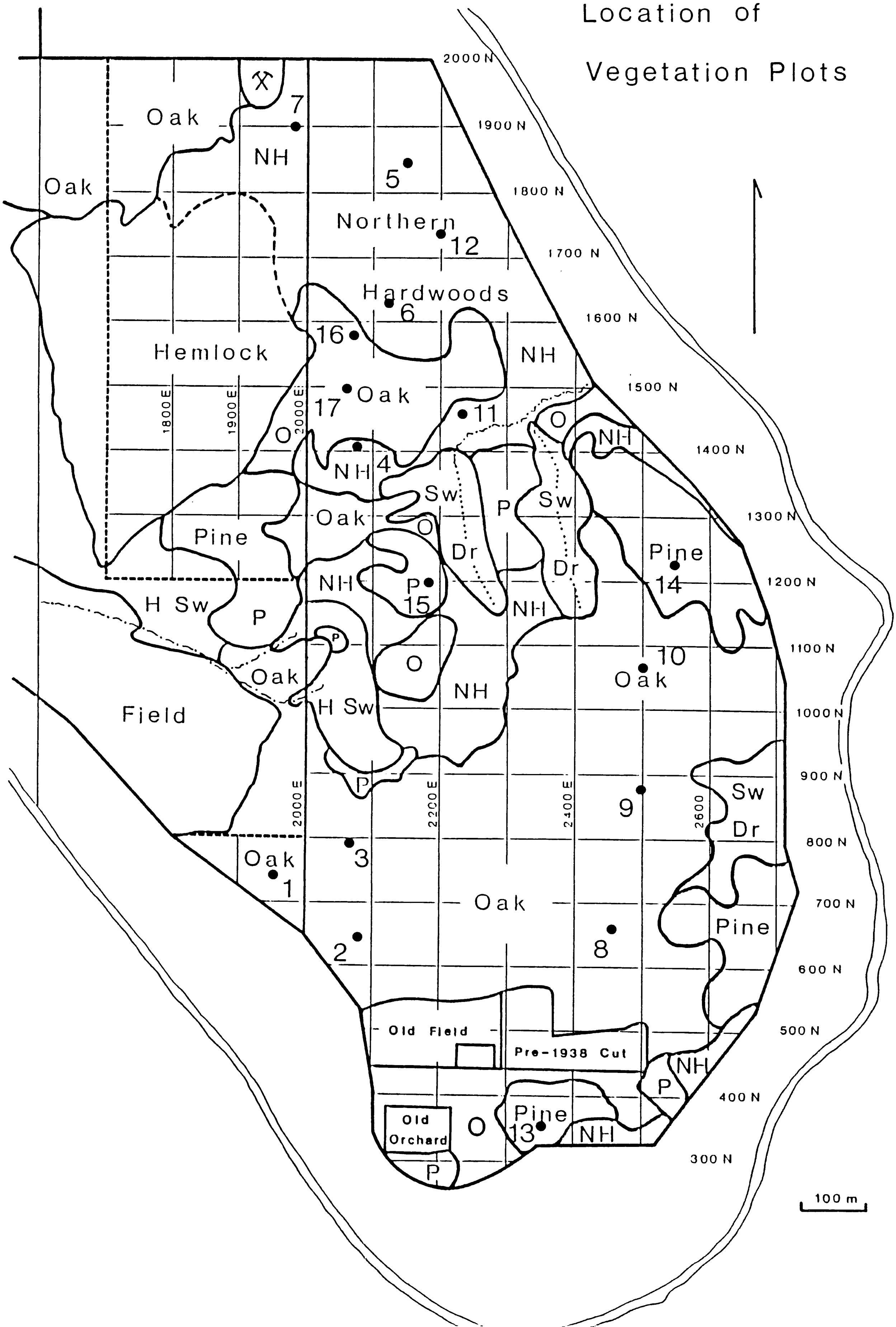
1. Agreement of sample (Yes or No) with Cheboygan County Preliminary Soil Survey classification (see Appendix II).


COLONIAL POINT
650'
BRUTUS ROAD
LATHERS ROAD
COLONIAL POINT TRAIL
Sec. 29
Sec. 28
660
665
665
660
655
650
650
660
670
680
675
670
665
660
655
650
645
640
635
630
625
615
610
615
670
660
650
640
100 m
-Poorly drained

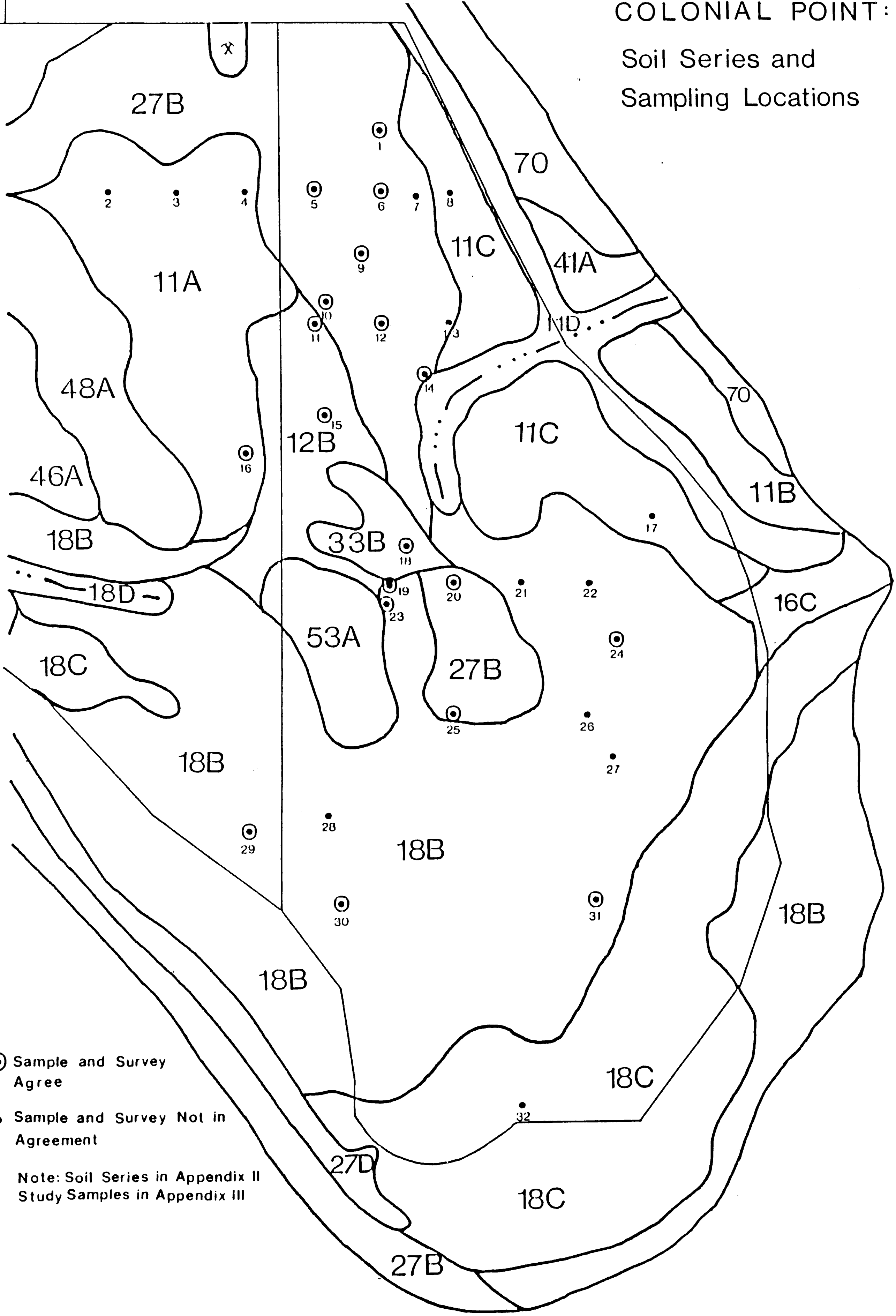

COLONIAL POINT
VEGETATION UNITS
2000 N
1900 N
1800 N
1700 N
1600 N
1500 N
1400 N
1300 N
1200 N
1100 N
1000 N
900 N
800 N
700 N
600 N
500 N
400 N
300 N
1800 E
1900 E
2000 E
2200 E
2400 E
2600
Oak
NH
Northern
Hardwoods
Hemlock
Pine
H Sw
P
O
Sw
Dr
Field
Old Field
Pre-1938 Cut
Old Orchard
100 m
O OAK
P PINE
H Sw HARDWOOD SWAMP
NH NORTHERN HARDWOODS
SwDr SWAMP IN DRAINAGE

COLONIAL POINT:

Location of Vegetation Plots



COLONIAL POINT:
Soil Series and
Sampling Locations



[illegible]