

VEGETATION ASSESSMENT OF
HIGH POINT STATE PARK
SUSSEX COUNTY, NEW JERSEY

AUG 01 1980

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HIGH POINT STATE PARK
R.R. #4, BOX 237
SUSSEX, NEW JERSEY 07461

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By

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INTRODUCTION

The following report is based upon a detailed inventory of the forest vegetation found within the area of High Point Park between Route 23 and the Deckertown Turnpike. This inventory was requested and financed by the New Jersey Department of Environmental Protection, Division of Parks and Forestry, and it was completed during the period May through August 1979. The design and sampling schemes of the inventory were devised with the objectives of providing an assessment of the general health and vigor of the forest vegetation contained within the park. One of the most prominent objectives of this vegetation analysis was to determine if possible imbalances in various animal (white-tailed deer and beaver) and insect (gypsy moth) populations along with intensive recreational use by humans are having an adverse or destructive influence on the vegetation. However, an effort was made to design the sampling procedures in such a way that the data obtained would be versatile and flexible so that they would become a valuable source of information for any management decision involving the vegetation contained within the park.

METHODS

The area studied consisted of approximately 2680 ha and it was stratified into eight blocks varying in size from 113 ha to 475 ha. ⁽⁴⁶¹⁾ This stratification was based upon the location of the major roads along with the prominent topographic and drainage features of the area. The area was stratified in order to make analysis and utilization of the data obtained

HIGH POINT STATE PARK STOKES STATE FOREST

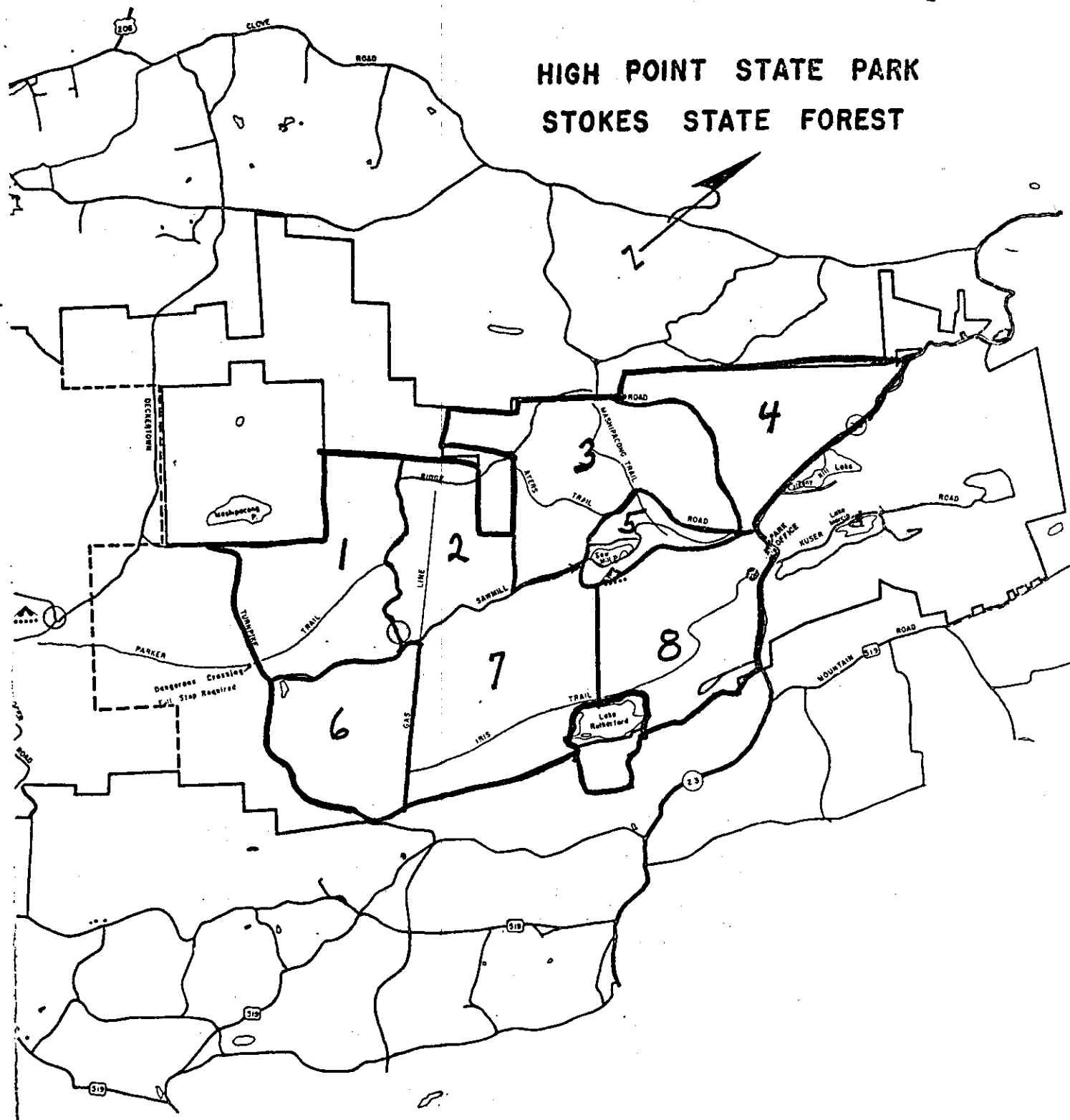


fig. 1

from the survey a more manageable task.

Originally, after considering time and financial constraints along with the variability of the vegetation, it was decided to locate 360 sample points throughout the study area. These sample points were allocated systematically to each block in proportion to the size of the block along cruise lines spaced 250 m apart with a sample point placed every 250 m along the cruise line. However, severe flooding caused by beaver dams made portions of the park inaccessible and it was only possible to locate 336 of the sample points originally allocated (Fig. 2).

At each sample point the following information was obtained by a two-man crew and recorded on a prepared survey form (Fig. 3).

- A. Site Information: slope position (low, mid, upper), slope %, aspect of slope, and soil drainage class (well, moderate, poor).
- B. Canopy Trees: all trees greater than 10 cm dbh were counted using a 4 (m^2/ha) factor angle gauge. The species and diameter (measured to the nearest 0.5 cm with a diameter tape) of each counted tree was recorded. The species and diameter of each dead tree was also recorded. During computer analysis the canopy trees were grouped into the following diameter classes.
 - 10 = 10-19.9 cm
 - 20 = 20-29.9 cm
 - 30 = 30-39.9 cm
 - 40 = 40-49.9 cm
 - 50 = 50-59.9 cm
 - 60 = 60-69.9 cm
- C. Growth Data: the following information was obtained from the three trees closest to plot center.

Plot #:

Cruiser:

Date:

Position:

Slope:

Aspect:

Drainage:

Remarks:

canopy trees					saplings				seedlings			dead			
BAF: 4					plot size:				plot size:			plot size:			
SPECIES	DIAMETER	Crown Class	Vigor	HEIGHT	SPECIES	1 cm.	4 cm.	8 cm.	SPECIES	NUMBER	BROWSE	SPECIES	BASAL DIAMETER	AGE	10yr DIAMETER
					SHRUBS										
					plot size:										
					SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER	SPECIES	% COVER			

1. Height (meters) measured with Sunto clinometer.
2. Diameter (0.1 cm)
3. Crown Class (dominant, codominant, intermediate, understory)
4. Crown Vigor (good (80% of crown healthy), medium (50 to 79% of crown healthy), poor (50% of crown healthy)).
5. Presence of animal, insect or disease damage
6. Age and 5 year diameter increment for the last 10 years were determined for the most dominant tree using an increment borer.

D. Saplings: The species and number of all trees greater than 1.3 m tall and up to 9.9 cm dbh were recorded by diameter class on fixed circular plots. These plots varied in size from 50 m² to 200 m² depending upon the density of saplings. Diameter classes were:

- 1 - .1-2.9 cm
- 4 - 3-5.9 cm
- 8 = 6-9.9 cm

E. Seedlings: The species and number of all trees less than 1.3 m tall were recorded on fixed circular plots. Plot size varied from 2 m² to 10 m² depending on seedling density. A measure of deer browse damage was also recorded for seedlings. Any seedling with 15 to 50% of its edible branches clipped was recorded as moderately browsed (MB). Any seedling with greater than 50% of its edible foliage clipped was recorded as severely browsed (SB).

F. Shrubs: The species and percent cover of all shrubs were measured using the line intercept method. The line was 5 m long and it started at the plot center and extended in the direction of the cruise line.

G. Beaver Damage: The length and width of all areas flooded by beaver were estimated by pacing. The dimensions and location of the flooded areas were recorded on U.S.G.S. topographic maps.

Upon collection all data were punched onto IBM computer cards and analyzed using the SAS 76 statistical computer package.

RESULTS AND DISCUSSION

All data collected in the survey and the descriptive statistics for these data are contained in the appendix tables 1-13 (See computer printout contained in accompanying binder). Other copies of these data may also be found in the office of the principal investigator and on disk within the Rutgers University computer system.

The quantity of information obtained in the survey was large and only a portion of it is dealt with in the following report. However, the data can be manipulated and reanalyzed in numerous ways in order to aid park managers in solving future management objectives and problems. In the absence of a major disturbance to the vegetation within the park the information obtained in this inventory should be useful for the next five to ten years. The principal investigator encourages the future use of these data and he would be happy to aid Division personnel in the technical aspects of retrieving and reanalyzing additional information from the computer files.

General Study Area

The area which was surveyed in this study contained approximately 2680 hectares. Most of the land (82%) was covered with mature forest communities (Table 1). Approximately eight percent of land consisted of areas which were formerly forested; however, due to flooding by beaver they now exist as swamps and small ponds. An additional

Table / . Total area (hectares) of major vegetation and land types
by block.

Block	Total Area	Mature Forest	Immature Forest	Beaver Swamp	Lakes or Ponds
1	400	374	0	26	0
2	248	173	0	75	0
3	474	331	52	91	0
4	318	300	18	0	0
5	113	99	6	0	8
6	327	296	26	4	1
7	423	355	32	28	8
8	378	278	100	0	0
Total	2681	2206	234	224	17

nine percent of the area (Immature Forest) is covered by old fields, early successional stage forest, and rock outcroppings dominated by shrubs and herbaceous plants. Less than one percent of the study area is covered by small lakes and ponds which have not originated as a result of beaver activity

General Forest Description

The study area lies within the oak-chestnut forest region as described by Braun (1950). To the east this forest type is replaced by oak-hickory forest and to the north and northwest it is replaced by the hemlock-white pine-northern hardwood forest type.

The Chestnut blight (Endothia parasitica) has essentially eliminated the American chesnut from the canopy at High Point and the result has been that the forest is now dominated by a mixture of oak species along with a variety of less important hardwood species.

The canopy data collected for the entire study area indicated that oak comprises 65% of all trees greater than 10 cm in diameter (Table 2). Chestnut oak (Quercus prinus) was the most dominant species within the study area followed by white oak (Quercus alba) and the red oak group which includes red oak (Quercus rubra), black oak (Quercus velutina), and scarlet oak (Quercus coccinea). Red maple (Acer rubrum) was the most common of the supporting hardwood species while sugar maple (Acer saccharum), shagbark and red hickory (Carya ovata and Carya ovalis), black and yellow birch (Betula Lenta and Betula alleghaniensis), and white ash (Fraxinus americana) were also found frequently in the forest canopy.

Table 2 . Basal area and species composition of canopy trees by slope position at High Point State Park.

Species	Entire Study Area	Slope Position		
		Lower	Mid	Upper
- - - - - % of Total Basal Area - - - - -				
Chestnut Oak	27.0	5.5	24.3	45.1
White Oak	20.5	19.7	22.1	17.9
Red Oak*	17.5	8.6	19.9	19.9
Red Maple	9.9	20.1	8.7	5.3
Sugar Maple	3.5	9.1	3.1	a
Shagbark Hickory	2.4	8.8	1.2	a
Red Hickory	2.6	1.5	2.2	4.1
White Ash	3.8	6.6	4.3	1.2
Black Birch	5.6	4.5	8.2	1.6
Yellow Birch	1.0	5.5	0	0
Gray Birch	a	1.5	a	a
Misc. Mesic Sp.**	a	3.0	a	0
Black Cherry	a	1.5	a	0
Amer. Beech	a	1.0	a	0
Yellow Poplar	a	a	a	0
Amer. Chestnut	a	0	a	a
Sassafrass	a	0	a	1.0
Bigtooth Aspen	a	0	1.5	0
Hemlock	a	1.5	a	0
White Pine	a	a	a	a
Pitch Pine	a	0	a	1.0
Total Basal Area (m ² /ha)	14.3	17.6	14.4	12.8

*Red Oak group includes red, black and scarlet oak.

**Miscellaneous mesic species include basswood, blackgum, green ash, River birch and silver maple.

^aSpecies comprises less than 1% of the total basal area.

The data presented in Table 3 indicate that there was little variability in age and structural characteristics within the canopy zone. The canopy trees were generally mature and the density values indicate that canopy stocking levels were relatively low in this forest. Diameter growth rates were also low in comparison to most oak forests.

Throughout the forested portions of the study area there was a very distinct understory tree layer (Table 4). This zone was dominated by red maple with a strong component of black birch. All species of oak comprised about 12% of this layer while the bulk of the remaining understory is composed of black cherry (Prunus serotina), American chestnut, red hickory and sugar maple which were present in decreasing amounts.

Tree seedlings were abundant throughout the forest with red maple and the oaks comprising the majority of the individuals (Table 5). Sugar maple, black birch and black cherry were also found frequently.

A shrub layer was generally present within the forest and it covered about 41% of the ground surface (Table 6). Ericaceous species particularly low growing species of Vaccinium and Gaylussacia comprised about 81% of this layer while witch hazel (Hamamelis virginiana), dogwoods (Cornus Sp.), Viburnum (Viburnum Sp.), shadbush (Amelanchier) and scrub oak (Quercus ilicifolia) were also found frequently.

Even though the overall species mix within the canopy and the stand structure remains similar throughout the forest, distinct forest

Table 3. Structural and growth characteristics (Means $\pm$ 95% C.I.) of canopy trees by slope position at High Point State Park.

Slope Position	Area Occupied	Basal Area	Trees	Dbh	Height	10 yr. diameter increment	Age
	ha (ac)	m ² /ha (ft ² /ac)	#/ha (#/ac)	cm (inches)	m (ft.)	cm (inches)	Years
Lower	324 (800)	17.6 $\pm$ 2.4 (77 $\pm$ 10)	400 $\pm$ 75 (161 $\pm$ 30)	32.4 $\pm$ 2.5 (12.8 $\pm$ 1.0)	22.1 $\pm$ 0.8 (72 $\pm$ 2.6)	1.92 $\pm$.30 (.75 $\pm$.12)	86 $\pm$ 7
Mid	1163 (2873)	14.4 $\pm$ 1.1 (63 $\pm$ 5)	335 $\pm$ 35 (135 $\pm$ 14)	30.9 $\pm$ 1.4 (12.2 $\pm$ 0.5)	21.5 $\pm$ 0.4 (70 $\pm$ 1.3)	1.75 $\pm$.12 (.69 $\pm$.05)	82 $\pm$ 4
Upper	719 (1776)	12.8 $\pm$ 1.5 (56 $\pm$ 6)	340 $\pm$ 50 (137 $\pm$ 20)	27.2 $\pm$ 1.6 (10.7 $\pm$ 0.6)	16.9 $\pm$ 0.7 (55 $\pm$ 2.3)	1.54 $\pm$.16 (.61 $\pm$.06)	79 $\pm$ 6
Entire Study Area	2206 (5449)	14.3 $\pm$ 0.9 (62 $\pm$ 4)	348 $\pm$ 26 (140 $\pm$ 11)	30.0 $\pm$ 1.0 (11.8 $\pm$ 0.4)	20.2 $\pm$ 0.4 (66 $\pm$ 1.3)	1.70 $\pm$.10 (.67 $\pm$.04)	82 $\pm$ 3

Table 4. Number of stems (Mean $\pm$ 95 C.I.) and species composition of sapling size trees by slope position at High Point Park.

Species	Entire Study Area	Slope Position		
		Lower	Mid	Upper
% of Total Number of Saplings				
Chestnut Oak	2.8	0	2.8	4.0
White Oak	1.2	1.0	1.3	1.1
Red Oak*	7.6	1.9	6.6	11.9
Red Maple	35.7	18.5	37.5	39.3
Sugar Maple	3.8	4.7	4.8	1.8
Shagbark Hickory	a	1.3	1.3	0
Red Hickory	5.4	2.0	5.4	6.7
White Ash	a	1.0	1.3	a
Black Birch	2	17.1	20.6	21.3
Yellow Birch	a	a	a	a
Gray Birch	2.5	4.3	2.0	2.9
Misc. Mesic Sp. **	a	a	a	0
Black Cherry	7.6	34.4	5.0	1.7
Amer. Beech	1.4	9.2	a	a
Yellow Poplar	a	a	a	0
Amer. Chestnut	6.4	1.6	7.3	6.7
Sassafras	1.4	a	1.5	1.4
Bigtooth Aspen	a	0	a	0
Hemlock	a	0	0	0
White Pine	a	0	0	0
Pitch Pine	a	0	0	a
Total stems/ha (#/ac)	1581 ⁺¹⁵³ (640 ^{+ 62})	1355 ⁺³⁸⁰ (549 ⁺¹⁵³)	1667 ⁺²⁰⁹ (675 ^{+ 85})	1543 ⁺²⁸³ (624 ⁺¹¹⁵)

*Red Oak group includes red, black and scarlet oak.

**Miscellaneous mesic species include basswood, blackgum, green ash, River Birch and silver maple.

^aSpecies comprises less than 1% of the total basal area.

Table 5. Number of stems (Mean $\pm$ 95% C.I.) and species composition of seedlings by slope position at High Point State Park.

Species	Entire Study Area	Slope Position		
		Lower	Mid	Upper
% of Total Number of Seedlings				
Chestnut Oak	17.3	a	13.8	28.3
White Oak	9.1	12.5	10.0	6.3
Red Oak*	11.9	3.3	8.8	20.0
Red Maple	41.0	52.9	47.0	27.2
Sugar Maple	6.9	6.4	8.9	3.6
Shagbark Hickory	a	a	0	0
Red Hickory	1.2	1.6	a	2.1
White Ash	a	a	a	a
Black Birch	6.3	11.2	4.9	7.2
Yellow Birch	a	a	0	0
Gray Birch	a	0	a	a
Mixed Mesic Sp.**	a	a	0	0
Black Cherry	2.4	4.9	2.2	1.8
Amer. Beech	a	2.6	a	0
Yellow Poplar	a	0	a	0

Species	Entire Study Area	Slope Position		
		Lower	Mid	Upper
% of Total Number of Seedlings				
Amer. Chestnut	1.4	1.5	1.4	1.4
Sassafrass	1.0	a	1.0	1.4
Bigtooth Aspen	0	0	0	0
Hemlock	a	a	0	0
White Pine	0	0	0	0
Pitch Pine	0	0	0	0
Total seedlings/ha	23,431 [±] 1,716	17,222 [±] 3,590	26,247 [±] 2,468	25,220 [±] 3,210
#/acre	9,498 [±] 694	6,972 [±] 1,453	10,626 [±] 999	10,210 [±] 1,299

*Red Oak group includes red, black and scarlet oak.

**Miscellaneous mesic species include basswood, blackgum, green ash, River birch and silver maple.

^aSpecies comprises less than 1% of the total basal area.

Table 6. Total percent cover (Mean $\pm$ 95 C.I.) and species composition of shrubs by slope position at High Point State Park.

Species	Entire Study Area	-----Slope Position-----		
		Lower	Mid	Upper
-----(% of Total Shrub Cover)-----				
Vaccinium & Gaylussacia	81.3	50.9	76.1	91.4
Witch Hazel	7.5	15.0	11.4	2.3
Viburnum	3.4	1.2	5.7	1.3
Shadbush	3.1	7.7	4.9	a
Scrub Oak	2.1	0	a	2.2
Dogwood	1.9	21.4	0	0
Raspberry	0.3	2.5	a	a
Hawthorn	0.09	1.2	0	0
Total shrub cover (%)	41.1 [±] 4.1	24.6 [±] 9.9	35.1 [±] 5.5	58.0 [±] 7.3

^aSpecies comprises less than 1.0% of total shrub cover.

communities appear to develop in relation to the topographic position of the site. Generally as one travels from the flats along streams and lower slopes toward the ridge tops, species diversity, height, diameter, stand density and growth rate of the canopy trees decreased while the percentage of oak (particularly chestnut oak) and the percent shrub cover increased (Tables 2-6).

Lower slopes and flats

The deeper more mesic soils of these sites supported greater diversity of tree species than did the more upland sites. The canopy was composed of a mixture of up to 10 different species, and while the oaks still dominated (34% of basal area), Chestnut oak (5%) was of minor importance while white oak was more dominant. Red maple was the single most important species on these sites and sugar maple was also very common. Essentially all of the yellow birch were located in these areas and shagbark hickory was much more common than red hickory. White ash was also more abundant than in any other zone.

The canopy trees on these lower sites tended to be taller, have a larger diameter, and a greater rate of growth than those trees growing on the poorer upland sites (Table 3). Furthermore, the density values indicated that the stands growing on these sites had a higher level of stocking than those growing on the upland areas.

Within the understory tree layer there was very little oak (3%), while black cherry, red maple, black birch and American beech

comprised about 80% of the stems (Table 4). The seedling layer within these sites was dominated by red maple; however, white oak and black birch were also abundant (Table 5).

Due to the high level of stocking within the canopy the shrub layer was sparse (25% cover). However, species diversity was greater than on the upper slopes. Along with the ericaceous species, witch hazel, dogwood, and shadbush were very common (Table 6).

Mid slopes

The soils contained on the mid-slope sites were generally more shallow and moisture and nutrients were more limiting than on the lower slopes. Canopy species diversity was also not as great with seven species comprising 90% of the canopy. The oaks were the most dominant group and they accounted for 66% of the total basal area. Chestnut oak was the most abundant species, however, white oak and the red oak group were present in only slightly lower amounts. Red maple, black birch, and white ask formed the majority of the remaining canopy trees. Stand density, tree size, and diameter growth rate were all slightly lower than on the lower slope sites.

The understory tree layer was more dense than on the lower slopes with red maple and black birch accounting for 58% of the stems in this zone. The three species of oak, black cherry, red hickory and sprouts of American chestnut comprised the bulk of the other stems in this layer.

Due probably to the lower canopy density, tree seedling regeneration was relatively high on these mid slopes with an increase

in stems of 52% over that found on the lower slopes. Red maple was again the most abundant species in this layer however the oaks, particularly chestnut oak, were much more abundant than on the lower slopes. Sugar maple and black birch also occurred frequently.

The shrub layer was also more dense with 35% of the ground being covered. The species composition was similar to that found on the lower sites with the exception that the ericaceous shrubs were more abundant and dogwood was absent.

Upper slopes and ridge tops

Sites located on the upper slopes and ridge tops are characterized by very shallow acid soils with limited amounts of moisture and nutrients. Species diversity within the canopy trees was very low, and only five species comprised more than 90% of the basal area. The oaks were by far the most dominant canopy component and they accounted for 80% of basal area within this zone. Chestnut oak alone accounted for almost one half of the trees present. Red maple and red hickory were the most frequent supporting species and most of the pitch pine (Pinus rigida) found within the study areas were on these sites.

Due to the poor growing conditions, the canopy trees found on these upland sites had very poor form, were smaller in size and they had a lower growth rate than those trees found on the lower sites. Canopy tree density was very low and the stands were generally understocked.

The understory tree layer was similar to that found on the mid-slopes; however, the oaks were slightly more abundant while black cherry and sugar maple were much less abundant. Seedling regeneration was also abundant and it was dominated by chestnut oak, the red oak group, and red maple. Black birch was also found frequently.

Due to the sparse canopy layer the shrub layer was the most dense (58% cover) on these upland sites. Vaccinium and Gaylussacia comprised about 91% of this layer while scrub oak was frequent on the driest sites and virburnum and witch hazel were more frequent on the more moist sites.

The basic structural characteristics of the canopy trees and the proportion of land occupied by the above communities for the eight block samples are given in Table 7.

Table 7. Structural characteristics (Mean $\pm$ 95% C.I.) of canopy trees and site classification of forest communities by block at High Point Park.

Block	Density	Trees	Age	Slope Position		
	Basal Area			Lower	Mid	Upper
	m ² /ha	#/ha	yr.	% of Total Block Area		
1	19.1 $\pm$ 1.1	428 $\pm$ 64	85 $\pm$ 9	20	46	30
2	15.2 $\pm$ 1.4	367 $\pm$ 92	84 $\pm$ 9	19	46	6
3	18.2 $\pm$ 1.2	361 $\pm$ 77	88 $\pm$ 7	7	41	22
4	13.5 $\pm$ 0.9	370 $\pm$ 75	82 $\pm$ 8	7	67	2
5	15.1 $\pm$ 1.7	409 $\pm$ 118	83 $\pm$ 11	36	51	0
6	13.6 $\pm$ 1.1	300 $\pm$ 68	81 $\pm$ 6	12	49	30
7	10.4 $\pm$ 1.1	286 $\pm$ 64	78 $\pm$ 8	12	26	46
8	10.4 $\pm$ 1.1	304 $\pm$ 77	70 $\pm$ 6	2	34	38

Impact of White-Tailed Deer

Background Information

Research in the Northeast has indicated that excessive populations of deer have relatively little influence on mature established forest trees. Due to the nature of the feeding habits of the deer, the forest tree is most susceptible to damage or alteration by excessive deer browsing during the early stages of development. Forest trees are particularly vulnerable to browsing pressure from the point at which their seeds germinate until the terminal leaders of the young trees reach 1.5 to 2m in height and are thus out of the reach of the deer. The most vulnerable forest communities, therefore, are those which have been recently disturbed or those which are in early stages of secondary succession and thus have large numbers of small trees which are easily browsed by the deer. Some of the most obvious indications of imbalances in deer populations and availability of suitable browse occur when entire forest stands fail to regenerate following natural or man-caused disturbances due to the excessive browsing of young trees by an enlarged deer herd. The overpopulation of deer throughout central and northern Pennsylvania has caused numerous forest stands harvested by man and the oak-leaf roller to be replaced by open meadows containing only herbaceous plants and nonpalatable woody shrubs.

High Point Park is dominated by mature forest communities and a very low percentage of the study area was occupied by young

developing forest communities. The results of our survey indicated that more than 82% of the study area (2680 ha) was covered with mature forest communities ranging in age from 60 to 153 years old. Much of the remaining area was flooded due to beaver activity and less than 5% of the total area was occupied by young forests and old fields. Therefore, the presence of an overpopulation of deer might not be as visible in these portions of High Point Park as it would in other areas containing a greater proportion of younger communities.

Eventhough the area studied at High Point consisted primarily of mature forest communities, it is still possible that an overpopulation of deer would have some detrimental effects on community development which might not show up until some time in the future. Past research dealing with oak-dominated forests has shown that successful regeneration is dependent upon the presence of seedlings in the understory prior to the removal of or disturbance to the overstory trees. Generally the presence of an overpopulation of deer in an area with limited amounts of available browse will result in the elimination of the advanced regeneration by the deer. This situation will cause problems if the overstory is removed by man or natural disturbances and there is not a sufficient quantity of new trees to replace those destroyed. Numerous studies have shown that heavy cutting in oak forests which lack sufficient advanced reproduction often results in the establishment of open meadow communities dominated by grasses, ferns and other herbaceous plants. Presently the cutting of trees, and particularly clearcutting, is not relevant

to High Point. However, Gypsy Moth have recently been selectively harvesting canopy trees throughout the park and in some areas mortality is very heavy. If sufficient amounts of reproduction are not already established in these stands their replacement may be delayed.

Study Results

The numbers and species composition of the seedlings for the entire study area and for the three major overstory communities were previously presented in Table 5. Table 8 contains the mean number of seedlings per hectare and the severity of browsing for each of the stratified blocks, while Table 9 contains the same information for all oaks and red maple.

Discussion

All data collected in this portion of the vegetation analysis indicate that deer are not having a detrimental influence on the forest plant communities within the study area. The total number of seedlings present is about average when compared to results from other studies dealing with similar forest types. While the quantities of advanced regeneration found at High Point are not extremely high they are certainly adequate enough to ensure stand replacement following a major disturbance.

The species composition of the seedling component is in general comparable to the overstory species composition. Oak seedlings are abundant, and comprise about 40% of the total number of seedlings. Red maple seedlings are also abundant accounting for 41% of the total

Table 8. Mean number of tree seedlings/hectare and degree of browse damage by block at High Point State Park.

Block	Seedlings	Moderately Browsed	Severely Browsed
	#/ha	Percent	
1	31,277	4	4
2	23,730	a	1
3	26,521	4	1
4	19,324	1	1
5	27,222	1	a
6	23,500	2	2
7	22,358	2	a
8	16,830	2	1
Entire Study Area	23,431 $\pm$ 1716 ^b	2 $\pm$ 0.6	2 $\pm$ 0.9

^aLess than 1%.

^b95% confidence interval n = 307

Table 9. Mean numbers of oak* and red maple seedlings/hectare and degree of browse damage by block at High Point State Park.

Block	----- Oak -----			----- Red Maple -----		
	Seedlings	Moderately Browsed	Severely Browsed	Seedlings	Moderately Browsed	Severely Browsed
	#/ha	Percent		#/ha	Percent	
1	8,723	3	a	10,234	1	1
2	5,769	1	a	16,923	0	0
3	10,195	7	8	14,978	0	0
4	6,720	a	2	9,511	0	0
5	7,777	4	0	13,833	0	a
6	8,640	3	3	8,760	0	0
7	12,660	3	1	5,320	a	0
8	8,717	3	2	4,340	a	0
Entire Study Area	8997 $\pm$ 1000 ^b	3 $\pm$ 1.0	3 $\pm$ 1.5	9577 $\pm$ 1393	0.2	0.1

*Includes red, white, chestnut, scarlet and black oaks.

^aLess than 1%.

^b95% confidence interval.

number of seedlings. This fact is significant because red maple is considered to be a preferred browse species and one would expect numbers of seedlings for this species to be low in areas experiencing severe deer browsing pressure.

Throughout the forest there are only a few areas where the supply of advanced regeneration is not adequate. Only 11% of the sample plots had less than 5000 seedlings/hectare and with the exception of block 8 there was no concentration of understocked seedling plots. Block 8 had the lowest mean number of seedlings present (16,830/ha) and this was due primarily to the disturbance caused by excavation activity along Route 23. If the eight plots contained in this disturbed area are not included, the average number of seedlings found in block 8 would rise to almost 20,000/hectare.

Our browse damage observation, similarly, showed very little evidence of excessive deer browsing. Almost 70% of the samples taken showed no evidence of browsing damage. Only two plots (1% of the total) showed browsing damage on more than 50% of the seedlings present, and only 10 plots (3%) showed browsing damage present on more than 25% of the seedlings. Red maple was the most abundant species and yet it was very rarely damaged, even though it is a preferred browse species.

Stands which have been recently disturbed by Gypsy Moth (greater than 50% mortality) were regenerating adequately. The quantity of seedlings found in these stands were slightly higher than the average for the entire forest. Oak seedlings were particularly

abundant in these stands making up about 50% of all seedlings. There was no evidence of regeneration failures in these areas.

The above facts do not necessarily prove that there is not an overpopulation of deer in the High Point area. The data that we have collected, however, do clearly indicate that deer browsing is not having a detrimental impact on the forest vegetation located between Route 23 and the Deckertown Turnpike within High Point Park.

Impact of Gypsy Moth

Background Information

Various forest communities within the High Point study area have been subjected to disturbance by scattered outbreak populations of Gypsy Moth (Lymantria dispar) throughout the last decade. In 1978 there was an especially large increase in the gypsy moth population and most of the study area experienced heavy defoliation. Throughout this period chemical insecticides were not used either for insect control or foliage protection. The one exception was a 112 ha area around Sawmill Pond which was treated in 1978 with an aerial application of Sevin 4-Oil. The boundaries of this treated area correspond very closely with those of block 5 in the present study. In the early summer of 1979 there was a general collapse in the gypsy moth population at High Point and there was also a large scale spray program carried out within High Point and Stokes State Forest. This resulted in very little gypsy moth activity within the park during the data collection period of our study.

Epidemic populations of gypsy moth directly influence forest trees by removing large amounts of foliage during the late spring and early summer. This in turn interrupts the normal physiology of the plant by interfering with a number of vital functions, including photosynthate and hormone production and the normal flow of water and solutes within the tree. This physiological interference generally results in a loss of growth and an increased susceptibility

to injury by other insects, disease, and environmental stresses. If defoliation coincides with periods of harsh environmental conditions, such as drought or late frosts, or if it is repeated two or three times in as many years, the gypsy moth may directly or indirectly kill their hosts.

Mortality

The canopy-tree data collected in our survey indicate that the forest communities within High Point have indeed experienced an unusually large amount of mortality during the last few years. Standing dead canopy-trees were found on over 40% of the sample points. Canopy tree mortality exceeded 50% of the standing trees on 13% of the sample points. The species, site location and the presence of large quantities of gypsy moth pupal-casings on many of the dying and dead trees indicate that while gypsy moth defoliation may not have directly killed all of these trees, they certainly were responsible for much of the mortality throughout the study area.

Our survey indicated that 18% of the standing canopy trees were dead (Table 10). This mortality accounted for 15% of the basal area (Table 11) and 14% of the volume (Table 12) of all canopy trees contained within the study area. On a block by block basis, mortality ranged from 8 to 26%. The volume of standing dead trees ranged from 4.1 cords/ha in block 5 to 14.1 cords/ha in block 1. The total volume of standing dead trees amounted to 19,400 cords for the entire study area. It is significant to note that block 5, which was treated with a chemical insecticide, had substantially lower rates of mortality

Table 10. Mean and total number of trees and degree of mortality for standing canopy trees by block at High Point Park.

Block	-----Trees-----			Total Trees	
	Live	Dead	Mortality	Live	Dead
	#/ha		%	Thousands	
1	428	84	16.4	160.1	35.9
2	367	57	13.4	63.5	9.9
3	361	60	14.2	119.5	19.9
4	370	102	21.6	111.0	30.6
5	409	36	8.0	40.5	3.6
6	300	47	13.5	88.8	13.9
7	286	77	21.2	101.5	27.3
8	304	105	25.7	84.5	29.3
Total Study Area	348 $\pm 27^a$	75 ± 15	17.7	767.7 ± 59	165.4 ± 32

^a95% confidence interval

Table 11. Mean basal area and degree of mortality for standing canopy trees by block at High Point Park.

Block	----- Basal Area -----		Mortality
	Live Trees	Dead Trees	
	m ² /ha	m ² /ha	% BA
1	19.1	3.5	15.4
2	15.2	1.8	10.3
3	18.2	2.5	12.2
4	13.5	2.7	16.4
5	15.1	1.2	7.2
6	13.6	2.2	13.8
7	10.4	2.4	19.1
8	10.4	2.3	17.9
Total Study Area	14.3 ± .9 ^a	2.5 ± .4	14.6

^a95% confidence interval

Table 12. Mean and total volume and degree of mortality for standing canopy trees by block at High Point Park.

Block	Volume/ha		Mortality	Total Volume	
	Live	Dead		Live	Dead
	---Cords---		%	Thousand	Cords
1	76.2	14.1	15.6	28.5	5.2
2	58.6	6.4	9.8	10.1	1.1
3	74.2	9.3	11.1	24.6	3.0
4	50.0	8.4	14.4	15.0	2.5
5	55.4	4.1	6.9	5.5	0.4
6	52.8	8.0	13.1	15.6	2.3
7	38.5	8.7	18.4	13.7	3.1
8	37.2	6.7	15.6	10.3	1.9
Total Study Area	55.2	8.8	13.8	121.8	19.4
	$\pm 3.6^a$	± 1.5		± 7.9	± 3.3

^a95% confidence interval

than any of the other blocks which had not been provided with chemical control in 1978.

As is generally the case during a gypsy moth outbreak, all tree species were not equally affected. The oaks, particularly white oak and chestnut oak, are preferred species of the gypsy moth larvae, while species such as red and sugar maple along with many of the other hardwood species are much less favored as a food source. The data obtained from High Point indicated that mortality by species was closely related to this feeding preference of the gypsy moth (Table 13). The oaks, which comprised 71% of the total number of live trees within the study area, accounted for 91% of all dead trees. Oaks also accounted for 88% of the basal area loss and 89% of the volume contained in dead standing trees. Within the canopy trees, 25% of all the oak trees within the study area were dead while less than 5% of all the other species had died. Chestnut oak, which is one of the species most favored by the gypsy moth, accounted for 58% of all the dead trees and comprised 43% of the volume contained in all dead trees. In contrast red maple which is not a preferred species of the gypsy moth comprised 15% of the forest canopy trees but accounted for less than 1% of the dead trees.

Due to species variation there was a considerable amount of variation in the rate of mortality depending on site location. The mortality within the forest communities located on the upper slopes and ridge top was almost three times greater than that which occurred on the flats and lower slopes (Table 14). This is understandable when it is remembered that the upper slopes are dominated by chestnut oak

Table 13. Mean basal area and degree of mortality for standing canopy trees by species at High Point Park.

Species	----- Basal Area -----						Mortality
	Live Trees		Dead Trees		Total Standing Trees		
	m ² /ha	% of Total	m ² /ha	% of Total	m ² /ha	% of Total	
Chestnut Oak	3.87	(27.0)	1.15	(46.7)	5.02	(29.9)	22.8
White Oak	2.91	(20.3)	0.60	(24.4)	3.51	(20.9)	17.1
Red Oak*	2.55	(17.8)	0.42	(17.1)	2.97	(17.6)	14.0
Red Maple	1.42	(9.9)	0.01	(0.4)	1.43	(8.5)	0.9
Sugar Maple	0.51	(3.5)	0	(0)	0.51	(3.0)	0
Shagbark Hickory	0.35	(2.4)	0	(0)	0.35	(2.1)	0
Red Hickory	0.38	(2.6)	0.05	(2.0)	0.43	(2.6)	12.0
White Ash	0.54	(3.8)	0.03	(1.2)	0.57	(3.4)	4.5
Black Birch	0.81	(5.6)	0.09	(3.6)	0.90	(5.3)	10.1
Others	1.00	(7.0)	0.11	(4.5)	1.11	(6.6)	10.1
All Species	14.34		2.46		16.80		14.6

*Red Oak group includes red, black and scarlet oak.

Table 14. Mean basal area and percent mortality for canopy trees by slope position at High Point Park.

Slope Position	Basal Area		Mortality
	Live Trees	Dead Trees	
	-----m ² /ha-----		%
Lower	17.6	1.2	6.5
Mid	14.4	2.7	15.7
Upper	12.8	2.6	17.1

while the lower slopes had a much greater component of red maple and other less-preferred hardwood species.

Mortality also varied greatly by size class of the canopy trees (Table 15). Generally, the smaller trees experienced a greater amount of mortality than the larger trees. More than 90% of the dead trees (70% BA) were within the 10 and 20 cm diameter classes while less than 10% of these trees (30% BA) were in the 30 to 50 cm diameter classes.

Condition of Live Trees

The most obvious impact of gypsy moth defoliation is the large number of dead trees scattered throughout the park. Less obvious but equally important is the impact of defoliation on the health and vigor of the residual live trees within the forest. Within our survey, crown condition (Crown Vigor Class) was used as a relative measure of the health and vigor of live trees. Stem growth within a forest tree is dependent upon products derived from the foliage within the crown. For a tree to be healthy and growing at a vigorous rate it must have a full and healthy crown. The permanent loss of foliage and the death of a large number of branches within the crown of a tree generally indicates that the tree is under severe stress. Subsequently if this condition is not improved, stem growth will decrease, and the tree will become very susceptible to wood boring insects and a variety of biotic and abiotic diseases and death may occur.

Table 15. Mean basal area, number of trees and percent mortality for canopy trees by diameter class at High Point Park.

	Diameter Class					Total
	10	20	30	40	50	
	Basal Area m ² /ha					
Live Trees	3.45	5.00	3.62	1.45	0.78	14.3
Dead Trees	0.95	0.66	0.52	0.21	0.07	2.4
	Trees/ha					
Live Trees	195.5	102.0	37.7	9.1	3.3	347.
Dead Trees	53.8	13.5	5.4	1.3	.27	74
% Mortality	21.6	11.7	12.6	12.6	7.6	17.6

The crown observations taken in the High Point Study area indicated that about one third of all live canopy trees were in poor condition (i.e. less than 50% of the crown was healthy) (Table 16). These trees were under severe stress and some will die during the next few years even if environmental conditions are favorable for growth. However, if these trees are subjected to drought or other harsh environmental conditions or if they are subjected to additional gypsy moth defoliation, then most of these trees will die and mortality figures will be much higher throughout the park.

In a one-time generalized vegetation study such as ours, it is impossible to blame the gypsy moth as being solely responsible for the poor condition of the trees at High Point. However, the species which have been most severely affected, the location of these trees, and the presence of pupal casings again indicates that gypsy moth have at least been one of the major contributors to the poor condition of the canopy trees within High Point Park.

On a block by block basis the percentage of poor canopy trees ranged from 16 to 45% (Table 16). The trees were generally in the best condition within block 5, which was sprayed with Sevin in 1978, and in the poorest condition in the blocks located along the ridge in the eastern side of the study area.

There is a considerable amount of variation in tree vigor between species (Table 17). The oaks were generally in very poor condition while most of the other species were in relatively good condition. Throughout the study area 46% of all oak trees had

Table 16. Crown vigor of live canopy trees
by block at High Point Park.

Block	-----Crown Vigor Class-----		
	Good	Medium	Poor
	% of Total Number of Trees		
1	41	38	21
2	23	38	40
3	35	32	33
4	35	38	27
5	49	36	16
6	26	35	39
7	28	32	40
8	23	32	45
Total Study Area	33	35	32

Table 17. Crown vigor of live canopy trees for major species at High Point Park.

Species	Crown Vigor Class		
	Good	Medium	Poor
	% Total No. Trees		
Chestnut Oak	3	42	55
White Oak	1	51	48
Red Oak	23	48	29
Red Maple	91	4	4
Sugar Maple	80	12	8
Shagbark Hickory	88	12	0
Red Hickory	68	20	12
White Ash	54	27	18
Black Birch	89	6	4
Others	67	23	10
All Species	33	35	32

crowns in poor condition while less than 8% had crowns in good condition. The red oaks as a group were generally in better shape than either the white or chestnut oaks. Among all other tree species 81% of the live canopy trees were in good condition and less than 8% were in poor condition. These data again indicate that those species which were preferred food of the gypsy moth were in much poorer condition than those which were less desirable to the insect.

Diameter growth rate is another measure which can be used to determine the relative vigor of forest trees. Past research with oak has indicated that average to good diameter growth over a 10-year period generally ranges from 3 to 6 cm. The data obtained from the increment boring of dominant trees indicated that diameter growth was very low within the study area (Table 18). These data further indicate that diameter growth decreased with a decrease in crown vigor class. The trees which had poor crowns, for example, were growing at a rate 30% slower than those with good crowns. Since even the trees with good crowns are growing very slowly these data indicate that those with poor crowns are just barely surviving.

Regeneration

As stated in a previous section of this report, the quantity of tree seedling regeneration is generally sufficient throughout the study area. In regards to the impact of gypsy moth, however, we are particularly interested in the quantity and species

Table 18. Diameter growth (mean $\pm$ 95% CI) of dominant canopy trees for the last 10 years at High Point Park.

Period	All Trees	Crown Vigor Class		
		Good	Medium	Poor
		-----cm-----		
1974 - 1978	0.76 $\pm$.04	0.93 $\pm$.11	0.80 $\pm$.06	0.64 $\pm$.06
1969 - 1974	0.94 $\pm$.05	1.16 $\pm$.13	0.97 $\pm$.08	0.82 $\pm$.08
Total	1.70 $\pm$.10	2.09 $\pm$.24	1.77 $\pm$.13	1.46 $\pm$.13

composition of the seedlings in those portions of the study area which have experienced heavy mortality. These new seedlings and sapling-sized trees will in all probability replace those trees which have recently died. The data in Table 19 indicate that the quantity of seedlings and small trees are nearly equal in those stands with no mortality and those which experienced heavy mortality. Although one might expect the quantity of regeneration to be higher in the areas with a large number of dead trees, this is not of major consequence because the number of seedlings is certainly adequate in both situations.

The major difference between the areas with heavy and no mortality appeared to be the species composition of the young trees. Specifically, the quantity of oak in both the seedlings and sapling-sized trees was considerably greater in those areas experiencing heavy mortality. This phenomenon indicates the future forest on these disturbed sites will be very similar to the forest which existed prior to gypsy moth defoliation.

Summary and Discussion

The major impact of the gypsy moth outbreak has been the direct and indirect mortality of 165 thousand trees within the 2606 ha area observed in this study. This would appear to be a tremendous loss, however, it should be remembered that there are still almost 768 thousand live canopy trees within the study area. The death of these trees has generally been evenly distributed throughout the forest and it has resulted in an average

Table 19. Quantity and species of regeneration for plots with no and heavy mortality in canopy trees at High Point Park.

Mortality	# Plots	Oak	R. Maple	B. Birch	Other	Total
%		-----% of Total -----				#/ha
		Seedlings				
0	175	37	42	8	13	24,108
>50	45	50	34	5	11	25,866
		Saplings				
0	175	11	34	22	33	1,690
>50	45	22	40	20	18	1,548

reduction in stand density of about 15%. Since a large percentage of the mortality was in the smaller diameter classes the forest stands at High Point now have a greater proportion of larger trees than they did prior to the gypsy moth outbreak.

The oaks, particularly chestnut and white oak, suffered much greater mortality losses than did the other hardwood species which are less preferred by the gypsy moth. One would assume that the disproportionate levels of mortality between the oaks and the other hardwood species would cause an alteration in the species composition in the disturbed forest. However, this does not appear to be the case.

For the purposes of discussion, we can assume that all dead trees within the study area were alive prior to the gypsy moth outbreak. The composition of this pre-gypsy moth forest would then resemble column three in Table 13. If we compare the composition of that forest with the one that exists today (Column 1, Table 13) we see that there has not been a great change in composition as a result of the gypsy moth outbreak.

Within the present forest chestnut oak is slightly less dominant and red maple is of slightly greater importance than before the gypsy moth activity but in general there has been very little change in species composition. Furthermore, since the regeneration on those areas which incurred the greatest amounts of mortality has a greater proportion of oak, it is likely that species composition of the forest will remain stable in the future as well.

The large number of dead trees throughout the study area could undoubtedly supply a large source of material (more than 19,000 cords) for the firewood program. Unfortunately many of these dead trees are on ridge tops and other inaccessible areas and their removal from the park would be very difficult unless new access roads are built.

The overall health and vigor of the live trees within High Point Park was not good. More than 30% of the live canopy trees (264,000 trees containing 37,000 cords) were in poor condition and growing at a very slow rate. Some of these trees will die during the next five years with the total depending upon the prevailing environmental conditions. In the case of another large gypsy moth outbreak during this period many of these trees will die if they are not protected. If management objectives of the High Point Park Staff are such that double or triple the present level of mortality cannot be tolerated then some type of aerial spray program should be undertaken if future outbreaks occur.

Any future management activities or natural occurrences which tend to increase tree vigor will also have a favorable influence on decreasing mortality during the next few years. The present mortality which is associated with past gypsy moth activities has in effect resulted in a natural thinning throughout the forest. Therefore, the residual trees in most areas are not suffering from severe competition. The removal of these dead trees will not greatly improve the growing conditions of the residual

live trees, however, it would not harm them either and as stated previously there is a tremendous amount of wood tied up in these dead trees.

One of the physiological imbalances that defoliated trees often suffer is an internal nutrient deficiency. Therefore in areas around campgrounds, and high use recreational areas where trees have a high value, it may prove beneficial to fertilize trees which are showing signs of stress.

Impact of Beaver

The beaver (Castor, canadenses) population within High Point Park and the surrounding areas has been steadily increasing during the last decade. This population will undoubtedly continue to increase in the future unless trapping or some other type of control is employed.

Beaver have an adverse impact on forest vegetation for a number of reasons. First, in the process of obtaining food and materials used in dam construction, beaver will cut or girdle a large number of trees. Secondly, and of greater impact, the flooding which results from dam construction causes the death of many trees which suffer from low soil oxygen which results from the raised water levels. Eventually, all trees within the flooded areas die and the habitat is converted from terrestrial forest to aquatic ponds. When beaver abandon an area the water level recedes and an open meadow is created. In the absence of future beaver activity this meadow will go through the stages of secondary succession and return to forest.

Within the High Point study area there are a number of active beaver colonies whose members have flooded and subsequently destroyed about 224 ha of forest (Fig.3). A portion of this total area has been flooded recently while other portions have had active beaver colonies for at least the last 5 to 10 years. Beaver activity within the park is localized at low elevations along the network of streams which run through the area. Over 98% of the beaver damage within the study area was contained in blocks 1, 2, 3 and 7.

In essentially all cases it is the lowland forest type which has been destroyed by the beaver. This is unfortunate because the lowland areas have the most productive and aesthetically the most appealing forests within the study area.

Young beavers either leave or are driven from the colony when they reach sexual maturity (generally 2 years of age) and they seek new areas in which to mate and build their own lodges and dams. Due to this behavior, it is likely that many new areas will be flooded in the future. Unless some type of beaver population control is employed, the quantity of lowland forest within the study area will continue to decrease as the beaver population increases. Furthermore, the continued flooding of these low areas will cause certain areas of the park to be inaccessible and destroy a portion of the trails and roads which have been established within the area.

Since the beaver alter the habitat in which they reside they will also influence other species of wildlife. The damming of cold water streams by beaver often results in increased summer water temperature and it contributes to water stagnation and increased siltation and toxicity. These conditions are generally detrimental to trout and other cold water fish species and their population will probably decrease due to the beaver activity within High Point.

Many other species of wildlife, however, are attracted to beaver ponds. Warm water fish such as sunfish, catfish, and bass would find the altered water conditions favorable. Furthermore, beaver ponds provide excellent resting and nesting areas for water fowl and many species of cavity nesting birds would also find these areas

desirable. Muskrats are also attracted to beaver ponds and in some cases they share the lodge with the beaver.

In the first section of this report data were presented which indicated that there was very little species or age class diversity within the vegetation at High Point. Mature forests between the ages of 60 and 120 years old accounted for more than 80% of the vegetation within the study area. The activities of the beaver are causing an increase in habitat diversity within the park and this will undoubtedly lead to an increase in wildlife diversity.

Other favorable benefits which have been attributed to beaver dam construction include stabilization of stream flow, conservation of water, prevention of rapid runoff, and the control of soil erosion.

In summary, the activities of the beaver within High Point Park will continue to be a nuisance, causing the flooding^{of} trails and roads as well as a decrease in the quantity of lowland forest. On the other hand, they are interesting to observe and they are creating increased habitat diversity which will be beneficial to many species of wildlife as well as improving the visual aesthetics for man in many instances.

However, if no population control is undertaken within the park, the beaver will eventually occupy all available habitat. This population expansion would cause the elimination of fast moving streams and much of the lowland forest within the park. The total area occupied would be approximately two to three times that which is presently disturbed (600-800 ha). This would not be a desirable situation.

One way of handling this situation would be to control the population (trapping) in certain areas but not in others. Hopefully an attempt would be made to keep beaver out of the areas which contained valuable stream segments and the more impressive lowland forests while they would be allowed to flourish in some of the less important areas.