New York State Museum Handbook 17

NEW YORK STATE MUSEUM

CHARLES C. ADAMS, *Director*

1 The Botanical Survey of the Allegany State Park
R. B. GORDON

2 A Botanical Survey of Big Basin in the Allegany State Park
F. W. EMERSON

3 A Botanical Survey of a Portion of the Allegany State Park
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4 A Botanical Survey of the Southwestern Section of the Allegany State Park ..... R. B. GORDON

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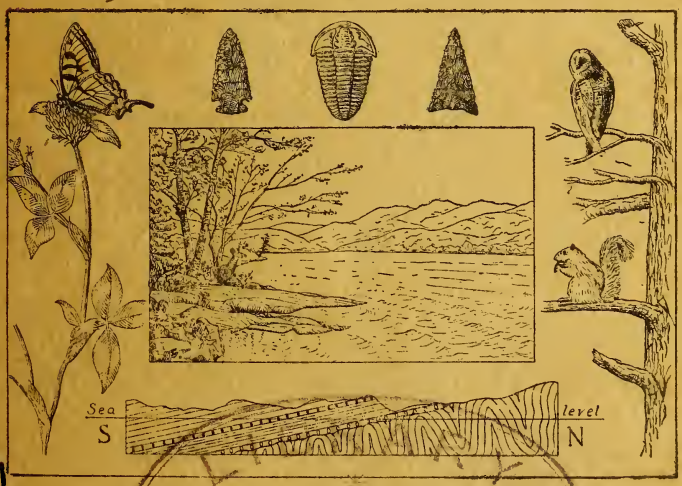
6 A Botanical Survey of the Northern Section of the Allegany State Park ..... R. B. GORDON

7 The Relation of Vegetational Surveys to a State Park Management Policy ..... R. B. GORDON

8 Suggestions Concerning Policies for the Allegany State Park
A. A. SAUNDERS

(Map Showing Vegetational Areas of the Allegany State Park, N. Y., and Adjacent Territory)



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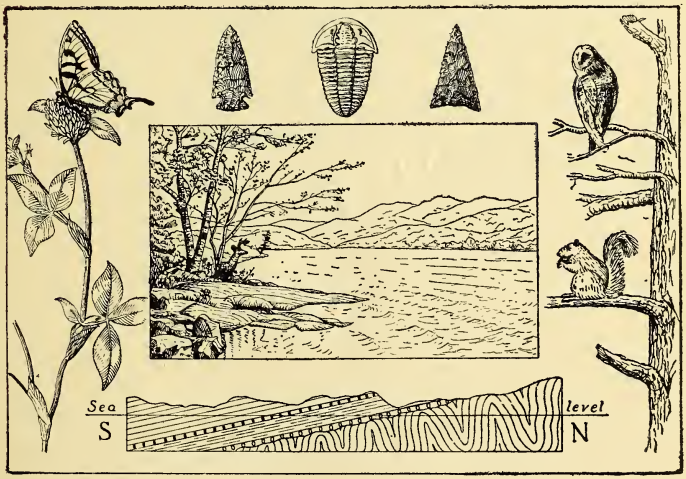

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ILLUSTRATIONS

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Figure 1 Panoramic view of the new artificial lake at the Administration Building, Allegany State Park

THE BOTANICAL SURVEY OF THE ALLEGANY STATE PARK

By Robert B. Gordon Ph.D.

Temporary Botanist, New York State Museum

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INTRODUCTION

The Allegany State Park is located in the southern part of Cattaraugus county, N. Y., and is bounded on the north and west by the Allegany Indian Reservation along the Allegheny river, on the south by the Pennsylvania state line, and on the east by Tunungwant creek, a northward flowing tributary of the Allegheny river (figures 2 and 3). The whole area is included on the topographic maps of the Randolph and Salamanca quadrangles of the United States Geological Survey.

Physiographically, it is a maturely dissected plateau, entirely unglaciated, ranging in altitude from 1280 feet A.T. on the Allegheny river bank at the state line to 2400 feet A.T. on the Salamanca-Bradford road at the crest of the plateau. The region has been influenced by continental glaciation, however, as shown by extensive valley filling along the Allegheny river and Tunungwant creek. Further discussion of the physiography of the region can be found in the first handbook of this series, by A. K. Lobeck (1927).

The vascular plants of the region are listed in the second handbook of this series, written by H. D. House and W. P. Alexander (1927). Major features of the vegetation have been outlined and described by Norman Taylor (1928) in Museum Handbook 5.

During the summer of 1928, F. W. Emerson made a botanical survey of the area known as "Big Basin," that portion of the park which lies between the old Bay State road and Red House brook. During the following summer (1929) L. A. Kenoyer charted the vegetation between the Bay State road and Quaker run, from Red

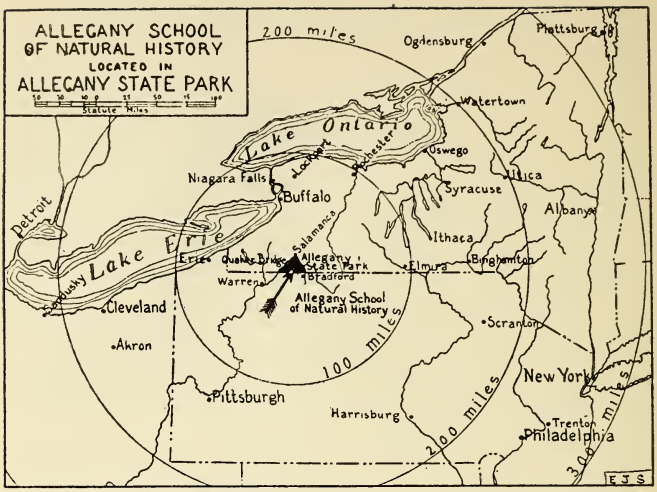

Figure 2 Map showing location of Allegany State Park

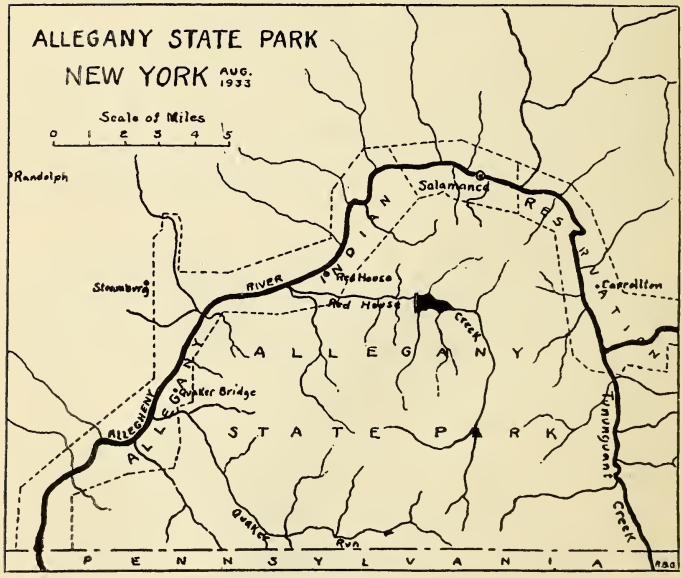

Figure 3 Sketch map of the Allegany State Park region

House road to the Allegheny river. Following these men, in the summer of 1930, I selected to chart the vegetation between Quaker run and the state line, from the Salamanca-Bradford road to the Allegheny river. In 1931, L. E. Hicks surveyed the vegetation in the eastern portion of the park, between Red House brook and Tunungwant creek. The next summer, 1932, I completed the botanical survey of the park by mapping the vegetation in the northern portion. The accompanying map (figure 4) shows the respective areas surveyed by each person. A complete vegetation map of the park has been prepared, using and combining the results of all the botanical work. Responsibility for accuracy in each area properly belongs to the individual workers.

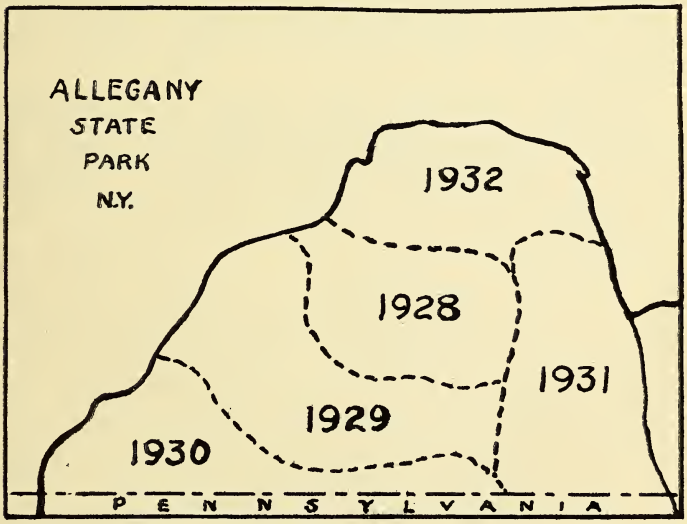

Figure 4 Outline map of areas surveyed each summer: 1928, E. W. Emerson; 1929, L. A. Kenoyer; 1930, R. B. Gordon; 1931, L. E. Hicks; 1932, R. B. Gordon.

The Allegany State Park enjoys the distinction of being the first state park in which a survey of the vegetation has been completed, following methods which are well known to plant ecologists. The field work has been done in five summer periods of two months each, July and August of each year, beginning with 1928.

Aretas A. Saunders and William P. Alexander, of the teaching staff at the Allegany School of Natural History, have been unsparing of important information which they had gained from many years of field experience in the park. To them, as well as to other members of the teaching staff, the botanical workers are indebted. Dr Charles C. Adams, Director of the New York State Museum, suggested the project, and has directed it from the beginning. He has aided generously and graciously throughout the years during which the survey has been in progress.

Courtesies have also been extended to the botanical workers by local residents in the region, particularly by John M. Holt, of Quaker Bridge, Charles E. Congdon, of Salamanca, and Leo Krampf, deputy county clerk at Little Valley.

THE IMPORTANCE OF VEGETATION SURVEYS

Vegetation surveys consist of distinguishing and mapping the plant associations, including grassland, shrub and forest types of a region. A plant association has been defined by G. E. Nichols (1923) as "a vegetation unit characterized by its essentially constant physiognomy and ecological structure and by its essentially constant floristic composition, at least with regard to dominant species." For example, the Beech-Sugar Maple association (forest type) is characterized by broad-leafed trees, of which Beeches and Sugar Maples together constitute over 50 per cent of the dominant species. Usually there is a scant undergrowth of shrubs and small trees, definitely limited as to species. The forest floor may contain shade-tolerant ferns and a number of wild flowers which bloom in early spring before foliage is well developed on the trees. Besides, there are present invariably certain fungi and parasitic seed-plants which do not require light for food manufacture.

It is only a fair question to ask: What is the value of a vegetation survey? Early surveys of natural vegetation were of interest to foresters and lumbermen as indexes to the location and extent of timbered areas. The treeless plains and prairies were perhaps equally of interest to the homesteaders who expected to engage in farming or in the grazing industry. To others, perhaps, botanical surveys were purely of academic interest. Practical farmers have been accustomed for years to make use of native plants in judging the potential value of land for agriculture. They left no published record of their experiences, however.

PLANTS AS INDICATORS OF LAND VALUE FOR AGRICULTURE

There are some statements in the writings of F. A. Michaux (1805) and of D. J. Browne (1832) to show that they appreciated the relations which exist between various kinds of soil and their plant coverings. Witness this assuring paragraph by Browne:

Plants are the most certain indicators of the nature of the soil; for while no practical cultivator would engage with land of which he knew only the results of a chemical analysis, or examined by sight and touch a few bushels which were brought to him, yet every gardener or farmer who knew the sorts of plants it produced, would be at once able to decide as to its value for cultivation. For example the garget (pokeweed?) and striped maple are generally found on a warm, loamy soil; rush on a clayey soil; the mullein and sorrel on a dry, sandy soil; and the cranberry on a peaty soil. But these plants, however, are not to be absolutely depended upon, as they are sometimes found in soils directly opposite; as climate and natural irrigation of plants have much more influence upon plants than mere soils.

PLANT COMMUNITIES AS INDICATORS FOR AGRICULTURE

Hilgard (1860) is regarded by F. E. Clements as the first investigator to recognize clearly the importance of indicators in soil studies and to make use of them in determining the agricultural possibilities of new lands. "Chamberlain (1877) shares with Hilgard the honor of being a pioneer. . . . He deserves special credit for being the first to recognize that the plant community was a better indicator than the species, and for classifying the vegetation of Wisconsin into communities with more or less definite indicator value." (Clements, 1920).

C. Hart Merriam (1898) attempted to organize the first system of climatic indicators for the United States. The following paragraph explains the practical basis for his work:

From the study of the geographic distribution of our native animals and plants it has been learned that the United States may be divided into seven transcontinental belts and a number of minor areas, each of which is adapted to particular associations of animal and vegetable life. It has been found also that each of these belts and minor areas, except the coldest, is adapted to the needs of particular agricultural products, and that the distribution of native animals and plants may be coordinated with the successful distribution of cultivated crops. In other words, the study of the geographic distribution of our native or indigenous fauna and flora has resulted in the establishment of a number of agricultural belts, each of which comprises several minor divisions fit for particular varieties of fruits, cereals, and breed of live stock.

Although the natural regions and the lists of crop plants and varieties, which were presented as best adapted to particular life zones, might not bear critical inspection today, nevertheless we must admit that Merriam saw clearly the value of such climatic indicators for agriculture.

Hilgard's book on Soils, published in 1906, devotes the last three chapters to the recognition of the character of soils from their native vegetation. He states the following important principle: "It is obvious that within the limits of the regional flora, the natural vegetation of any tract represents the best adaptation of plants to soils, in the results of long periods of the struggle for existence between competing species; the survivors being those best adapted to the entire environment."

Since the date of Hilgard's publication, Shantz (1911), Kearney and others (1914) have demonstrated the use

which could be made of native vegetation in land utilization for various types of farming and grazing. In 1917, Korstian concluded that native vegetation found on deforested areas may be used as an indicator of forest sites, "provided that the vegetation has not been too seriously or too recently disturbed, and that the more important phases of the successional series are properly understood."

The important and intimate relation which exists between crop centers and natural vegetation areas was demonstrated and explained by A. E. Waller (1918). In summarizing he stated that "the crop centers agree with the biotic centers. In detail this means that the corn and winter wheat belts correspond to the deciduous central forest and the prairie climaxes, the tame hay and pasture region to the northeastern evergreen forest, the cotton belt to the southeastern evergreen forest, and so on."

Figure 5 is a sketch map showing the major vegetation areas of New York, Pennsylvania, New Jersey and portions of adjacent states. The relation of these vegetation areas to major physiographic regions is clearly shown. Forests of spruce and Balsam Fir occur in the higher portions of the Adirondack mountains, the Catskills and the Allegheny mountains in West Virginia. At lower altitudes we find Hemlock and spruce mixed with the so-called northern hardwoods—Beech, Sugar Maple, Yellow Birch and Basswood. Over a large part of New York State and northern Pennsylvania forests of Hemlock, White Pine and northern hardwoods predominate, while spruce and fir grow chiefly in bogs. Clothing the slopes of the Allegheny plateau to the west and the Appalachian Valley region to the east are remarkable Mixed Mesophytic forests mostly of hardwoods, with some pines and melock. On the Atlantic Coastal plain, condi-

tions favor Pitch Pine, Loblolly Pine, Black and Scarlet Oaks, Persimmon, Sweet Gum and other southern hardwoods. Parts of New Jersey and Long Island are covered with Pitch Pine "barrens." Each one of these areas shown on the map constitute a peculiar geographic region, marked by characteristic climate and soil types and by a distinctive flora and fauna.

In 1920, F. E. Clements' volume on Plant Indicators appeared, summarizing previous studies of the subject and containing a wealth of original botanical information secured chiefly in the western United States.

At a meeting of agricultural workers in Ohio, Waller (1925) advocated a complete primary vegetational survey of Ohio as a means of approach to many agricultural problems.

VEGETATION SURVEYS AS A BASIS FOR LAND CLASSIFICATION

The state of Michigan has already undertaken a land and economic survey, of which a vegetation survey was an important part (Smith, 1926). It is expected to form the basis for land classification, which will in turn determine utilization, present value and potential value. What this means to the state of Michigan in an economic way can only be surmised. Certainly it will bring the state closer to a fair settlement of the land taxation question which today constitutes one of the larger problems of government.

A Preliminary Wild Life and Forest Survey of Southwestern Cattaraugus County, N. Y., just west of the Allegany State Park, has been completed by V. H. Cahalane and the results have been published under that title in a Roosevelt Wild Life Bulletin (1928). These

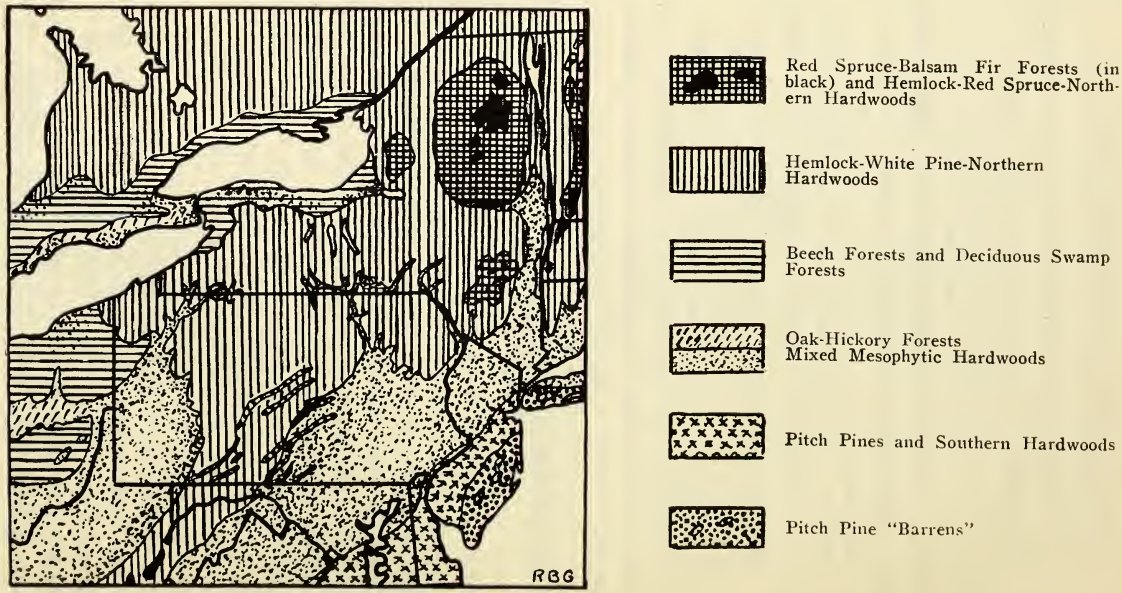

Figure 5 Natural vegetation areas of some northeastern states

results have a definite bearing on the utilization of land unsuitable for agriculture, a problem by no means limited to New York State.

PRIMARY VEGETATION AS A BIOTIC INDICATOR

Even after the original vegetation cover has been destroyed, the climatic and edaphic (soil) factors which have favored its development continue to influence all forms of life within the area. Rather recently (1927), E. N. Transeau has observed correlations between primary vegetation types and insect devastations, as shown by the distribution of the Mexican Bean Beetle and the European Corn Borer in Ohio. A demonstration of the use of original plant associations as indexes to biotic habitats was contributed by Sampson and Transeau in 1928, in an article from which the following paragraphs are quoted:

> A reconnaissance survey in Ohio, New York, Michigan, and Ontario during the summer of 1926 showed that the most serious borer infestation was in those areas formerly occupied by bogs, swamps, and swamp forests. . .
>
> During the present survey, particularly during the more detailed survey by Sampson and Robert Gordon in 1927 . . . it became evident that the various origins and phases of the swamp forest should receive more attention. These differences are of interest to botanists and foresters, and there are also indications that some of them may be correlated with differences in the behavior of the corn borer.

Unfortunately it has been only in late years that we have begun to realize the fundamental importance of a knowledge of natural vegetation in economic affairs. Few and fragmentary are the records existing today. Especially can this be said of the eastern states, which were rapidly cleared and settled. No time should be lost in making permanent and accurate records of what is known regarding the original associations of forest trees in this region.

Figure 6 A virgin Hemlock forest at Heart's Content, Pa. Such forests originally clothed the cool mountain slopes in Allegany State Park.

NATURAL AND SEMINATURAL VEGETATION

By natural vegetation is meant that which has been undisturbed by man. A virgin forest is a good example. Anyone who is studying the vegetation of Allegany State Park should keep in mind that, although mature timber may be found in many portions of the park, there is no virgin forest here comparable to that at Heart's Content, Pa., (figure 6) as described by H. J. Lutz (1930). Thus descriptions of the vegetation of the park include descriptions of forests in seminatural condition, that is, forests which have been modified in some way or another by man. The lumber and tanbark industries, wood-cutting, fires, grazing and cultivation in some areas have entirely changed the appearance and composition of a large part of the primeval forests which once clothed the valley slopes and bottomlands.

METHODS OF DETERMINING CHARACTER OF NATURAL VEGETATION

Fortunately there are methods by which the character of the natural vegetation can be determined with a fair degree of accuracy. These methods are presented here:

1 Study vegetation types and successions in the *least disturbed* areas of the region.

2 Note the relation of these vegetation types to topography and soil types.

3 Determine what kinds of vegetation are likely to follow each of the relatively undisturbed vegetation types after clearing, selective cutting, fires, grazing and abandonment after cultivation.

4 Obtain local vegetational history by means of early surveyors' records, county histories and county atlases,

Figure 7 Original forest profile in Big Basin. Sketch by Louis Jacobson from data furnished by R. B. Gordon.

and by talks with old settlers, who may have reliable information on such matters.

In order to apply these methods to a given area we must make this fundamental assumption: *Proximate areas having the same type of climate, physiography and soils probably had the same or similar natural vegetation on comparable sites.* For instance, the virgin forest at Heart's Content, Pa., is located within 50 miles of the Allegany State Park, in the unglaciated Allegheny plateau. The Hemlock-Beech association, according to Lutz (1930) lies at the head of a valley at an elevation of 1800 to 1850 feet, with a northeast aspect. The soils have been classified in the DeKalb series and originated from the weathering of sandstones and conglomerates. Suppose we choose an area similarly located with respect to topography and soils in Allegany State Park. Perhaps the best example is found today at the headwaters of Stoddard creek, in the area known as Big Basin. My own observations show that along the creek itself and extending for some distance up the slopes, Hemlock is the most abundant species, forming approximately 75 per cent of the mature trees, the rest being principally Beech and scattered specimens of Yellow Birch and Sugar Maple (figures 7, 8, 9 and 10). Here the timber has scarcely been disturbed by lumbering operations and shows a composition almost exactly similar to the Hemlock-Beech association at Heart's Content, though the trees are not so large, nor presumably so old.

Through the courtesy of the deputy county clerk of Cattaraugus county, Leo Krampf, I had the opportunity to study the original lot maps prepared for the Holland Land Company. The original field notes by Joseph Ellicott, surveyor in charge, show that the lots were surveyed in the

Figure 8 A mature Hemlock forest in Big Basin

Figure 9 A wind-thrown Hemlock in Big Basin. Notice the exposed shallow root system, which is characteristic.

period between September 1798 and June 1799. Witness trees were indicated at the lot corners, which were from three-quarters of a mile to slightly more than a mile apart, depending on the size and shape of the lots. I superimposed the lot map of the Allegany State Park on the topographic sheets of the Randolph and Salamanca quadrangles, and transferred the names of the witness trees to the new map. Using this information, supplied by the witness trees, in addition to the vegetation map of the park, it will be possible to reconstruct with a fair degree of accuracy the original vegetation of the whole area.

PRINCIPAL VEGETATION TYPES IN THE ALLEGANY STATE PARK

Whatever may have been the character of the original forests of the region, it is necessary to use the present vegetation as a basis for reconstructing the primeval, if such a project should appear desirable. The maps and charts which have been prepared by Messrs Emerson, Kenoyer, Hicks and myself show areas occupied by the following types of vegetation, which are, on the whole, rather well marked in the Allegany State Park.

BIG TREES, MATURE TIMBER OF BEECH-SUGAR MAPLE TYPE

The best example of this kind of forest is found at the head of Stoddard hollow in Big Basin. Frequency counts made by Kenoyer in this area showed that Beech and Sugar Maple clearly predominate over Yellow Birch and Hemlock. Some observations of my own show that Hemlock and Yellow Birch become much more frequent on the lower slopes and in the valley bottom, the Hemlock in some places growing in nearly pure stands, as can readily be observed by driving through Big Basin on the new road

Figure 10

Figure 11

Figure 10 Effect of a wind-throw in a Hemlock forest, Big Basin. An old Sugar Maple is leaning heavily on a Hemlock about 12 inches in diameter. Three Hemlocks are down, in the foreground. Shallow root-systems cause Hemlocks to be particularly susceptible to this type of injury.

Figure 11 Hardwood forest of Sugar Maples on a ridge in Big Basin, between Stoddard hollow and Bee Hunter's creek. See figure 7.

running in a southerly direction from the Administration Building. American Elm and Blue Beech are rather infrequent, but occur very close to the brook margin in Stoddard hollow. Above the "spring water horizon," which is here about 1850 feet, the forests approach more definitely the Beech-Sugar Maple type. Basswood is regularly associated with this type of forest. As the ridge tops are approached, Red Oak, Red Maple and Chestnut appear in the stand, together with White Ash, Yellow Poplar, Cucumber Tree, Black Cherry, and White Pine. Some of the ridge tops are capped with a mixed mesophytic hardwood forest rather than with the Beech-Sugar Maple type. The big trees are only remnants of the magnificent forests which clothed the slopes of the Allegany State Park. About 1700 acres within the park boundaries are of this type.

SUGAR MAPLE-BEECH FOREST, MAINLY SECOND GROWTH

Where Sugar Maple and Beech predominate in the forest they are practically all young growth, much being of sprout origin. *This is by far the most extensive type of vegetation in the region.* Kenoyer's estimates of frequency show Sugar Maple occurring twice as often as Beech, and indeed pure stands of Sugar Maple are not uncommon (figures 11 and 12). A great majority of the "sprout maples" are of small diameter. This leads us to believe that such forests result from cutting mature Beech-Sugar Maple forests to small diameter limits, as is the practice in cutting wood to be used for destructive distillation ("chemical wood"). Anyone who examines a mature Beech-Sugar Maple forest can not fail to be impressed by the huge number of Sugar Maple seedlings and saplings in the undergrowth. When these are released by the cutting of

larger trees which have shaded them, they grow rapidly. Sprouts also grow vigorously from trees which have been cut, and, in a few years, a Sugar Maple-Beech forest is established. The heavy shade produced serves to exclude

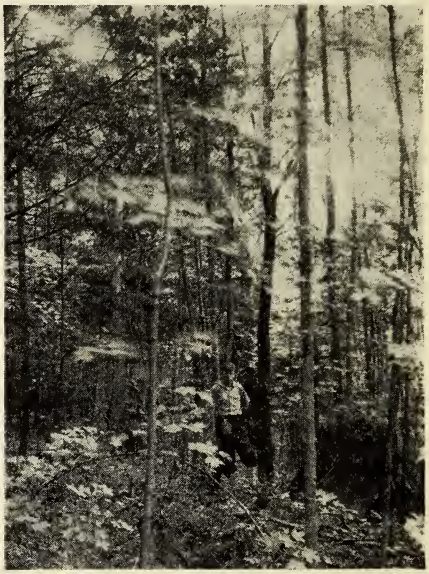

Figure 12 A dense growth of Sugar Maple saplings surround decaying Hemlock stumps, like the one shown at the right of the boy.

all invaders. In some areas nearly pure stands of young Sugar Maple can be found. One such area occurs along the pole-line on Blacksnake mountain, within easy access from the Allegany School of Natural History. The Sugar Maple-Beech forests cover more than 40,000 acres within the areas surveyed.

LAND IN CULTIVATION OR PASTURAGE; OLD FIELDS AND CLEARINGS REVERTING TO FOREST

Little explanation is needed for this class of land. It can scarcely be called a vegetation type because it consists of several types. Its vegetation varies or is likely to vary from year to year so that it has not been found practicable to map it in detail. Oats, rye, buckwheat and potatoes seem to be the most productive crops under cultivation. Some corn is grown for fodder. Timothy forms the principal hay crop. On account of the acid character of the soils in this region, legumes are not successful, except where lime may have been added. Dairying is an important industry in this region and much of the open land is grazed. The pastures in the valley are located on deeper and heavier textured soils; they are more productive than

Figure 13 A decayed Hemlock makes an ideal seed bed for the next generation

Figure 14 Scene in a pasture, showing Hawthorns browsed by the cattle

Figure 15 Wasteland in the Allegany Indian Reservation, south of the village of Quaker Bridge

those on the uplands. Many of the upland pastures are stony and contain Wild Oat Grass, Oxeye Daises and Wild Strawberries. There is plenty of opportunity for pasture improvement, even in the valleys.

It is significant, however, that such lands in the park do normally and naturally revert to forest. In areas adjacent to Sugar Maple-Beech forests, Hawthorn and Hemlock may be the only kinds of trees to survive browsing by cattle (figure 14). Where Oak forests surround pastured areas, Staghorn Sumac, Sassafras, aspens and Red Maple are among the earliest invaders, accompanied by White Pine where old "seed trees" remain. The sumacs, sassafras, aspens and pines also appear to withstand grazing (figure 15).

Hundreds of acres of abandoned farm clearings have been planted to conifers, largely Red Pine, Scotch Pine, White Pine and Norway Spruce. The total area of cultivated land, pasture land and old fields is not much more than 13,000 acres, within the region covered by our surveys.

AREAS RECENTLY BURNED OR OTHERWISE DENUDED AND IN ASPEN-RED MAPLE-FIRE CHERRY STAGE OF REVERSION TO FOREST

Although several such areas can be found in the western portion of the Allegany State Park, by far the greatest extent of the aspen types is found in the northern and eastern portions. In general, these are portions of the park area north and east of Red House brook. The composition of these types is quite variable, but the aspens are usually present in abundance. The Trembling Aspen is found on all recently burned or cleared sites. The Large-toothed Aspen occurs principally on the upper slopes and ridge tops, where it was originally an associate in the Oak-Chestnut forest. The common Brake or Bracken fern

(*Pteridium latiusculum*) and Rough-leaf Goldenrod (*Solidago rugosa*) are the two most abundant herbs to be found in the undergrowth beneath aspens.

About 12,000 acres of land within the park boundary and about half of the land in the Allegany Indian Reservation has been mapped as Aspen-Red Maple-Fire Cherry type. It is of course only a temporary type. With the cessation of fires and of wood-cutting, it will eventually be replaced with a forest consisting of oaks or of Sugar Maples. Which type of forest will eventually succeed depends principally on what was the original type in the area. Areas originally containing Sugar Maple and Beech are frequently found stocked with seedlings of Sugar Maple. Where the original vegetation consisted of Oak-Chestnut, Mixed Mesophytic, or White Pine forest, the temporary aspen forests are being replaced with oak.

OAK FOREST, MAINLY SECOND GROWTH

Oak forests today occur where originally there were at least three primary types, Oak-Chestnut, Mixed Mesophytic, and White Pine (Gordon, 1932). Of such value were these forests that they were the first types to disappear when the lumber industry invaded the region.

Cut-over areas were subject to frequent fires, which destroyed the majority of White Pine seedlings. Following the fires, Fireweed (*Epilobium angustifolium*) covered the landscape with a sea of light magenta or purple color. Soon the Bracken replaced the Fireweed; aspens and Red Maples seeded into the area, and thickets developed in addition, as a result of sprout growth from the Oaks and Chestnuts.

The Chestnut Blight Fungus (*Endothia parasitica*) during the past 14 years has infected every Chestnut tree.

Hickories have been selectively cut by the Indians on the reservation for home industries. The oaks, however, have resisted these attacks and have sprouted vigorously and persistently after cuttings and fires.

Approximately 11,000 acres within the limits of our survey are covered with second-growth oaks and Chestnut sprouts, aspens and Red Maples with some hickories and White Pine. Some is on the Indian Reservation; but 9500 acres, including the best of this type, lie within the park boundary.

HEMLOCK-BEECH FOREST

This type of forest now occurs mainly on lower slopes of the valleys, near the streams, and in moist coves, especially those facing north and east. It represents most nearly the natural climax forest of the region, which apparently was a forest in which Hemlocks formed 50 to 75 per cent of the dominant stand. Original forests such as these can now be found at Heart's Content, Pa., below the spring horizon, and also at the Cook Forest State Park, in Pennsylvania. By far the largest tract of virgin forest of this type in Pennsylvania is located about five miles south of Ludlow, in Warren and McKean counties. It is owned by the Central Pennsylvania Lumber Company, which is engaged in logging the entire area for lumber and tan bark. The composition of this virgin forest has been studied intensively by A. F. Hough, assistant silviculturist of the Allegheny Forest Experiment Station, who has kindly allowed the writer the privilege of inspecting the area and of reading his manuscript report.

Hemlocks 350 to 450 years old have by far the greatest basal area in virgin forests of this type. Beech is next in basal area, and is much more abundant than Hemlock

in the reproduction or young growth. Sugar Maple is usually third in abundance among the dominants, followed closely by Yellow Birch (Hough, 1936).

The ground cover vegetation here is composed almost wholly of five species of vascular plants, *Aspidium spinulosum* var. *intermedium, Lycopodium lucidulum, Oxalis acetosella, Mitchella repens,* and *Viburnum alnifolium.*

Removal of Hemlock forests by windstorms, by lumbering or by tanbark operations always results in a decided change in forest composition, the forest becoming definitely a hardwood type, with Beech, Sugar Maple, Black Cherry and Yellow Birch as the dominant species. The undergrowth in this secondary type consists very largely of Sugar Maple seedlings and saplings, interspersed with Beech and Black Cherry.

Hemlock reproduction in this region seems to be confined to decaying hemlock logs or to seepage zones on the slopes and near the streams (figure 13). Indications are that the Hemlock forests in this region are decadent and for the most part will be succeeded by a Beech-Sugar Maple or Sugar Maple-Beech type, if fires do not destroy the ground cover and humus.

THE FOREST CLIMAX

Let us have a clear idea as to what is meant by the term "climax forest." A *climatic climax association* has been defined as the most advanced or most mesophytic type of vegetation which the climate of a given region will support (Nichols, 1923). A climax forest must therefore be a mature one which has practically ceased to change in composition, at least with regard to dominant species. Furthermore, we must be careful to distinguish certain edaphic climaxes, that is, forests which have reached maturity on

extreme types of soils. This is particularly important in a hilly region such as Allegany State Park, where there is every gradation from poorly drained soils of the bottomlands to excessively drained soils on the ridges.

Taylor (1928) recognized *two* major climax types, Birch-Beech-Maple and Oak-Hickory. Kenoyer disagrees with Taylor and considers the climax forest to be Beech-Sugar Maple-Yellow Birch-Hemlock, in which "the first two clearly prevail over the others" (Kenoyer, 1937). William L. Bray (1916; 1930) in an attempt to apportion the vegetation of New York into life zones, characterizes the Allegheny Transition Forest Zone as being dominated by Sugar Maple, Beech-Yellow Birch, Hemlock and White Pine mixed forest. In reference to its distribution in New York State he states that this forest has a "tendency to recurrence upon every favorable edaphic situation throughout the State up to more or less 2000 feet (Catskills) excepting, in general, the Adirondacks, but dominant over the Allegheny plateau region and the Catskills below the Spruce-Balsam Zones."

PRIMARY FOREST TYPES OF THE PARK REGION

The Allegany State Park region contains vegetation elements belonging to two major plant formations of North America, namely, the northern evergreen forest and the eastern deciduous forest. An outline of the primary forest types of the region is presented here as a basis for mapping natural vegetation, should such a project appear desirable.

A Northern Evergreen Forest Formation

1 **White Pine—American Elm type.** White Pine evidently occurred on poorly drained "flats" and boggy areas in the lower valleys of the major streams, where it

Figure 16 A virgin forest of the White Pine-Hemlock type. Cook Forest State Park, Pa. Forests like this were the source of White Pine in the Allegany State Park region.

Figure 17 White Pine in a pasture, Lower Quaker Run valley

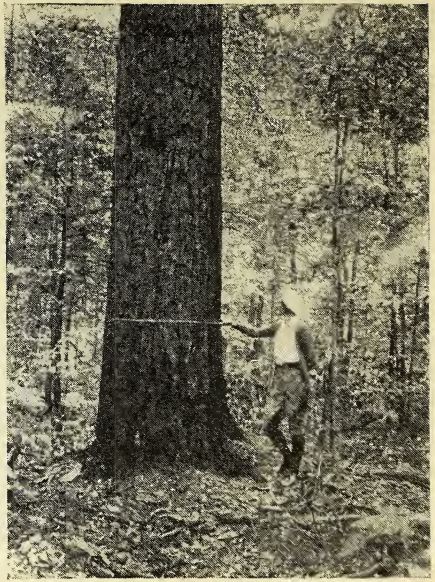

Figure 18 White Pine in a virgin forest, Heart's Content, Pa.

was associated with American Elm, Hemlock, Yellow Birch, Red Maple, Black Ash, and even Balsam Fir. Bogs in the glacial moraine area north of Steamburg, are surrounded or covered with this type of vegetation even today.

2 **White Pine type.** In this region, White Pine alone, or in mixture with Hemlock, formerly occupied lower slopes, "benches" and gravel terraces in the valleys of the Allegheny river and its tributaries (figures 16, 17 and 18). A pure stand of White Pine grew on the high terrace of the river south of Quaker Bridge (figure 25). Joseph Ellicott, in his field notes, referred to this place as "a fine Pinery" in 1798.

3 **Eastern Hemlock type.** The upper valleys have for centuries been covered with stands of Hemlock and the northern hardwoods, Beech, Sugar Maple and Yellow Birch, whose relative abundance, in the order given, can be verified by inspection of the Holland Land Company's survey records dating to 1799. Pure stands of Hemlock once composed the climatic climax forest of this region (figure 8), occupying the well-watered and fairly well-drained valley slopes. On slopes with a northeast aspect the Hemlock forest extended nearly to the ridge tops. In water-logged, colluvial soils of lower slopes and in the valleys Yellow Birch became a more important constituent of the Hemlock forest than it was on better drained sites. On better drained soils, Beech and Sugar Maple were the principal associates of Hemlock in the original forest.

B Eastern Deciduous Forest Formation

1 **Beech-Sugar Maple type.** In this type, Beech and Sugar Maple comprise from 50 per cent to 90 per cent of the dominant stand, associated commonly with Black

Cherry, Basswood, White Ash and Red Maple. This type of forest covered the upper slopes and some ridge summits where water loss was never excessive. It graded into the Hemlock forest below and into the mixed mesophytic hardwood forest above. A Sugar Maple-Basswood type should perhaps also be recognized on slightly drier sites, always above the spring horizon, in localities where tree species of the Oak-Chestnut forest may have been eliminated by too much shade (figure 7).

2 Mixed Mesophytic hardwood type. In the region covered by this survey, this type is represented by a mixture of Beech, Sugar Maple, Basswood, White Ash, Black Cherry, Red Oak, Chestnut and Red Maple, with a number of other scattered species, including White Oak, Yellow Poplar, Cucumber Tree, Hemlock, White Pine, Shagbark Hickory, Sour Gum and Striped Maple. The species of dominants are so numerous and so nearly equal in abundance that it is impossible to name this type from two or three important dominants. Foresters have applied the term "cove hardwoods" to such types, which occupy many slopes throughout the dissected Alleghany plateau from western Pennsylvania south to Georgia. The type approaches the northern edge of its range in the Allegany State Park region, where it originally occurred on slopes near the river and on summits in Big Basin, in the central portion of the park (figure 7). Several areas now mapped as Oak forest today were formerly covered with the Mixed Mesophytic hardwood forest. About half way to the summit of Jones hill, south of Steamburg, is an excellent remnant of this type of forest, below the Oak-Chestnut forest which is to be found at the summit.

3 Oak-Chestnut type. The principal associates of Chestnut in the park region are Chestnut Oak, Red Oak,

Red Maple, White Oak and White Pine, while Black Oak, Pignut Hickory, Large-toothed Aspen, Trembling Aspen, Cherry Birch, Fire Cherry, Sour Gum and Sassafras were originally less frequent than they are today in the oak forest. There are good grounds for recognizing Oak-Chestnut-White Pine as a distinct type in western Pennsylvania and in parts of northeastern Ohio. The undergrowth is usually characterized by shrubby heaths, such as Huckleberry, Low Blueberry, Creeping Wintergreen and Trailing Arbutus, which indicate the very acid character of the soils on which the Oak-Chestnut forest grew. In this region it occurred originally on ridges and steep slopes exposed to excessive water loss. It represents the most xerophytic forest type of any great extent to be found in this vicinity.

CLIMATIC CONDITIONS IN THE PARK REGION

The climate of the Allegany State Park region is determined in general by the following factors: (1) its latitude, or the distance north of the equator, 42°00′ at the Pennsylvania State Line; (2) its altitude, or the elevation above the sea level, from 1280 feet along the Allegheny river to 2400 feet at the highest point on the Bradford road; (3) its position with respect to large bodies of water, at least 50 miles southeast of Lake Erie, one of the smallest of the five Great Lakes; (4) its position with respect to the usual paths of cyclonic storms.

Weather records have been kept since September 1924 by DeForest A. Matteson, forest supervisor of the Allegany State Park, who has courteously made these records available. They represent the most complete records which have been kept in this vicinity, with the exception of Jamestown, N. Y., in Chautauqua county to the west.

FROSTS AND THE GROWING SEASON

The local records for the length of the growing season for seven years, 1925 to 1931, show the period between the date of the last killing frost in spring and the date of the first killing frost in autumn. The following table gives the data for Allegany State Park, as prepared by Mr Matteson:

TABLE 1

Frost dates and growing season in Allegany State Park

YEAR	DATE OF LAST KILLING FROST IN SPRING	DATE OF FIRST KILLING FROST IN AUTUMN	LENGTH OF THE GROWING SEASON (DAYS)
1925.....	June 17	September 23	98
1926.....	June 4	September 14	102
1927.....	June 16	September 24	100
1928.....	June 16	September 18	94
1929.....	June 7	September 19	104
1930.....	June 1	October 2	123
1931.....	June 2	September 29	119

The growing season, as determined above, has an average length of 106 days for the period given. It must not be thought, however, that the growing season here is a frostless season. Light frosts may occur any month in the year in Allegany State Park. On these occasions the temperature usually drops to 31° or 32°F. The following table shows the frequency with which light frosts occur during the growing season, from 1925 to 1931.

TABLE 2

Light frosts during the growing season in Allegany State Park

YEAR	GROWING SEASON (DATES)	NO. OF FROSTS IN GROWING SEASON			
		JUNE	JULY	AUGUST	SEPTEMBER
1925...	June 17–Sept. 23	2	0	2	2
1926...	June 4–Sept. 14	3	1	1	4
1927...	June 16–Sept. 24	3	1	3	4
1928...	June 16–Sept. 18	1	0	0	2
1929...	June 7–Sept. 19	1	1	1	1
1930...	June 1–Oct. 2	0	1	2	3
1931...	June 2–Sept. 29	0	0	0	1

According to charts prepared by Mordoff (1925), whose bulletin on The Climate of New York State has been freely consulted, the average date of the last killing frost in spring is June 1st and the average date of the first killing frost in autumn is September 20th. This gives an average length of 112 days for the growing season, in the southwestern part of Allegany county, while Jamestown, N. Y., in Chautauqua county, enjoys a growing season averaging 166 days in length, from May 10th to October 10th. Jamestown shows the modifying effect of nearness to the Great Lakes more than its lower altitude, in prolonging the growing season. Allegany State Park, with a growing season of less than 110 days, is comparable to the northern Adirondacks in this respect (figure 19).

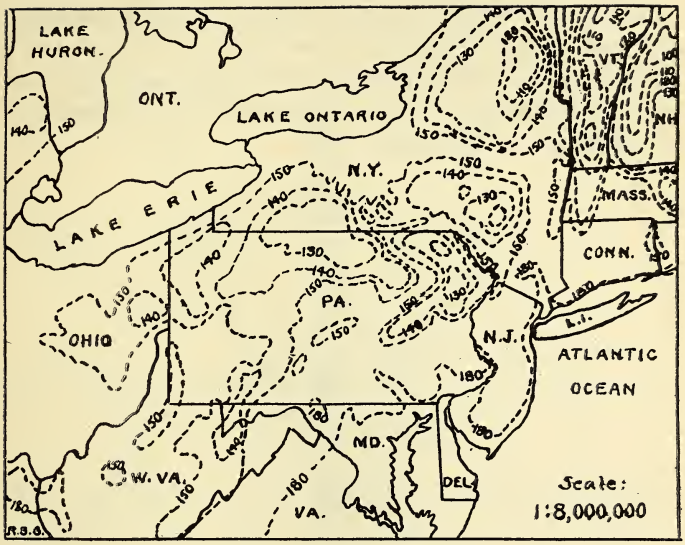

Figure 19 Average number of days a year without killing frosts. From Atlas of American Agriculture, Part II, Sec. I (U. S. Dep't Agr., 1915).

RAINFALL AND SNOWFALL

The total annual precipitation in Allegany State Park for eight years, 1925–32 inclusive, averages very close to 44 inches, with a maximum of 52.17 inches in 1927, and a minimum of 36.27 inches in 1930. Average precipitation for each month of the year from 1925 to 1932 inclusive is shown in the following graph. The apparently high average for November is due to a phenomenal precipitation of 11.92 inches in November 1927.

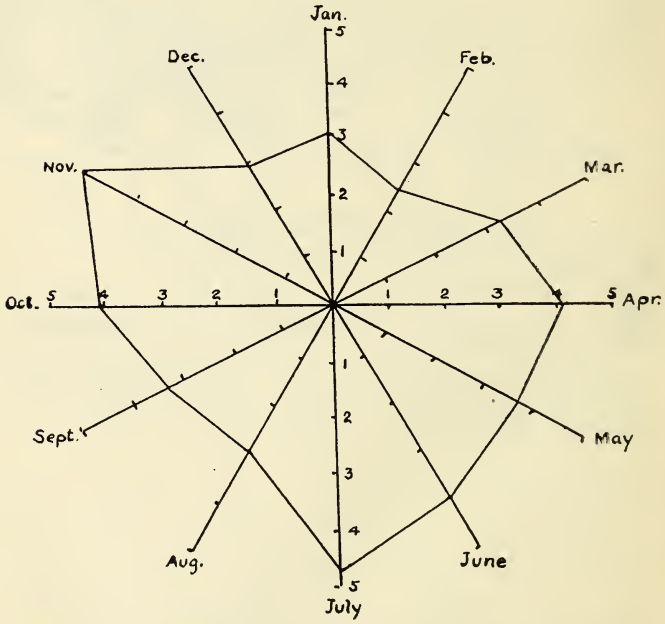

Figure 20 Distribution of precipitation through the 12 months in Allegany State Park, N. Y. Based on averages for eight years (1925–32). Data supplied by DeForest A. Matteson. (Each division on radial scale represents one inch of precipitation.)

The records of precipitation at Jamestown, N. Y., for the same eight-year period are shown in the following graph. Here, too, the highest average is reached in the month of November. The "normal" distribution for a longer period, 33 years, however, shows a more even distribution throughout the year.

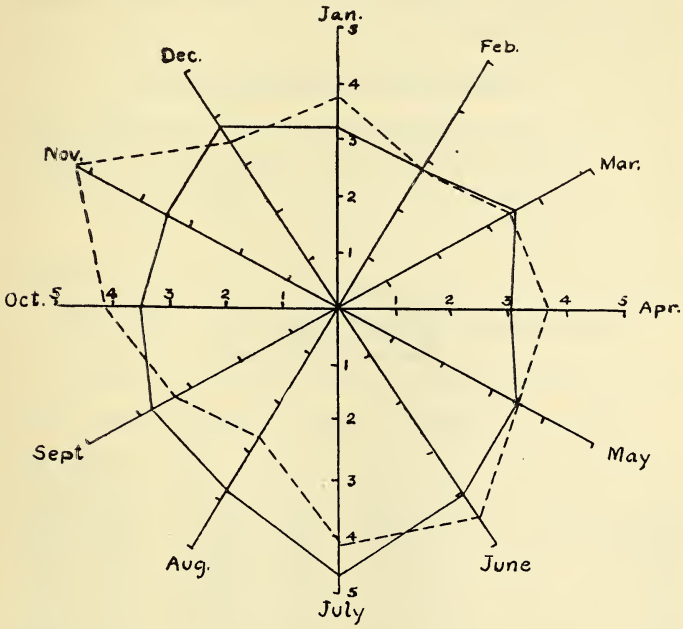

Figure 21 Distribution of precipitation at Jamestown, N. Y. Averages for eight-year period (1925–32) follow dotted lines. Averages for 33-year period follow solid lines. Data compiled by Carol Y. Mason. (Each division on radial scale represents one inch of precipitation.)

The average annual snowfall in the southern part of Cattaraugus county is close to 60 inches. In Allegany State Park for the eight-year period, 1925 to 1932, the average annual snowfall has been 62.3 inches. The maximum during this period was 85.9 inches in 1925, while the minimum was 48.6 inches in 1928. Snow occurs usually from October to April, inclusive, but traces have been recorded by Mr Matteson in both May and September within the past nine years.

TEMPERATURE CONDITIONS

The average mean temperature for each month of the year in Allegany State Park is shown in the following table, which also shows the extreme highest and extreme lowest temperature recorded during the month.

TABLE 3

Temperatures in Allegany State Park (1925–1932) in Degrees Fahrenheit

MONTH	AVERAGE MEAN	HIGHEST	YEAR	LOWEST	YEAR
January	25.0°	67°	1932	−25°	1925
February	27.0°	69°	1932	−19°	1929
March	32.5°	74°	1928*a*	−17°	1926
April	42.5°	86°	1925	10°	1926
May	52.6°	88°	1929	18°	1928
June	61.1°	93°	1925	24°	1926
July	65.6°	97°	1931	31°	1927*b*
August	63.8°	95°	1930	29°	1925
September	59.8°	94°	1931	24°	1927
October	47.9°	90°	1927	16°	1925
November	38.5°	73°	1931	−30°	1929
December	28.1°	65°	1932	−19°	1926

a Also in 1927 and 1929.
b Also in 1929.

Since temperatures during the growing season are often critical in determining conditions for plant growth, Dr. Kenoyer, Dr. Hicks and myself have kept temperature records at the Allegany School of Natural History during the months of July and August. The thermometers used in recording temperatures here were of the maximum and minimum type, furnished by the New York State Museum. They were kept in an improvised shelter, open on the north side, fastened to a Sugar Maple tree about five and one-half feet above the ground in a shady forest of second growth Sugar Maple, Beech and Yellow Birch. The altitude of the school grounds where the thermometers were located is about 1875 feet.

TABLE 4

Maximum temperatures July and August at Allegany School of Natural History

PERIOD	1929	1930	1931	1932	1933
July 6–10	83°	.....	.....	.....	80°
July 11–15	81°	*a* 82°	*a* 81°	.....	76°
July 16–20	77°	85°	83°	82°	79°
July 21–25	82°	91°	79°	82°	91°
July 26–31	85°	89°	84°	79°	88°
August 1– 5	73°	92°	88°	79°	90°
August 6–10	80°	90°	86°	80°	77°
August 11–15	80°	79°	76°	75°	77°
August 16–20	76°	77°	76°	83°	79°
August 21–25	80°	72°	73°	81°	78°
August 26–31	*a* 79°	*a* 78°	70°	83°	.....

a Records incomplete for period given.

TABLE 5

Minimum temperatures for July and August at Allegany School of Natural History

PERIOD	1929	1930	1931	1932	1933
July 6–10	51°	.....	.....	.....	43°
July 11–15	41°	*a* 32°	*a* 47°	.....	46°
July 16–20	32°	42°	55°	*a* 49°	42°
July 21–25	39°	51°	43°	39°	53°
July 26–31	44°	40°	45°	40°	43°
August 1– 5	38°	40°	49°	41°	44°
August 6–10	39°	50°	54°	40°	44°
August 11–15	46°	32°	50°	40°	40°
August 16–20	33°	37°	49°	34°	44°
August 21–25	42°	42°	43°	36°	46°
August 26–31	*a* 43°	44°	40°	.....	.....

a Records incomplete for period given.

HUMIDITY AND DROUGHT

It has been the established custom of the United States Weather Bureau to publish observations made at 8 a.m. and 8 p.m. Relative humidity determinations so recorded are considerably higher than those made at 2 or 3 p.m. Diurnal changes in relative humidity at the Allegany School of Natural History are indicated in the following table:

TABLE 6

Relative humidity determinations in second-growth Maple-Beech Forest at Allegany School of Natural History

PERIOD OF RECORD	RELATIVE HUMIDITY AT 8 A.M.			AT 3 P.M.		
DATES	HIGHEST	LOWEST	MEAN	HIGHEST	LOWEST	MEAN
July 13–31, 1930.....	95%	57%	76%	....	....	.....
July 19–31, 1932.....	....	....	....	95%	39%	67%
August 1–15, 1930.....	97%	58%	77%	....	....	.....
August 1–15, 1932.....	....	....	....	97%	43%	70%

Although determinations made in different years are scarcely comparable, it should be remembered that droughts prevailed in the summer of 1930, while the summer of 1932 was more nearly normal.

As far as plant growth is concerned, drought periods are often the critical periods. This is particularly true of the plants classed as mesophytes, which make up the largest part of the forest vegetation in Allegany State Park. If these plants are not destroyed by dessication, they may remain in a wilted condition so long that the stomata (tiny pores in the epidermis of leaves and young stems) remain closed most of the daylight period. As a result, diffusion of carbon dioxide into the green tissues is retarded and the food-manufacturing processes are considerably reduced. Food consumption may still proceed, theoretically, until accumulated foods are used up, in which case the plants will die of starvation.

Drought periods are rather infrequent in the Allegany State Park, although occasionally there may be a month with less than an inch of rainfall. In the seven-year period from 1925 to 1931 inclusive, the average rainfall during the growing season has been about 14 inches. In August 1929, in July and in August 1930, however, less than one and one-half inches of rainfall was recorded during each month.

SOILS OF ALLEGANY STATE PARK

Although the soils of Allegany State Park have not yet been surveyed, some studies of water-holding capacity and acidity of various soil samples have been made by Taylor (1928).

Modern soil classification is based on definite soil characteristics, such as the following:

1 Stage of maturity or development of profile
2 Texture of various horizons in the profile
3 Color of various horizons in the profile
4 Structure of various horizons in the profile
5 Soil reaction, whether acid, neutral or alkaline

The stage of maturity of a soil may be determined by the development of its profile. "The series of layers in any given soil is designated as its profile and its characteristics are made up of the sum total of the characteristics of the layers in its profile" (Marbut, 1927).

Mature soils in the Allegany State Park are characterized by surface layers of leaf litter and duff over an ashy gray layer of mineral soil from one to three inches thick; below the gray layer a thin coffee-brown layer ("orterde") may be distinguished. The coffee-brown layer contains compounds of iron, alumina and organic matter, which have been leached from the upper layers.

The subsoil is uniformly some shade of brown, light brown or in some places, reddish brown. Angular fragments of sandstone and siltstone are plentiful, giving the soil a gravelly or stony texture.

PODZOLIZED SOILS AND PODZOLS

Such soils which possess an ashy-gray layer underlain by brownish or yellowish subsoils are said to be *podzolized.* When the gray layer or "bleicherde" is present they are classed as true podzols. *Podzol* is the term applied originally to the gray soils of northern Russia. Environmental conditions determine how rapidly and how far this process of podzolization may proceed. First of all, the climate must be comparatively cool, with precipitation in excess of evaporation. Secondly, soils derived from sandstones and shales become podzolized more rapidly than those derived from limestone, because the presence of calcium and magnesium ions tends to retard the development of podzols. Third, podzols develop best under a forest cover of conifers, such as White Pine and Hemlock or Spruce and Fir.

A brief description of the chemical processes of weathering as they are involved in the formation of podzols has recently been published by S. A. Wilde (1933). The following paragraph deserves quoting:

In the region of high precipitation and low temperature, there is a surplus of snow and rain water which percolates down into the soil. The percolating water gradually dissolves easily soluble chemical compounds (bases), and leaches them down into the lower part of the soil profile. The impoverishing of the upper soil layer in the electrolytes *Ca* [calcium] and *Mg* [magnesium] lends to the incomplete decomposition of organic matter, which accumulates as raw humus, or as peat material. This is asso-

ciated with the formation of organic acids, and with the concentration of large quantities of free hydrogen ions in the so-called organic absorptive complex. The presence of *H* - ions affects the larger solubility of the humus and its intensive leaching in the form of colloids. The colloidal solution of the humic part of the soil possesses a considerable physical and chemical energy, is very movable, and is well adapted for the development of the micro-organisms. All these peculiarities make the colloids of humus the most active factor of soil degradation, and under their influence follows the dissolving of the iron and aluminum sesqui-oxides. The percolating water leaches these compounds down into the lower parts of the soil, where the solution comes in contact with bases, and is precipitated. Such a translocation of *Fe* [iron] and *Al* [aluminum] leads to a discoloration of the upper podzolic or eluvial soil layer, and to an intensive rusty color of the lower accumulative or illuvial layer.

On the Allegheny plateau, most of the well-drained podzolic soils have been classed in the DeKalb series (figure 22). Unfortunately the name has been used as well for soils that are not podzolic, that is, which have no gray layer in their profile. A description from the Bureau of Soils, Bulletin 96 (1913) follows:

DeKalb series. The surface soils of the DeKalb series are gray to brown, while the subsoils are commonly some shade of yellow. The soils are derived from the disintegration of sandstone and shales, from Silurian to Carboniferous in age. The surface features consist of gently rolling tablelands, hills, and mountains. The soils are generally not very productive. The stony and sandy members of the series are adapted to orchard fruits, while the heavier soils make good hay and pasture land.

More than 15,000,000 acres of soil in the eastern United States were classified in the DeKalb series before 1913. In Ohio, well-drained brown or yellowish brown

soils of the Appalachian plateau have been classed in the Muskingum series in the more recent soil surveys (Conrey, 1928). The Muskingum series of soils does not possess a gray layer in the profile, and therefore is not podzolic. Some of the soils in the Allegany State Park apparently belong to this series or to a newly distinguished group in Pennsylvania tentatively called the Tionesta series.

WATER-LOGGED SOILS

Under conditions of water-logging and consequently poor aëration, mottled gray and yellow-brown subsoils may develop. Such conditions are readily observed below seepage zones on the hillsides and on most of the lower slopes near the streams. Such soils have been classed in the Lickdale series by the Bureau of Soils (1913).

The soils in the Lickdale series are grayish and the subsoils are of mottled yellow, gray and bluish color and intractable structure. The types usually occupy slopes where drainage is poor owing to the accumulation of seepage water. These soils are derived from brown, gray, olive, and bluish shales and from sandstone. They have not been used extensively for agriculture owing to their poor drainage and unfavorable position. With the establishment of good drainage grasses do well. The Lickdale soils are closely associated with the DeKalb. (Bur. of Soils, Bul. 96.)

The Lickdale series as well as the Muskingum series represents two different kinds of immature soils. Immature soils are usually soils which are poorly drained (also poorly aërated) or, on the other hand, may be subject to such rapid run-off or erosion that the normal profile characteristic of a mature soil does not develop. The Lick-

Figure 22 Podzol profile in sandy loam at altitude of 2360 feet. Allegany State Park, N. Y. Photograph by F. T. Thwaites.

Figure 23 Openwork gravel in river terrace at altitude of 1360 feet. Allegany State Park, N. Y. Photograph by F. T. Thwaites.

dale series is an example of the former and the Muskingum series is an example of the latter.

ROUGH STONY LAND AND VALLEY SOILS

Excessively steep slopes and ridges are often covered with an abundance of large loose stones and rock fragments accumulated as loose talus or as large blocks. Such areas are usually designated by soil surveyors as rough stony land, unsuitable for agriculture, affording sparse pasturage, and for the most part suited only for forests. Near the Allegheny river, "mountain" ridges (for example, Elko mountain) have considerable rough stony land.

Besides the soil series mentioned above, there are present in the park small areas of soil which undoubtedly belong to other series (figure 23). Valley soils belong to the Elk and Atkins series, which have been described as follows:

Where sandstone and shale predominate (as in the Muskingum soils) the flood plain soils are included in the Pope, Philo, and Atkins series. . . . Atkins soils have gray to dark gray surface soils and mottled gray and yellowish brown subsoils. They include the very poorly drained areas in the flood plains in association with the Pope and Philo soils (Conrey, *loc. cit.*).

The Elk series include light brown to brown soils and pale yellow to yellow subsoils. It is developed on second terraces lying largely above overflow. The material is entirely alluvial, and is derived from the soils of limestone, sandstone, and shale formations. . . . Gravelly material is frequently encountered in the substratum. In places the surface is so flat that water stands after wet seasons. With good drainage and careful management the soils are adapted to corn, wheat, oats, grass, and forage crops (Bur. of Soils, Bul. 96).

THE RELATION OF SOILS TO FOREST VEGETATION

According to the twentieth century ideas concerning the dynamic nature of the soil-forming processes and processes of vegetation (particularly plant succession), the soils and the vegetation of the region have developed together, the one being a part of the environment of the other. Theoretically, then, immature soils should have types of vegetation which do not represent the climax of the region while mature soils should always have climax vegetation growing on them.

There is often no very close correlation between them, however, because forest vegetation may reach a climax or stable condition with respect to its environment in a few hundred years. On the other hand, the soil developing processes are slow, and it may take thousands of years for soils in a given locality to reach maturity.

Until the character of the soils and native vegetation is definitely determined for an area, any attempt to relate soils to vegetation is hazardous, to say the least. At the same time, there are some general observations which may be worth recording here, regarding the intimate relation which exists in Allegany State Park between forests and the soils on which these forests grow.

FORESTS ABOVE THE WATER TABLE

Oak-Chestnut forests undoubtedly occupied the rough stony land on excessively steep slopes and ridges bordering the Allegheny river, extending down the southwest-facing slopes more than northeast-facing slopes. Such forests were situated above the water table, certainly above the spring horizons, and graded into the Mixed Mesophytic

forests where soil moisture conditions were slightly more favorable. On account of the rapid run-off, drying-out of the leaf litter, comparatively slight accumulation of humus and rapid removal of snow, podzolization has been very slight indeed on such soils.

FORESTS PERIODICALLY INFLUENCED BY THE WATER TABLE

Where moisture conditions are somewhat improved, tree roots are periodically under the influence of the water table. Here the Mixed Mesophytic hardwood forest and the Beech-Sugar Maple forests were found originally. The former forest type was not very extensive in the park, but in most places was represented by a narrow transition zone between the Oak-Chestnut and the Beech-Sugar Maple associations. The leaf litter and humus which accumulates beneath the broad-leaved hardwoods is not so acid as that which accumulates under conifers. This brings about a condition which is not so favorable to podzolization. Therefore soils under a Beech-Maple or Sugar Maple-Baswood forest are usually not podzols.

FORESTS ON UNIFORMLY MOIST SOILS

Below the spring horizons, Hemlock enters the forest stand, together with Beech and Yellow Birch. Seepage zones on hillsides offer favorable conditions for the germination and early growth of Hemlocks, the first steps in the development of the Hemlock-Hardwood forest type. Except in times of severe drought the Hemlocks and Beeches usually have their rootlets in contact with moisture. The fall of Hemlock needles in the forest stand contributes more acid types of leaf litter and humus to the forest floor. This brings about a condition favorable to podzolization.

Coupled with this is the fact that winter snows remain longer in the shade of evergreens, melt more slowly and provide water over a longer period. The slow percolation of snow water is doubtless as favorable to the leaching process as the percolation of rain water. As a consequence the soil becomes podzolic, and is here classed in the DeKalb series, perhaps incorrectly.

EFFECTS OF PODZOLIZATION ON FOREST VEGETATION

S. A. Wilde (1933) has made some observations on the relation of soils to forest vegetation in the Lake states which in general agree so well with my own observations in Allegany State Park that I quote a few paragraphs at length:

Podsolization has a tremendous influence upon both soil and forest growth. First of all, podsolization entirely modifies the texture of soil. The accumulation in the illuvial layer of clay and colloidal particles considerably increase the water holding capacity, and in this way sandy soil may be converted ecologically into sandy loam, or even a heavier soil.

As to forest growth, a slight podsolization of sandy soils, always associated with the presence of some fine soil material and larger moisture, increases the productivity of pine stands. Considerable podsolization of sandy soils, associated with the cementation of the lower soil layer, also increases the moisture content, and makes it possible for a large number of forest species to grow (white pine, hemlock, aspen, birch, etc.). However, at the same time, the cementation of the soil has a number of unfavorable influences upon forest growth. It may cause excessive moisture in the spring or a breaking off of capillary water and drought in the summer. It may effect an unsatisfactory reproduction due to impoverishing of the eluvial layer and imperviousness of the illuvial layer. Finally the cementation may cause a wind throw of the forest stand.

"Podsolization of non-calcareous loamy soils has somewhat similar effect upon the forest growth. The best growth and natural reproduction of sugar maple and other hardwoods are found on the undegraded "mull-loams". A strong podsolization of loams, resulting in the formation of a sticky, mottled horizon brings, as a rule, an admixture of yellow birch and hemlock, and leads to poor growth of the sugar maple, which shows in advanced age the so-called dry tops.

In the last paragraph quoted, we find, I believe, the explanation of the fact that in Allegany State Park, the Hemlock-Yellow Birch forest apparently has reached its best development on the lower slopes of the valleys, in more strongly podzolized, colluvial soils, with mottled subsoils of heavy texture.

A HISTORY OF THE FOREST INDUSTRIES IN THE ALLEGANY STATE PARK REGION

Before the white race came to exploit the natural resources of the state park region, the forests were the hunting grounds of the Indians. "By the conveyance executed by the Seneca Nation to Robert Morris at the treaty of the Big Tree, in August, 1787, the Holland Land Company obtained a title in fee simple to the lands in which Allegany State Park is located, with the exception of the Allegany Indian Reservation, along the Allegheny river (figures 24, 25 and 26). The company . . . employed Joseph Ellicott as chief surveyor to commence at once to lay out this immense tract [3,600,000 acres in western New York] into townships and to subdivide the townships into lots, as soon as the title was perfected. The survey was completed in 1798 and 1799." (Historical Gazetteer, 1893). In 1803, the Society of Friends (Quakers) from Philadelphia established a school for the Indians at Tunesassah (Indian name

for Quaker Run). This was the first white settlement within the present boundaries of the park.

PIONEER OPERATIONS IN THE FOREST

Before 1828 early pioneers were engaged in cutting and burning timber and leaching the ashes to obtain "black salts" (crude potash), which was about the only commodity that could be sold for money in those days.

In 1828 the first sawmill (Morrison's) was erected on the Tunungwant creek, near the Indian Reservation line. White Pine was the principal timber utilized.

In 1840 the Bay State Tract of 14,000 acres in the Red House valley was purchased by a company in Boston. This tract was worked for a number of years, first for the splen-

Figure 24 A woodlot in the Allegheny bottomland just south of the state line through the Allegany Indian Reservation. White Pines have reached maturity in this woodlot.

Figure 25 Scene at a bend in the road along Wolf run. One of the many good dirt roads in the park.

Figure 26 The Allegheny river and bottomland opposite Elko P. O., about two miles south of Quaker Bridge, N. Y. Formerly this region was covered with splendid White Pine forest.

did White Pine timber, and later for Hemlock and hardwoods.

In 1860 a stave mill was in operation at West Salamanca, using ash for cooperage. In the 25-year period following the Civil War, 1865–90, the rafting of White Pine down the Allegheny river to Marietta and Cincinnati became a thriving industry.

THE HEMLOCK HARVEST

The next operation, beginning about 1890 and extending over a period of about 15 years, was devoted to the harvesting of virgin Hemlock, the principal conifer of the region. The cutting of Hemlocks for tanbark accounts for the disappearance of most of the big conifers, whose red-

Figure 27 Logging team dragging Hemlock logs to railroad near Ludlow, McKean county, Pa. Scenes like this were enacted in Allegany State Park more than 40 years ago.

brown trunks, covered with moss, lie decaying in the Maple-Beech forests today. The income from the sale of tanbark paid for the logging operation (figure 27). Lumber was sold for the cost of sawing it, about $4 a thousand board feet, previous to 1900. In 1893 many of the Hardwoods (Beech, Maple, Oak, Chestnut, Cucumbero Tree, Ash and Baswood were finding a market in Buffalo, Rochester, Syracuse and other eastern cities (Historical Gazetteer).

"After three successive attacks on the primitive forests there was little left to encourage the lumbermen. There was hardly a vestige remaining of the luxuriant groves that had formerly completely wooded this section." (*loc. cit.*)

Figure 28 shows an idealized cross-section of the Allegheny River valley south of Quaker Bridge. The diagram is practically a reconstruction; the original forest vegetation has been entirely destroyed, save for a few small islands in the river.

WOOD CUTTING FOR CHEMICAL PURPOSES

"The rapidity with which the forests replenished with hardwood trees the cut-over areas, however, soon attracted men interested in the chemical industry. A chemical plant for wood distillation was established in 1899 at Red House." All hardwoods were cut to a 3 or 4-inch diameter limit. In some places the woods were absolutely cleared. The cordwood was usually left to dry for two or three years before it was utilized. "Cordwood to supply the business has been cut from the remaining woodlands for the past twenty years" (Francis, 1922). "During the war this business was prospering as never before. But like many other similar activities throughout the country, a

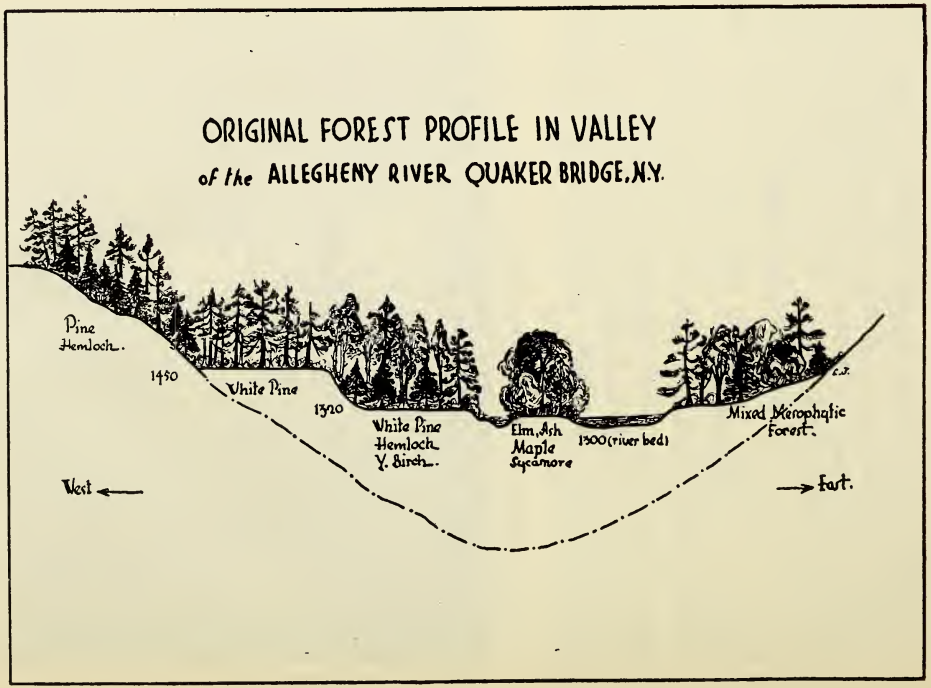

Figure 28 Original forest profile in the Allegheny River valley south of Quaker Bridge, N. Y. Sketch by Louis Jacobson from data furnished by R. B. Gordon.

large store of cordwood was accumulated which was not needed for immediate use after the close of the war." (*loc. cit.*).

EFFORTS TOWARD REFORESTATION

In the sixth Annual Report of the Commissioners of the Allegany State Park (Fancher, 1927) the following statement appears:

This Commission has always had in mind the desirability of bringing the park back, so far as possible, to its primitive state so that future generations may see forests as they were before the lumberman came, and to this end have inaugurated a program of extensive reforestation. Hundreds of thousands of trees, received from the Conservation Commission have been planted on cut-over lands and abandoned farm clearings. A tree nursery has been established that now covers an area of about six acres and contains 150,000 trees; 35,000 of these will be transplanted to the field in 1927. We have ordered 427,000 trees from the Conservation Commission for spring delivery, which will bring our 1927 field planting up to about 450,000 trees which will cover an area of practically 450 acres. The planting so far has been red, white and Scotch pine, Norway and white spruce, with some hemlock, fir, balsam, and ash. In 1924 and 1925 a small experimental planting of nut trees was made in the Quaker Run valley. These were principally hickory, black and English walnut and butternut. It was hoped to grow something to replace the chestnut, which was formerly quite abundant in various sections of the park, but is now practically extinct owing to the Chestnut blight. It is the intention of this Commission to remove, as far as possible, all down and dead timber and clear out the underbrush so the young healthy trees will have a better chance. If the present policy is carried out for fifteen or twenty years, a splendid revenue will be returned to the State from annual timber cuttings.

EARLY EXPERIENCES IN PLANTING

Matteson (1924) described early planting experiences as follows:

Ten thousand White Pine transplants, twenty thousand Red Pine; twenty thousand Scotch Pine and thirty thousand Norway Spruce seedlings were received from the Conservation Commission. Labor shortage almost completely blocked our planting plans. Few laborers were available. These had no experience in planting and few stayed long enough to acquire any skill. Nine thousand White Pine transplants and almost one thousand of the three species of seedlings were planted in the field. The transplants appear vigorous. Part of the seedlings planted experimentally in an old field were choked out by a dense growth of goldenrod. The rest of the trees were planted in a hastily prepared nursery" (from the Third Annual Report of the Commissioners of the Allegany State Park).

REFORESTATION VERSUS AFFORESTATION

The results of reforestation can be plainly seen by observing the several plantings of conifers in old fields and in clearings within the park boundary. The principal areas which have been reforested are located at the summit of Parker hill, in several places along the Bradford-Red House road, and along the Quaker Run road near the mouth of Fox hollow. Of all the species planted, Red Pine seems to be making the most rapid growth, with Scotch Pine second best, and White Pine third. Only a few Jack Pines have been planted, and Mr Matteson, the forest supervisor, is of the opinion that these may be even more successful than Red Pine. Both White Pine and Norway Spruce have been severely damaged by the White Pine Weevil. This is indeed unfortunate, because White Pine is commercially the most valuable species of conifer

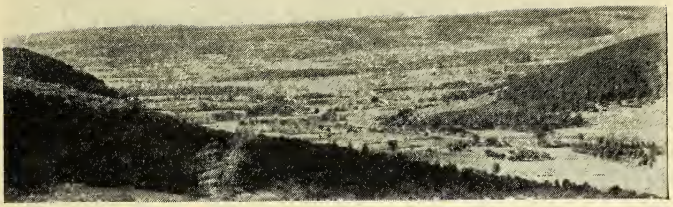

Figure 29 View north from Jones' hill, toward the glaciated area. It is apparent that little of the land is forested. Photograph by F. T. Thwaites. Compare with figure 30.

Figure 30 View east from Jones' hill, toward the unglaciated area. Allegany State Park, shown in the distance, is heavily forested. Photograph by F. T. Thwaites. Compare with figure 29.

planted, and is the only one of the species which is native to this region.

Afforestation is taking place naturally in many of the open areas, aspens being the first trees usually to invade old fields and clearings. It is interesting to compare the results of afforestation with those of reforestation. It has been estimated that approximately 12,000 acres within the park are now covered with forests of the Aspen-Red Maple type. Old fields and clearings reverting to forest probably constitute about 6000 acres within the park and about 7000 acres in the Indian Reservation. Of these, about 1000 acres have been planted with conifers. Thus it would not take long to entirely reforest all of the cleared areas, should it appear to be desirable. Compared with the glaciated country to the northwest (figure 29) the Allegany State Park contains almost a complete forest cover, broken here and there with some open farmland, mostly in the lower valleys.

There is always the question, however, as to whether it is actually advisable to plant all of the open areas with forest trees, now that a state park has been established. So much of the park, approximately 90 per cent, is already forested, and one may walk for miles through unbroken forests, of which thousands of acres are truly wilderness (figure 30). Perhaps the 10 per cent of open land is not more than will be needed for the development of camping and recreation areas, which are most important considerations of the State Park management.

LIST OF TREES MENTIONED IN TEXT

Ash, White..... *Fraxinus americana* L.
Aspen, Large-toothed..... *Populus grandidentata* Mich.
Aspen, Trembling..... *Populus tremuloides* Mich.
Balsam ..... *Abies balsamea* (L.) Mill.
Basswood ..... *Tilia americana* L.
Beech ..... *Fagus grandifolia* Ehrh.
Beech, Blue or Water..... *Carpinus caroliniana* Walt.
Birch, Cherry or Black.... *Betula lenta* L.
Birch, Yellow..... *Betula lutea* Mich. f.
Cherry, Black..... *Prunus serotina* Ehrh.
Cherry, Fire, Pin or Bird.. *Prunus pennsylvanica* L. f.
Chestnut ..... *Castanea dentata* (Marsh.) Borkh.
Cucumber Tree..... *Magnolia acuminata* L.
Elm, American..... *Ulmus americana* L.
Fir, Balsam..... *Abies balsamea* (L.) Mill.
Hawthorn ..... *Crataegus* (species of)
Hemlock, Eastern..... *Tsuga canadensis* (L.) Carr.
Hickory, Bitternut..... *Carya cordiformis* (Wang.) K. Koch.
Hickory, Pignut..... *Carya glabra* (Mill.) Sweet.
Hickory, Shagbark..... *Carya ovata* (Mill.) K. Koch.
Maple, Red..... *Acer rubrum* L.
Maple, Striped..... *Acer pennsylvanicum* L.
Maple, Sugar..... *Acer saccharum* Marsh.
Oak, Black..... *Quercus velutina* Lam.
Oak, Chestnut..... *Quercus montana* Willd.
Oak, Red..... *Quercus rubra* L.
Oak, White..... *Quercus alba* L.
Pine, Jack [1]..... *Pinus banksiana* Lam.
Pine, Red or Norway [1]..... *Pinus resinosa* Ait.
Pine, Scotch [1]..... *Pinus sylvestris* L.
Pine, White..... *Pinus strobus* L.
Poplar, Yellow..... *Liriodendron tulipifera* L.
Shadbush ..... *Amelanchier canadensis* (L.) Medic.
Sassafras ..... *Sassafras sassafras* (L.) Karst.
Sour Gum..... *Nyssa sylvatica* Marsh.
Spruce, Norway [1]..... *Picea abies* (L.) Karst.
Spruce, White [1]..... *Picea canadensis* (Mill.) B.S.P.

[1] Not native; introduced in plantings

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A BOTANICAL SURVEY OF BIG BASIN IN THE ALLEGANY STATE PARK

(Figures 31–55)

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CONTENTS

PREFACE

During the months of July and August 1928 the writer made a somewhat detailed botanical study of the part known as Big Basin in Allegany State Park. This section of the handbook is a result of that study. In its preparation an attempt has been made to present information which will be of use to students in the Allegany School of Natural History, to the general reader trying to become acquainted with the botanical features of the park, and to the technically trained biologist whose interest will be related mostly to the more detailed descriptions as a basis for further study.

In writing for the first two groups the purpose has been to make clear the concepts involved without needless use of technical language. Where technical terms have been necessary they have been defined and illustrated with a view to making them a part of the vocabulary of even the nontechnical reader. Complete accuracy has been, perhaps, impossible in gathering and organizing data over so large a field in the short space of two months. It is hoped, however, that a sufficient degree of accuracy has been attained to make this record prove of value to future students in the park.

INTRODUCTION

The name Big Basin is applied to that part of Allegany State Park occupying about 10,000 acres near the center of the park area. As the term is now used it refers to the section bounded on the south and west by the Bay State road and on the east and north by the Red House road (see folding map). These two roads join at the new, unnamed camp now known as Camp 12 and at the Indian village of Red House. Hence the new Administration Building, Camp Carlton and Camp 12 are all within Big Basin, and Camp Yowochas is just out of the area at its northeast corner. To reach these roads which form the boundary, one travels eastward from the Allegany School of Natural History to the junction of the Bradford and Salamanca roads. At a point 3.6 miles north on the Salamanca road the Bay State road branches off sharply to the left. Camp 12 is to be seen near-by, set somewhat back in the woods toward the northwest. From this point there can be no question of the route around Big Basin by referring to the map.

The elevation of this area varies from about 1400 feet in the lowest portion to two points which extend to an elevation of a little more than 2300 feet toward the southeast portion. In Handbook 1 of this series Doctor Lobeck has given an excellent discussion of the topography of this region.

To one looking for significance in the name Big Basin there appears little meaning, for the plot is in no sense the shape of a basin. The name, however, seems to have more of a historic meaning than of topographic significance. Howard Carr, the oldest resident interviewed, says that he

moved with his father to his present location near the mouth of Hardscrabble almost 80 years ago. At that time only the beginnings of lumbering activities were taking place in this part of the woods. According to his account, a sawmill was operated at the head of Hardscrabble until the immediate forest was used; the lumbermen then "crossed the divide into the next basin" which is the largest hollow in the vicinity and hence came to be called "The Basin." The stream flowing down this hollow is now usually called Stoddard creek and is so marked on some of the maps, named for the old Stoddard homestead about a mile up-stream from its mouth. Some of the older people, however, call it "Big Basin creek" or simply "The Basin." For that reason the area outlined in the preceding paragraphs is merely an extension of the lumbermen's name to include adjacent territory. This more extended meaning of the name is gradually coming into general use.

Other names of roads, streams and hollows have interesting origins. Usually the names of old settlers have been applied to places where they lived and we have such names as Stoddard hollow, Sheffield hill and Lonkto knob. The Bay State road is one of the old lumber trails used by the Bay State Lumber Company. Red House creek and later the Indian village of Red House near the mouth of the creek is said to have been named for an Indian who had a cabin there with its door painted red. He came to be called Red House, and the creek, according to custom, was Red House creek. Bee Hunter creek was named in much the same manner for a recluse who lived in that hollow 60 or 70 years ago and who spent his time hunting, trapping and gathering wild honey. It is said that no one ever knew his real name but that he was called Bee Hunter because of his search for bee trees.

At this place it may be well to indicate errors that should be corrected on some of the maps in general use. In Handbook 1 of this series figure 132 shows Bee Hunter creek as Beeline creek. A similar map appears also in Handbooks 2 and 3. In the earlier edition of the Salamanca quadrangle topographic sheet Bee Hunter creek is called Stoddard hollow while Stoddard hollow is named Beeline creek. In the Randolph quadrangle sheet correction has been made and the name Stoddard hollow is used as it should be. The correct locations are shown on the map at the end of this Handbook.

Even to the casual observer these wooded mountains present an attractive and alluring picture; but to the lone hiker who day after day breaks into their depths, following streams to their sources and mountains to their tops, there is an indescribable fascination. The stillness is broken only occasionally by such sounds as the rippling song of the Winter Wren and the loud, raucous call and resonant tapping of the rare Pileated Woodpecker. To meet a human being is out of the realm of probability in the deeper parts of the woods and it is possible to walk for many miles and find no traces of civilization except the mute ones of years long gone. Innumerable questions arise in the mind of the interested wanderer and we know that if we are to understand present conditions we must consult all possible sources of information about past activities that have brought about changes.

GEOLOGICAL AND VEGETATIONAL HISTORY

It is not our intention to write a geological account of this region, as Doctor Lobeck has done so excellently, but rather to make a setting for our studies of the vegetation as we find it in the Allegany State Park. There is

abundant evidence that during the geological epoch past North America has been visited by a succession of continental glaciers, which extended as far south as the states of Kansas, Iowa, Illinois, Kentucky, Ohio, Pennsylvania and New Jersey. It is thought that a decline in annual temperatures brought about accumulation of snow and ice in northern latitudes, until portions of southern Canada came to resemble Greenland of today. The glacial ice moved in all directions from various centers of accumulation. At least one of these continental ice sheets, during the Wisconsin glacial period, reached the Allegany State Park region. It was stopped in its advance by the rugged plateau topography because of the great distance from its center of accumulation, and by the generally higher temperatures which it encountered here. The park itself is unglaciated, and is the only part of New York State which was not covered by a continental ice sheet during the Pleistocene Glacial Epoch. The natural vegetation which clothes the plateau is essentially like that to the southward in Pennsylvania and West Virginia, in regions far distant from the glacial drift border.

So slow was the advance of the glacier, however, that it was possible for species now found in the frozen tundra and the spruce-fir forests of the far north to clothe the ice margin with vegetation almost as rapidly as other plant life in the region was destroyed by the glacial advances. What are the means by which plants come to populate barren areas? Plants of course can not walk or fly as do members of the animal kingdom, but they do migrate. Seeds, spores and other agents of dissemination are spread far and wide in all directions from their parents by wind and water, by birds and mammals. Of course, however, only those grow to maturity which can withstand the con-

ditions of the environment in which they happen to fall. As has been stated, the continental glaciers stopped just north of what is now Allegany State Park, but to the east and to the west they traveled farther southward into northern Pennsylvania. One of the immediate effects on the park area was the blocking of the outlets of Quaker run, Red House creek and lesser tributaries to the interglacial Allegheny river by outwash fill from the last glaciation. This brought about the development of lakes in the side valleys, a condition favorable to silting and to the development of bog vegetation. Later, while the Allegheny river was carving a new outlet south of Kinzua, Pa., at "Big Bend," the lakes were very slowly but eventually drained. The Balsam swamp in lower Red House valley is but a pitiful remnant of bog vegetation which probably began its development about 40,000 years ago.

The melting of the glacial ice, brought about by an increase in temperature, left deposits of gravel and boulders in the valleys, filling them to a depth of three or four hundred feet, in some instances. Probably at no time was this glacio-fluvial deposit barren of vegetation.

The changes in vegetation since the decline of the ice have been recorded in peat deposits beneath sphagnum bogs. Dr. Paul B. Sears (1930) has recently brought to light some interesting facts by the method of pollen analysis. In an Ohio bog, Doctor Sears reports a historic succession from Spruce and Fir to Pine and Oak-Mixed Deciduous forest. There seems to have been a steady decrease of Spruce and Fir pollen from the 14-foot level to the two-foot level and a marked increase in Pine pollen from the seven-foot level to the two-foot level. The pollen of deciduous trees was found chiefly in the upper two feet. These data indicate that the coniferous forests

of Ohio bogs gradually disappeared and were replaced by the deciduous forest.

The valley of the Allegheny river and its tributaries in this region were originally covered with magnificent forests of White Pine, according to all accounts. The presence of Balsam Fir, Hemlock, and Yellow Birch in the swampy portions of the valleys indicates that in this region the Spruce-Fir vegetation was probably followed by Hemlock, Yellow Birch, White Pine and American Elm, and were not invaded by the Oak-Mixed Deciduous forests until the destruction of the pines by the lumber industry within the last century.

EFFECTS OF HUMAN OCCUPANCY

The earliest inhabitants of the region of whom any knowledge exists were the "Mound-Builders," peoples who occupied the Allegheny valley before the Indian tribes of the Iroquois Nation. All of these early human inhabitants of the forests apparently succeeded in living with the trees without destroying them. When white men first came to these mountains they found them covered with virgin forests. The advent of the white man was so recent that there are still a few old people living in Big Basin who came in as children with their pioneer parents. Since their stories of those early days agree closely, except in minor details, it seems safe to record with some confidence their descriptions of conditions as they remember them.

It would seem that these primeval forests were composed chiefly of wonderful White Pines (*Pinus strobus*) and Hemlocks (*Tsuga canadensis*) mixed through a fine stand of Beech (*Fagus grandifolia*), Sugar Maple (*Acer saccharum*), Basswood (*Tilia americana*), White Ash

(*Fraxinus americana*), Wild Black Cherry (*Prunus serotina*), and Tulip Tree (*Liriodendron tulipifera*). There is no way to determine what were the relative numbers of individuals of these species but they seem to have composed the greater part of the forests. Conditions as we find them now corroborate these descriptions from memory, for in a few of the more protected or less accessible spots there are still some fine specimens of all these kinds of trees. Besides, occasional stumps and old logs tell their story of forest magnificence such as we do not now see in the park even among the finest living trees. We found a few Hemlock stumps and logs with diameters of 40 to 50 inches while few of the trees now standing are as much as two feet in diameter.

During the century in which the white man has been active here there has occurred the lumbering of all the kinds of trees listed above. Hemlock has been cut for lumber but especially has it been cut for tanbark. In some cases the bark has been removed and the logs are still lying about, decaying, while in other cases the bark has been peeled off and the logs cut into lumber. Hundreds of acres have been stripped of all trees, except small saplings two or three inches in diameter, for "chemical wood" and considerable areas along the roads have been cleared for pasture, hay and other farm crops. Dairying has been profitable during recent years, hence hay and grain raising have been promoted as a means of supplying feed to as great an extent as the poor soils permit. Hogs, oats, corn and buckwheat have been raised on a rather small scale.

As we study the forests we find the effects of these various activities scattered all through them and in these pages we shall try to trace some of this most fascinating story.

DESCRIPTIONS OF DEFINITE PLOTS

THE BIG TREES

On the vegetation map the places occupied by the biggest trees are indicated by the symbols designated as "mature timber." These places are some of the most interesting spots within Big Basin, because here the forests are at their best. Lumbering operations have been very limited and of remote time. The reader will notice that there is one large area comprising about 1300 acres around the headwaters of Stoddard creek which is by far the largest extent of this type of forest. This has come to be generally known as "The Big Trees." Besides this, there are three smaller and less important places in which these forest giants still persist. Of these stations it is sufficient to note that the one above Camp Carlton (figure 31) is said by old residents never to have been cut over. It was kept from early days as "sugar bush" where maple sugar was made until about 1920. It is a fine stand of large beeches and maples with a few individuals of other species such as White Ash and Tulip Tree.

The plot of a few acres of big trees on the side of The Peak near the northwest corner of Big Basin illustrates the effects of careful management in these forest tracts. The owners have always refused to sell to the lumber and chemical-wood companies. Instead, they have harvested the mature trees as they have become ready, protecting the immature ones and so preserving the vigor of the forest to the present time.

The few big trees on Lonkto knob and extending a little distance down Lonkto hollow appear to have been left standing because they are in a position too difficult to re-

Figure 31 Camp Carlton. The hills immediately above are covered with fine Sugar Maples and Beeches, said never to have been lumbered. Used as "sugar bush" until about 1920.

Figure 32 Wild Black Cherry tree in one of the most primitive spots in The Big Trees. Three trunks arise from one root. Combined diameter at six feet from ground is 55 inches.

move in routine lumbering operations (figure 36). This is a stand of beeches, maples and hemlocks.

The area generally known as The Big Trees is worthy of more detailed study. As one enters the forest at Hill Crest the margin nearest the road is found to be a jungle of aspens (*Populus tremuloides* and *P. grandidentata*), Pin Cherries (*Prunus pennsylvanica*) diseased Chestnuts (*Castanea dentata*), and a few other light-tolerant species of trees and shrubs with a tangled ground cover of Bracken (*Pteridium latiusculum*) and associated undergrowth. On continuing northward up the hillside almost suddenly the uncut area is entered as if one stepped into an immense room. Here, instead of a tangle of vegetation, trees stand far apart, supporting a dense canopy. There is little undergrowth. There are no cut stumps or other marks of lumbering. The only logs and stumps to be found are those obviously broken and fallen from natural causes. If lumbering has ever occurred here the last traces of stumps and logs have decayed. Search as you may, the marks of the ax are absent. Old settlers, however, seem to agree that in early days the White Pine was removed as well as Wild Black Cherry and perhaps others of the more valuable trees. There are two little clumps of White Pine standing, totaling about 20 trees. They are apparently a part of the primeval forest that was left when all their neighbors were cut. Near the larger of these clumps, which is somewhat north of the center of The Big Trees (see map) are about a dozen fine Chestnuts that appear to be quite healthy. These are the only ones seen at any place in the park not afflicted with chestnut blight. There are also a few remarkable Wild Black Cherry trees near-by. One of the largest is shown in figure 32. This is composed of three trunks, with a combined diameter

of 55 inches, arising from a single stump. This small area of fine old trees probably gives us our best clue to primitive conditions in Big Basin.

The margin of The Big Trees area is surprisingly easy to follow in the woods. If, after breaking through the tangle of vegetation at Hill Crest, one turns to the left (west) one comes to an abrupt change from the big trees to trees that are all much smaller; from trunks that stand far apart to those that are crowded close together; and from an expanse free from stumps to one covered with decaying stumps and logs. This line between old and young forest can be followed (figure 33) around its west and north margins but becomes somewhat obscure on the east, where there are numerous mature trees but with them numerous stumps and cut logs, which indicate partial lumbering. This is indicated on my map by symbols for mature trees interspersed with those for stumps.

Throughout The Big Trees area the species are largely Beech (*Fagus grandifolia*), and Sugar Maple (*Acer saccharum*), with patches of Hemlock (*Tsuga canadensis*). There are occasional individuals of Yellow Birch (*Betula lutea*), Cherry Birch (*Betula lenta*), White Ash (*Fraxinus americana*), and Basswood (*Tilia americana*). The scattered undergrowth is chiefly young trees of these same species along with a few shrubs. Taylor has given such a good description and analysis of the vegetation of this area in Handbook 5 of this series that it is unnecessary to go into more detail here. The interested reader is referred to pages 14–37 of that handbook for additional descriptions.

In the dense shade of this forest the seedlings grow very little from year to year. They can endure shading far better than can mature trees of the same species, but even

Figure 33 Line between The Big Trees (right) and surrounding young forest (left).

Figure 34 Young Beeches and Maples growing rapidly in light admitted by fallen trees. Note difference in undergrowth from that in figure 33, which is a similar situation but without break in canopy.

these shade-resisting species die by the millions over the forest floor. Wherever a tree falls and increased light penetrates to these young, half-starved trees they begin at once to grow with great rapidity upward into the light, pushing the canopy of their small crowns of leaves into the open space (figure 34). Notice the difference in height of the undergrowth in figure 33 where the canopy is intact and in figure 34 where a tree has fallen. In such cases, because of the rapid growth of the young trees in increased light, the shade is almost as intense in a few years as it was before the tree fell. This raises the question of the relation of light to growth rates of forest trees.

In order to obtain a more definite understanding of this relation, a number of measurements of both were made. By means of a photometer, an instrument used in determining the length of exposure in photography, a number of light tests were made. It should be made clear that this is not a precision instrument but it does roughly indicate the amount of light that finds its way to the ground. While it is not necessary to go into detail as to methods, it may be useful to explain that a standardized photographic paper is used and the color is matched, as it changes in the light, with a standard color. The stronger the light the more quickly the test paper changes to match the standard. Numerous tests were made in the open where the sun shone directly on the instrument. These varied from five to eight seconds depending on the clearness of the air and time of day. The average was about six seconds. All records were made between 9.30 a.m. and 3 p.m. As contrasted with these short periods which indicate strong light, the time element was much longer in the woods, indicating correspondingly weaker light, as would be expected. An average of a considerable number

of tests in the shade of the big trees was about 600 seconds. This means, of course, that the light is only 1 per cent as strong in the dense shade as it is in the direct sunshine, and in some of the densest shade it was only about one-half of 1 per cent as strong as in the open.

Before going farther with this discussion it may not be amiss to describe the way in which we determine the amounts of growth in length and ages of woody plants. It is generally known that the age can be determined in a cut log by counting the rings of growth. But in these studies data were needed on the amounts of longitudinal growth of young trees since the differences are more evident in this dimension than in diameter. The growth in length of any twig depends on its terminal bud. When winter ends and the buds swell, the hard, protective scales drop off, leaving circular scars around the tiny tip. As this elongates the scars remain in the outer bark. In many species they persist for several years. In order to find how much a given young tree has grown in a certain year it is necessary only to measure the distance between the scars for the years in question.

Measurements of length of growth in height of young maple trees, in the shade of the big trees, agreed well with the measurements of light. In the densest shade the average annual length of growth was about one-half inch, while in an opening caused by a large fallen tree the average was about seven and one-third inches. Under a medium shade, cast by trees five inches or less in diameter, the average yearly growth in height was one and three-fourths inches. While more critical studies and larger numbers of data are needed on this question it is evident that there is a fairly close correlation between amounts of light and

rates of growth. This leads to the further question of how light affects growth rates in the woods.

The green coloring matter in leaves, called chlorophyll, is responsible for photosynthesis. Primarily this is a process of food manufacture. The foods formed are carbohydrates. The most familiar examples of these are sugars and starch. The idea of manufacture is used advisedly in this connection for the plant uses raw materials that are not foods and changes them into foods capable of releasing energy and of building the bodies of plants and animals. The raw materials used are water, with the minerals dissolved in it, and carbon dioxide, which is produced in the respiration of both plants and animals. This gas is always to be found in the air. Carbon dioxide and water meet in the chlorophyll bodies and, if exposed to light, these simple substances are quickly combined into a sugar. This process can not take place without the presence of chlorophyll, water, carbon dioxide and light. Hence the leaves in the dense shade have little opportunity to carry on photosynthesis, and the slight growth or death of the trees results from starvation. With this explanation in mind it is clear why light in the forest and growth rates of trees are so closely correlated. For without light there can be no carbohydrate manufacture and carbohydrates are the fundamental food substances which must enter into the construction of all other foods.

GRASSLANDS

At no place in Big Basin is grassland to be found far removed from roads. This is because the grass has been introduced in clearings. These have been opened along the roads to make home sites and little farms, and so are purely artificial. In these grasslands the presence of seed-

Figure 35 Lonkto knob. Hayfield in foreground. Comparatively recent clearing part way up hill with patches of Hay-scented Fern marking location of decaying stumps. Young Beeches and Maples on top of knob.

Figure 36 Camera set at same place as in figure 35, but pointing a little to the right showing eastern margin of hayfield. At top of hill are a few mature trees of Beech, Maple and Hemlock. Most of the smaller trees are Aspens and Pin Cherries.

ling trees growing everywhere indicates the persistent tendency of the forest to return. Even casual observation will convince one that the grass continues to hold out against the encroachment of the forest only by continuous human interference. This is indeed a "tension line between man and the forest." On the map no distinction is made between pasture land and hay fields because either the cutting of hay or the cropping of grass and young trees by farm animals prevents any considerable growth of tree seedlings while not damaging the grass. So the two are equivalent, so far as the return of the forest is concerned. This fact becomes more convincing when we see that wherever human interference has been relaxed there is a corresponding advance of tree growth and with this a gradual destruction of the light-requiring grasses in the resulting shade.

As type examples of grasslands in various stages of preservation and of return to forest we may examine first, Lonkto knob and second, France's hill. On these areas the one on the south and west sides of Lonkto knob (figures 35, 36 and 37) is most devoid of trees. The lower part of the hill is used as a hay field and the upper part is pasture land. Numerous decaying stumps over a considerable part prove that there have been forests on the place until recent years and that the grass is not the original cover. Small seedlings of trees, especially of aspens, show also how the forest is beginning to reach out into its old territory. East of the fence shown in figure 36 is a stand of aspens and Pin Cherries, with a few oaks and other trees, which is beginning to dominate the hillside after complete cutting of the original forest.

On France's hill, man has almost completely ceased to interfere; in a deserted field there are numerous stages

Figure 37 View from top of Lonkto knob looking southward and showing farm carved out of forest

Figure 38 Aspens coming in as seedlings in a deserted field on France's hill. Herbaceous vegetation is mostly wild grasses and Goldenrods.

present in the return of the forest. Some of these steps have been recorded in photographs (figures 38 and 39). In figure 38 the grasses and Goldenrods are interspersed with seedling trees, mostly of Pin Cherry and the aspens. In the shadier parts, such as that shown in figure 39, numerous Red Maple (*Acer rubrum*) seedlings are becoming established. In places where the grasses are weakening under the aspens, Brackens are advancing into the grass and growing vigorously. Under the oldest aspens, even though they do not cast a very dense shade, there are few of their own seedlings living and these are not thriving. Instead there are the more shade-enduring Red Maple and White Oak seedlings. In such places there are to be found frequent patches of Wintergreen (*Gaultheria procumbens*), forming a ground cover. Wherever the mature aspens are overtopped and shaded, they are dying, and in somewhat denser shade the young Red Maples are also dying. In these places young Beech and Sugar Maple trees are becoming established. Thus, the shade-enduring, shade-requiring Beeches and Maples are recapturing the area.

We have continually assumed a difference in ability on the part of various species to withstand shade on the one hand and strong sunshine on the other. As an example we have noticed that the aspens die in shade that will permit the successful growth of Beech and maple seedlings. This means that the Aspens require more light than do these other species. In contrast, the young seedlings of Beech and Sugar Maple can not endure such strong light as can the aspens for they seldom become established in direct sunshine. We have very convenient terms to express these differences in the expressions, "light requirement" and "light and shade tolerance."

Botanists only partly understand the reasons for these differences but a few points are clear. One of these is that the chlorophyll of some plants is of such character that it will carry on photosynthesis in much weaker light than is necessary for this process in others. A plant of this sort is called shade-tolerant. It is also known that light slowly destroys chlorophyll and that the chlorophyll of some plants withstands stronger light than does that of others. This is one factor in light tolerance. Research also proves that some kinds of plants retain the water that comes into their leaves much more firmly than do others. The name applied to the evaporation of water from the tissues of a plant is *transpiration.* It is at once clear that for a plant to be light-tolerant it must have a rather high degree of power to retain its water supply, because, when in strong light, in nature, it is almost certain to be in high temperatures which increase rates of evaporation. Usually such plants have thick coats of wax over their exterior, or other protection against water loss. The leaves, therefore, usually seem thick and somewhat leathery. Compare the consistency and rate of wilting of the leaves of aspens, oaks and hawthorns, as light-tolerant species, with those of any plants under the Beech-Maple canopy and these differences will be obvious. The question may be asked why the entire leaf surface might not be completely sealed with wax in the economy of nature so that no transpiration could occur. It would seem at first thought that a plant so provided could live in extreme conditions of sunshine and dryness. In discussing photosynthesis we explained that the carbon dioxide used in the manufacture of carbohydrates comes from the air. It is at once evident that carbon dioxide must have a way of entrance into the leaf. Otherwise the leaf, and then the plant, would die of starva-

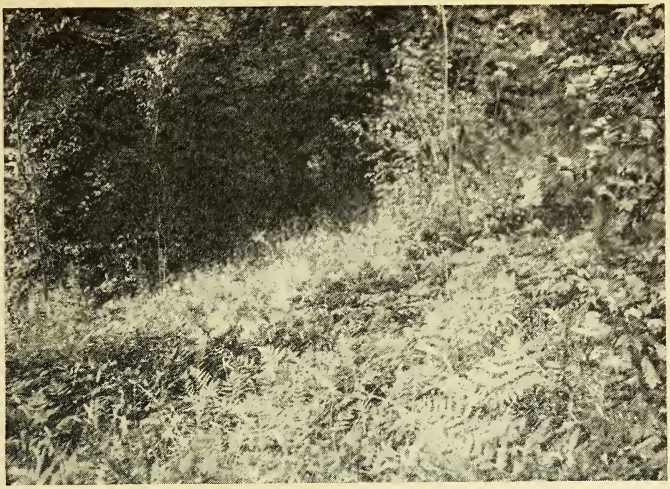

Figure 39 Older Aspens and Pin Cherries casting increased shade. Bracken has largely replaced other ground cover.

Figure 40 Effects of cutting, followed by grazing. The fence is the dividing line between pasture on right and ungrazed part on left. Sheffield hill in background. Camera in road pointing southward.

tion. There are thousands of tiny openings, called *stomata* (singular *stoma*), in the surface of the leaves through which the carbon dioxide enters. But with these openings it is impossible to prevent the water vapor in the leaf from passing out into the air and being lost to the plant. So, in order that a plant be light-tolerant it must also be provided with some means of protection against high transpiration.

SHEFFIELD HILL REGION

By referring to the map it can be seen that the greater part of the trees on the area north of Sheffield hill have been cut and that there are considerable areas now in grass. Largely this is the low flood plain along Red House creek. As is shown in figure 55, a fence bisects the area, the east part being free from indications of pasturage while the west end is used as pasture for cattle. In order that the effects of pasturing may be made clear, figures 40 and 41 are included here. It will be noted that there is a definite change of vegetation type at the fence. Trees dominate, tree seedlings are thriving, and a normal succession is progressing rapidly toward the production of a forest in the area where there has been no recent interference from domestic animals, while grass is dominant where they are kept. It seems certain that the forest was cut over the entire part studied at about the same time, since logs and stumps are about equally decayed on both sides of the fence. Therefore we can be sure that the differences in vegetation are due chiefly to the presence or absence of farm animals. The question naturally arises as to how grazing animals can throw the balance in such a way as to make grassland from potential forests. Examination of this pasture shows that there are numerous

seedling trees but that the tender tops and leaves are continually eaten to such a degree that they are not able to thrive and in many cases they are actually killed. Since the grasses form a sod of roots and underground stems and only a small proportion of the living parts are above ground, the eating of their above-ground parts affects their growth much less. On the other hand, where the young trees are not damaged by grazing they soon cast shade, which interferes with the growth of the sun-requiring grasses and permits luxuriant development of forest seedlings.

Over the entire area under discussion except the extreme northeast corner, which is an abandoned hay field, there are scattered individual trees or clumps of trees that were left when cutting took place. Some of these show that they grew to early maturity in forest surroundings (figure 44) and that their neighbors have been removed, leaving them standing, towerlike, with lower branches gone and their crowns at a height which does not occur in trees that grow entirely in the open. A plant growing in a dark cellar produces a very long stem and extends toward the light. The same principle acts in the shade of the forest where all the trees, cutting out light from their neighbors, grow upward into the light together. As long as the crowns of the trees are exposed to the light the process of photosynthesis goes on and the surrounding shade prevents production of side branches, while young trees under the forest canopy starve for want of light. Figure 45 shows trees grown entirely in the open.

The soil over the entire Sheffield Hill region is thin and decidedly acid. (See Taylor, Handbook 5, pages 84–88 for a discussion of soil acidity.) It is underlain with numerous conglomerate blocks, which in some places are

Figure 41 Same situation as figure 40. Camera in pasture pointing at right angles to view in figure 40. Fence posts can be seen about four rods away. Young trees beyond (east) in ungrazed part. Note absence of young trees in pasture.

Figure 42 Red House creek bordered by willows where protected from grazing.

Figure 43 Red House creek where tree and shrub growth are prevented by grazing

Figure 44 Forest grown tree (*Ulmus americana*) left standing when other trees were cut. Two White Pines (*Pinus strobus*) to the right; Red House creek with border of trees to left; abandoned hayfield in foreground. Photograph taken north of Sheffield hill looking westward.

piled in irregular heaps. In such locations the soil is often completely washed off leaving exposed rock.

On a bare rock surface there is only one kind of plant that can grow, and that is so simple and often so inconspicuous that many people do not recognize its existence. This first plant to appear is some species of lichen. Fine examples of these can be found on almost any exposed rock surface in these fields. In fact, they can be found in any similar place in the park. On the grounds of Allegany School of Natural History there is a fairly good example on some blocks on the left side of the service road as one goes down the hill from the school buildings to the bridge. Better examples can be seen just below Cabin 11. Unless the reader is already familiar with this very important, though simple, plant, it will be both interesting and profitable to examine rocks, tree trunks and decaying logs for some kinds of lichens. Any gray, greenish gray (but not grass green), yellowish or black patch is likely to be a lichen. Characteristically each kind of lichen grows in one of three fairly distinct forms. Those on bare, smooth rocks are usually crustose. Many on the bark of trees are also of this form. This means that they assume the form of a crust tightly attached to, or even imbedded in, the surface on which they are growing (figure 46). Other kinds take a leafy shape and curl outward from their points of attachment. These are called foliose, that is, leaflike lichens (figure 47). The third form is called fruticose (meaning shrubby) lichens. These stand upright in a variety of shapes. They range in height here from about a quarter of an inch to perhaps three inches. The well-known reindeer lichens are examples of the taller ones. These often grow much taller in other places than they do here. The three types are only life forms, each of

Figure 45 Well-rounded Maple tree (*Acer saccharum*) grown in the open

Figure 46 Crustose lichen on rock surface

which is represented by a large number of species. The crustose type of lichen is usually the first plant to gain a foothold on a bare stone surface. Picture if you can the conditions under which it must grow. Its supply of water must come from dew and rain. But water does not appreciably enter stone. Therefore, about all the water the rock-inhabiting lichen can have for growth must be absorbed directly into its own minute body. Its soil is limited to the hard, almost insoluble rock surface. The lichen secretes certain substances, however, that slowly dissolve the underlying rock, furnishing the plant with the necessary soil elements for its growth. Under these handicaps the plant can grow only slightly before its supply of water, after each rain, has dried up. Nevertheless it grows a little each time and in time does succeed in expanding and covering more and more surface. After some years the older parts die, leaving a residue in the form of a bit of soil. In this soil, meager as it is, it is possible for other plants with slightly higher water requirements to grow. These are usually foliose lichens. With the trace of soil left by their forerunners they have a considerable added advantage. The soil furnishes a ready supply of necessary minerals for growth and at the same time holds a little moisture after each rain. With these advantages the foliose lichen grows more rapidly than did its predecessor, and in a comparatively short time overshadows it. This cuts off its supply of light and causes its death. By the time the foliose lichens have added their bit to the soil, both from decay of their own bodies and by further dissolving the stone, there is often enough soil to support certain drought-resistant mosses and fruticose lichens. Since these often grow closely packed they cast a considerable amount of shade, and soon the foliose

Figure 47 Foliose lichen on rock. Dark irregular blotches are crustose lichens.

Figure 48 Hay-scented Ferns growing in decayed log. In figure 35, similar clumps can be seen dotted over Lonkto knob.

forms have gone the way of their crustose cousins. With the more upright mosses and fruticose lichens, dust lodges among their branches, soil accumulates more rapidly and soil minerals are consequently more abundant. Often a spongy soil, made largely of decaying older parts of these plants, develops. This holds water much more efficiently and growth can be more nearly continuous. In this way the entire process of the conquest of the rocks by plants is accelerated.

With the above picture in mind it will be well worth while to find these steps as they actually exist in nature, since no words are adequate to take the place of living plants. By a little search in places such as the piles of conglomerate blocks, which have been described, every step can be traced, as well as many intermediate grades between these steps. With figures 46 and 47 before us and with the fact in mind that mosses, in contrast with lichens, have actual stems and green scale-leaves, we may distinguish the various stages of this primitive development of soil as they occur.

Returning from this general discussion of the early stages in soil formation on stone, it will be well to make a study of some of the plants in the Sheffield Hill region. *Polytrichum* (Hair-Cap Moss) is to be found wherever there is comparatively new soil not too much invaded by grass. The several species of *Polytrichum* are the largest of our mosses. Some of these grow to be several inches tall. They have comparatively long, pointed, dark green leaves. By these characteristics they can usually be recognized even by the person not much acquainted with the mosses. This moss is especially abundant in association with fruticose lichens. Where it grows vigorously it usually forms a brown, spongy, peatlike soil which is quite

acid. It holds water well, and some other plants which can endure the acid find with it suitable soil for growth. Some of the commonest of these invaders are Sheep Sorrel (*Rumex acetosella*), White Clover (*Trifolium repens*), Devil's-Paint-Brush (*Hieracium aurantiacum*), King-Devil (*Hieracium florentinum*), and a considerable number of species of grasses. Where these plants, which grow taller and cast shade, develop in considerable numbers the mosses and lichens largely disappear, apparently from lack of light. At about this stage seedlings of young trees often appear.

Another conspicuous moss is *Sphagnum* or Bog Moss. *Sphagnum* often grows in the form of beautiful, well-rounded, deep cushions of a light yellowish green color, at times tinted with pink. It is characteristically a peat bog plant but is to be found in several places here. While this pasture land is in no sense a peat bog, decaying stumps and logs, along with considerable seepage, furnish conditions in which this moss grows very well. Associated with it there are a number of other bog plants, especially Blueberries (*Vaccinium pennsylvanicum*) and Goldthread (*Coptis trifolia*).

The north-facing slope of Sheffield hill together with the adjoining flood plain of Red House creek afford an unusual display of ferns. House and Alexander, in Handbook 2 of this series, list a number of these as infrequent or even rare. A list of the species follows:

Ostrich Fern *(Pteretis nodulosa)*, along Red House creek

Sensitive Fern *(Onoclea sensibilis)*, along Red House creek

New York Fern *(Thelypteris noveboracensis)*, in clearings

Marginal Shield Fern *(Thelypteris marginalis)*, in woods on Sheffield hill

Goldie's Fern (*Thelypteris goldiana*), in woods on Sheffield hill

Figure 49 Leatherwood (*Dirca palustris*) growing in pasture. While considered an infrequent plant in park, several are to be found in Big Basin, mostly in Red House and Stoddard valleys.

Figure 50 Natural graft between White Elm and Yellow Birch

Spiny-toothed Shield Fern (*Thelypteris spinulosa* var. *intermedia*), in woods on Sheffield hill

Christmas Fern *(Polystichum acrostichoides)*, in woods on Sheffield hill

Hay-scented Fern *(Dennstaedtia punctilobula)*, commonly in decaying stumps and logs in the open (figure 48)

Narrow-leaved Spleenwort *(Athyrium angustifolium)*, in deep woods

Silvery Spleenwort *(Athyrium acrostichoides)*, in deep woods

Lady Fern *(Athyrium angustum)*, in woods on Sheffield hill

Maidenhair Fern *(Adiantum pedatum)*, in deep woods

Common Brake or Bracken *(Pteridium latiusculum)*, common in open fields and other exposed places

Common Polypody *(Polypodium virginianum)*, a fine display on rock outcrop along the north slope of Sheffield hill

Interrupted Fern *(Osmunda claytoniana)*, along Red House flood plain

Cinnamon Fern *(Osmunda cinnamomea)*, along Red House flood plain

Lance-leaved Grape Fern *(Botrychium lancevlatum* var. *Angustisegmentum segmentum)*, in the woods on Sheffield hill

Ternate Grape Fern *(Botrychium obliquum)*, on Sheffield hill

Leathery Grape Fern *(Botrychium ternatum)*, on decaying wood in pasture

Rattlesnake fern *(Botrychium virginianum)*, common throughout the woods

All of these ferns can be found within a radius of one-half mile or less from the point where Red House creek is undercutting the north slope of Sheffield hill.

A few other plants should be mentioned before we leave this rather surprising list. A little way up the north side of Sheffield hill and extending for a considerable distance in an east-west direction is an unusually fine display of American Yew (*Taxus canadensis*). Perhaps the most unexpected species remaining to be mentioned is Leatherwood (*Dirca palustris*) (figure 49), several individuals of which are growing in the pasture lands mentioned before. It seems that cattle do not eat the tough twigs of these

shrubs and hence the species can thrive in places where the common trees and shrubs are restrained by grazing animals. This species is also encountered from time to time when one follows Bee Hunter and Stoddard creeks into the deeper parts of the forest, growing usually near the water courses. Mention should be made here of an unusual phenomenon, to be found within this area, in the form of a natural graft between two species of trees not usually making such a graft. The smaller tree (figure 50) is a Yellow Birch (*Betula lutea*), and the larger one is a White Elm (*Ulmus americana*). It can be seen that they are grown together at the base and that a limb of the elm is firmly grafted across the birch. These trees are growing together on an old Hemlock log embedded in the soil at the confluence of the east mouth of Bee Hunter creek where it flows into Red House creek.

In an earlier section of this article we considered the pronounced effects of light on the growth rates and distribution of plants. We also observed that when conditions are right for the entrance of carbon dioxide into the plant, in the process of photosynthesis, conditions are equally good for the evaporation of water from the tissues. Thus, the plant growing in air is certain to lose water in the form of vapor much of the time. This unavoidable loss must be recovered by absorption or the plant will die. For this reason the supply of water available to the plant and the plant's ability to use water are quite as important as any other factor to its life. The region about Sheffield hill is the best place in Big Basin to study the fundamental relation of water to plant distribution. In the running water of this part of Red House creek and in the pools near its course we find numerous plants of many species. Some of these are so small that they are never noticed

except by the specialist. Others are larger, forming the so-called pond scums. All of these are very simple and primitive and are given the general name of algae. These, and some of the complex higher plants such as certain grasses, sedges, forget-me-nots, and a few others, grow in water, either completely submerged or in wet mud. In contrast we find other kinds of plants growing in very dry, sunny places. Any of the rock outcrops by the road somewhat west of the northeast corner of Big Basin will prove suitable for a study of this type of vegetation. On dry rocks and shallow soil exposed to the drying action of direct sunshine no plant that requires any considerable amount of water can grow. A few lichens, drought-enduring mosses, and hard, dry grasses constitute the major part of the plant life here. If we were to compare the list of species of plants growing in the water of Red House creek with that of the species in this dry habitat we would find not a single name common to the two lists. The reasons will become more evident as our study advances.

To express the differences in water requirements of plants, the famous plant ecologist, Warming (1909), has coined three words. These are *hydrophyte, mesophyte* and *xerophyte,* meaning respectively, water, medium and dry land plants. These words are built from Greek roots. *Phyte* comes from a word meaning plant; *hydro,* from one meaning water; *meso,* from one meaning middle, and *xero* from one meaning dry. A xerophyte is a plant which can endure such conditions as lack of water and the extreme drying effects of sun and wind. The rock-inhabiting mosses and lichens are the best examples of xerophytes in the park. A xeric environment here is relatively rare and of restricted area, owing to the heavy rainfall distributed well throughout the growing season. A hydrophyte is a

plant that grows in water or in a wet situation. The floating algae and the higher plants rooted in mud are our best examples. Intermediate between xerophytes and hydrophytes are the mesophytes. In this entire region it is the mesophytes that give the real color and character to the vegetation. An almost perfect example of true mesophytism is the Beech-Maple-Hemlock forest on Sheffield hill.

The extreme effects of water supply on the plant life of these three types of environment can be readily understood and made striking by a very simple experiment. If we were to transplant the hydrophytes from wetter parts of this area to the xeric soil on rock outcrops, most of them would be dry and dead within a few minutes, and all would die in a comparatively short time. If, on the other hand, were we to move the xerophytic lichens, mosses and grasses to the water they would soon decay. While results would not appear quite so promptly in an exchange between the mesophytes and either of the others, these results would in time be almost as definite and decisive. This experiment only illustrates common observation, that plants are adjusted to certain water requirements and can not live in very different surroundings. While light, as we have seen, plays a great part in limiting the distribution of plants, water is possibly an even more important factor.

If we study in detail the structure of hydrophytes, mesophytes and xerophytes we find that hydrophytes have little or no means of restricting evaporation from their tissues. This is the reason they die very quickly in a dry location. In contrast, xerophytes have a large number of means by which they keep any water they absorb. Some of the more evident of these are thick coverings of wax or other waterproof substances. As a supplement to the ability to retain

water, the majority of xerophytes have very efficient means of absorbing water. As might be expected, mesophytes are almost always intermediate between xerophytes and hydrophytes in water-retaining powers. While it is a very crude experiment, the following exercise very well illustrates the water-holding capacity of the three kinds of plants we have been studying: Choose leaves from as many species as can be found growing in water; from xerophytic plants; and from plants in the mesophytic Beech-Maple forest. Place them on a table or other flat surface and keep a record of the length of time required for each to become dry enough to crumble between the fingers. While this does not give any indication of the absorptive powers of these plants it does show the relative powers of water-retention of plants in the different environments. All of this helps to illustrate the fact that each species of plant is largely restricted to an environment to which its structure consigns it. Individuals that start to grow in surroundings for which they are not fitted soon die, leaving the well-adjusted plants to thrive and propagate their kind.

During these studies the reader may have noticed that we continually meet groups of species regularly growing together because growth conditions in these places are right for these particular species. Certain kinds of lichens grow together; Beeches, Maples and Hemlocks grow together; oaks and hickories grow together, and we might multiply examples such as these. Such groupings are called plant associations. We refer to these as lichen associations, oak-hickory associations etc., naming each after the important plants that are grouped together. The various plant groupings result from the fact that several species may be adjusted to almost the same light, soil and

water requirements and hence can thrive in the same places.

Usually a given association is controlled by one or a very few species. These controlling members of the group are called the dominants, and the association is named for them. For example, in the Beech-Maple-Hemlock forest these three kinds of trees almost exclusively determine what other plants may enter and which are to be excluded. Their shade is too dense for sun-requiring plants. Their decaying leaves make a rich humus soil that holds water exceptionally well. This prevents the growth of xerophytes, at the same time making ideal conditions for shade-tolerant mesophytes such as many of the mosses, violets and some of the ferns. Although there are many more individual moss plants in the forest than there are of trees, no one would be inclined to consider the mosses as dominant species. It is the tree and not the moss that makes the important features of the forest environment. This is the reason the trees are said to be dominant and the association is named for them rather than for the more numerous individuals of the small species.

Earlier in this section of the handbook there was a brief discussion of the fact that the lichens prepare soil in which other plants grow; that these are usually tall enough to shade the pioneer sun-requiring lichens, thus weakening and eventually killing them; and that these secondary invaders increased the amount of soil by the decay of their own older parts, thus allowing still larger plants to have root room, and therefore to cast a still greater amount of shade. At another place we saw that the aspens prepare the way in much the same way for Red Maple and the birches and that these in turn cast sufficient shade and prepare suitable soil for Beech, Sugar Maple and Hemlock. Each plant

community, from the lichens growing on bare rock to almost the highest expression of forest we have, has run somewhat the same course of self-destruction while preparing the way for succeeding associations. This is called plant succession and is in fact a succession of associations. Each association gradually merges into the next, slowly dying out as its successor develops. This is the reason we often find mixed associations. That is to say, we find remains of an older plant society persisting while the newer one is entering. In this way we find members of two societies mingled, often appearing as if they were fully adjusted to each other. Perhaps it will clarify our ideas to summarize briefly the steps of succession as we have seen them. If we begin with a bare rock surface, our first vegetation is some species of crustose lichen which eventually forms a minute bit of soil. This permits the growth of foliose and fruticose lichens and often of xerophytic mosses. Soil gradually forms through their activities. Certain weedy xerophytes gain root room. Shade cast by these taller plants soon makes growth impossible for the earlier occupants of the place. Seeds of trees and shrubs germinate in the increasing soil mass and some of the most light-tolerant and xerophytic of them survive. These trees and shrubs cast increasing shade as they grow older. This produces two results. First, it kills those light-requiring species that have prepared the soil, and second, it produces a denser shade in which shade-tolerant species may grow. Some of these that are of tree dimensions overtop their light-requiring nurse trees and cause their death. So step by step association succeeds association, each preparing the conditions for its successor while at the same time making conditions less suitable for its own seedlings to grow. Thus each associa-

tion commits suicide by its own growth. Development continues in this way until the Beech-Maple-Hemlock association is reached. Beyond this, succession does not go, for these trees make conditions of soil and light suitable for the development of their own seedlings. Since no other tree species in this part of the world can thrive better under these conditions and compete for room, this forest perpetuates itself generation after generation. A plant association that can do this is called a climax association.

If, instead of beginning the study of successions on bare rock, we should begin with a hydric location such as a pool or pond we would find that the water plants gradually fill the depression with the decayed remains of their older parts. In this way soil is gradually built up above the water level, and plants that are less hydrophytic crowd in and occupy the newly formed soil. In time the succession becomes more mesophytic as soil builds higher and higher. The end of this series is just the same as that on the rocks—the Beech-Maple-Hemlock forest. Examples of the climax forest at the end of both of these lines of succession can be found in many places in Big Basin. On Sheffield hill the dominant species can be found with their roots growing in the thin humus overlying conglomerate blocks, thus ending the rock succession. In Stoddard hollow the Beeches and maples crowd down in places to the very moist soil near the flowing water.

Such a sequence of events leading toward mesophytism from both the xeric and the hydric environments, of course is not limited to Allegany State Park but is a general phenomenon wherever climatic conditions resemble those in the eastern United States. For this reason a thorough understanding of all phases of vegetational succession in

Big Basin will give a good basis for the study of successions elsewhere.

If our analysis of plant associations were being conducted in a place of considerably less rainfall we would find both the hydrophytes and the xerophytes similar to the ones we have been studying here. There might be exactly the same species, or if not, at least plants with similar structural characteristics. The successions would follow almost exactly the same steps and for similar reasons. But the climax would be of more xerophytic species. A trip across the continent gives an excellent picture of this fact. There is a gradually decreasing annual rainfall as we travel westward from the Allegheny mountains toward the Rockies. When we leave the Beech-Maple climax in Ohio, Indiana or eastern Illinois, we find that oaks and hickories form the climax in the states next westward. Even in Allegany State Park there are locations of somewhat greater drainage and exposure to drying action of the sun, in which the Oak-Hickory association is acting as a temporary climax. It is to be expected, however, that this apparent climax will be replaced in time by the true Beech-Maple-Hemlock climax. But in places of lower rainfall such as those states bordering both sides of the Mississippi river, Beech and maple trees do not thrive except in very much protected spots where humidity is high because of shade cast by bluffs or other relief features. In unprotected places throughout the Midwest oaks and hickories are the characteristic trees.

Farther to the west, where precipitation does not much exceed 30 inches a year, a condition found in Kansas and Nebraska, grasses constitute the major climax vegetation. The extensive climatic grasslands are usually called the prairie. In the prairie climate it is only along stream courses,

where there is a greater supply of ground water, that tree species propagate themselves. Still farther west, and especially in the Southwest, is the desert with comparatively little rainfall. In the desert the climax may be only the pioneer lichens or the very earliest stages of succession, because there is not sufficient water to support any but the most pronounced xerophytes.

All of this illustrates the fact that water is one of the most potent factors in the distribution of plants, and that with sufficient water true mesophytism will be reached in time even on exposed rock surfaces.

THE NEW HEADQUARTERS

Changes are taking place and new plans are being made so rapidly around the new headquarters that it is quite impossible to do more than make a fairly clear picture of the situation as it stands in the summer of 1928. According to the statements made by Howard Carr, the slopes of the hill on which this new project is being developed were stripped of trees for use as "chemical wood" 25 years ago. This means that practically every living tree, even down to the smallest, was cut and removed. A description of this process is given elsewhere in this article (see page 141). Time did not permit a detailed study of this plot to check the dates given from Mr Carr's memory, but it would seem that he was fairly near correct in his statement. Now this hill is covered with a young, mixed growth of aspens, Pin Cherry, Red Maple, Black Oak, Red Oak and White Oak and, mixed through these, multitudes of young Beeches and Sugar Maples. Here three steps of the succession seem to be telescoped and overlapping. It does not require prophetic vision, however, to see the early disappearance of the light-requiring aspens

and pin cherry, as oaks, beeches, and maples gradually overtop them. This is certain to occur soon since the aspens have already reached nearly their upper limit of growth in height while the other species may be expected to continue to grow upward and overtop them. This gives a picture of the conditions as they are up the hill and to the west of the new headquarters. Eastward from the new building, one looks up Red House valley seeing only a few trees scattered through the grassland which has been kept by human effort from returning to forest (figures 51 and 52). Surveys have been made for a dam across Red House creek just north of the headquarters building so as to make the broad valley of Red House creek and the mouths of Stoddard, Bee Hunter and McIntosh creeks into an artificial lake that will spread out in front of the building over an expanse of perhaps 100 acres, varying in depth from 15 or 20 feet in the deepest parts, to swamp lands at some of the margins. The lake will close present roads for some distance and these are to be replaced by new ones skirting the water's edge. In addition surveys have been made for a road extending from the new headquarters up Stoddard creek to its headwaters, thence out of Big Basin, across the mountains to English run and ending at or near the old headquarters at Frecks. This will open to the public an entirely new part of the forests.

These activities bring about many fundamental changes in environment which are certain to raise interesting problems for students of plants and animals. It is always somewhat dangerous to forecast in great detail the effects of such far-reaching human interference with natural processes. If these plans are carried out as they have been described, however, we may feel certain of some of the effects.

Opening the road through the deeper parts of the forest will permit the quick entrance of sun-tolerant xerophytes along the roadside. If these are not disturbed by the scythe the steps of plant succession may be expected to follow each other in rapid sequence because the shade and moisture of the forest will keep mesic conditions very near at hand. This will permit the mesophytic climax to be reached much more rapidly than would be the case if this were a large cleared area instead of a narrow roadway through the woods. Much cutting of woods along the road will tend to make a permanently attractive roadside more remote because it will prevent as rapid stabilization of the vegetation as would occur if left without interference. Nature should be left to take its course here.

Perhaps the most interesting change botanically, and the one most difficult to foresee, is the one around the margin of the artificial lake at the new headquarters. Here we will have a sheet of water, of approximately one hundred acres in area, covering the flood plain of Red House creek and its tributaries. The part near the headquarters building will be deep. That toward the eastern margin of the lake will be shallow water, and swampy land may extend beyond the edge of the lake proper. The presence now of some sphagnum moss, blueberries and a few other peat bog plants in the wetter parts of the flood plain raises the question whether there may not develop a small area of peat bog at the east end of the lake. If the bog does not develop, a true swamp with the usual kinds of hydrophytes may be expected to appear. A careful series of studies should be made from year to year in this area until

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Editor's Note. The English-Stoddard road through Big Basin was open for traffic in 1930, and the artificial lake near the Administratoin Building was filled with water in 1931.

Figure 51 Looking eastward up Red House valley from new Headquarters, before the construction of the dam across Red House creek making this into an artificial lake

Figure 52 Looking southward up Stoddard valley from hillside opposite. The new Headquarters is being built in the clearing to the right in the background. A considerable part of cleared land in middle of picture is occupied by the artificial lake. See figure 1.

the trend of the succession is certainly determined. Such a series might be of considerable scientific value because there have been few if any studies made under just such conditions.

YOUNG BEECH-MAPLE-HEMLOCK FORESTS

By far the greatest area of Big Basin is covered with second and third-growth trees. Except in limited stretches these are predominantly Beech and Sugar Maple with young Hemlock trees appearing in many places. Among the younger stands there are a great many individuals of Aspen but everywhere, with the exception of the very youngest growths, these are shaded and dying. Throughout the returning forest there are numerous scattered Red Maple and Blue Beech trees (*Carpinus caroliniana*); here and there is to be found a Tulip Tree, a White Ash, a Basswood or an occasional Cherry Birch or Yellow Birch. In the more westerly parts there are considerable numbers of Black Oak (*Quercus velutina*), Red Oak (*Quercus rubra*) and White Oak (*Quercus alba*), in places mixed with the other species. But the number of individuals of these species is comparatively small so that, except in the very youngest parts of the forest, one may tramp for mile after mile with but little variation from beeches, maples, and hemlocks. This is a word picture of these forest-covered mountains as they were in the summer of 1928.

MISCELLANEOUS INFLUENCES ON VEGETATION

THE EFFECTS OF FIRE

In almost any part of these woods can be read the tragic story of fire. Nearly all of Big Basin appears to have been visited at some time by one or more fires. These were not the spectacular ones so often pictured

when an entire forest is burned in a terrible rush of flame but rather the quieter type burning the dry leaves, humus and brush on the ground. This is what is known as a ground fire. The more spectacular crown fire could not occur in a deciduous forest such as this is because the living leaves and twigs do not contain pitch or other easily inflammable materials and fire could not persist in the green twigs even though it were to start. A ground fire may not seem to be a tragedy at first thought, until we recall the fact that the priceless humus which acts as a sponge to hold water and as a reservoir for plant nutrients has required centuries to accumulate and that the trees suffer irreparable loss when this is destroyed. Moreover, the intense heat kills or destroys the live bark, leaving wounds which often fail to heal. If we examine trees at almost any place in Big Basin we find such scars extending up from the ground for a few inches or even for some feet in the most severe burns. Into these scars, if they are deep, various fungi find ready entrance causing the decay of the heart wood, and the weakening of the tree. In many cases disease attacks the living outer wood, called sap wood, and hastens the inevitable downfall of the tree. One does not have to look far to find these dead or dying specimens. Sometimes they have already fallen, but many are still standing, awaiting only a heavy wind to send them crashing to the ground. Some of these diseased trees have a long time yet to live, but premature destruction is certain for all of them. Among them are fine old beeches and maples already large but doomed to fall before reaching the stature of the giants they might have become without these devastating influences.

TANBARK AND CHEMICAL WOOD INDUSTRIES

The tanbark and chemical wood industries have been mentioned in the earlier parts of this handbook. An understanding of them may be useful in interpreting conditions found in the woods and as an end in itself. The oldest inhabitants tell us that in the early days after enough trees were cut to permit the building of cabins and the clearing of small farms, or in some cases even before that, sawmills were set up and the White Pine was made into lumber. At about the same time, much Wild Black Cherry was selected for furniture, and White Ash for tool handles and similar uses. Next Hemlock was taken both for lumber and for tanbark. There was a wide variety of methods used in dealing with the Hemlocks. Where they were used for tanbark most of the work was done during the months of May and June when large numbers of transient workmen came in to peel the bark. During those months the bark peeled readily and mosquitoes and "punkies" were not bad. When the bark-peeling season was over and these hungry insects became a nuisance the workmen moved out of the woods. In removing the bark the tree was cut down and the bark cut into four-foot lengths. Each of these sections was split down a side and peeled off. The bark was then taken to market to be used in the tanning of leather. Now tanning is done by other means and the Hemlock bark is no longer needed in large quantities. The more careful operators took the logs after the bark was removed and converted them into lumber. The presence of decayed remains of what were large logs proves, however, that there must have been a great waste of the Hemlock. It also indicates that this species was once more plentiful than it is now. Young trees are found in considerable numbers, however, and it is to be expected

that in time this species will return to some of its ancient splendor.

The chemical wood industry, unlike the tanbark industry is still going on actively in many places. It is true that all these destructive activities have been brought to a close throughout Allegany State Park. It seems to be impossible to obtain exact data as to the time when the last cutting was done in the park for wood distillation purposes. It is said that the plant operated within Big Basin by the A. B. Smith Chemical Company used wood shipped from other places for years before the plant was finally closed. The records of the company have been destroyed and no one seems to have any very definite idea of actual dates of cutting. As near as it has been possible to determine, the company must have done its last cutting within Big Basin about twenty or twenty-five years ago. Figure 53 shows the abandoned distillation plant of the Smith Company near Red House, while figure 54 shows The Peak which rises above it. This mountain is a landmark that can be recognized for long distances. Wood distillation is a highly technical industry, but it will be worth while to understand it to some extent. Beech and maple are considered the best woods for distillation because of the weight and quality of the wood. All sizes of trees are cut, even very young ones. The larger ones are split into smaller sizes and the wood is corded and allowed to dry for several months. It is then taken to the distillation plant where it is heated in air-tight containers. A series of chemical changes takes place leaving a residue of charcoal and a mixture of crude wood alcohol, calcium acetate and other by-products such as wood tar, wood gas etc. The charcoal, alcohol and acetate are all put to a variety of industrial uses, while the wood tar and gas are used as fuels in the heating process.

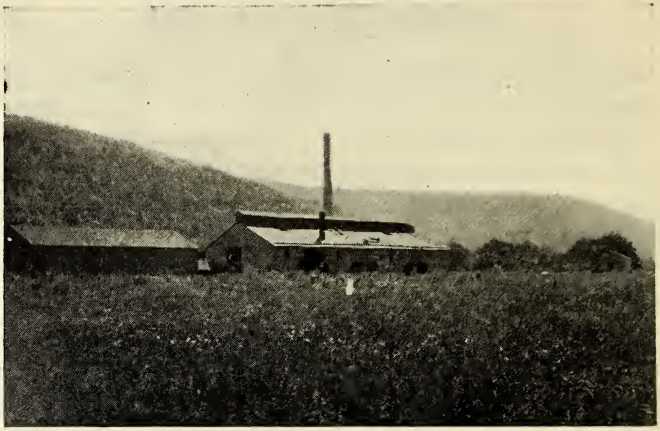

Figure 53 Abandoned wood-distilling plant of the A. B. Smith Chemical Company

Figure 54 The Peak as seen from road not far west of new Headquarters

Our interest, however, is largely in the effect of this industry on the plant cover of the mountains. It requires little imagination to see that when the cutting is carried to such a degree of completeness as has been described above, the sunshine for the first time in many years reaches the soil, drying it and killing many of the young trees. A few of the hardier individuals persist but most of them die. While there are no exact data available for Big Basin, data taken in similar situations by various investigators shows that the chief species to come in are light-tolerant and that these are gradually replaced by a series of associations which finally ends with the Beech-Maple-Hemlock climax forest. Thus man, for his own gain, interrupts nature's cycle. But he only interrupts, and in the course of a few decades without his destroying hand, the cycle completes itself and the Beech-Maple-Hemlock climax is returned.

SUMMARY

In conclusion we may, with profit, summarize these pages in such a manner as to bring together into concise form the facts we have followed in more detail.

We have seen that the Wisconsin glaciers as they approached from the north some thousands of years ago, must have brought with them conditions for vegetation much as they are in the present tundra of the polar regions. The characteristic plants of the tundra are lichens, mosses, willows, birches, blueberries, sedges and grasses. Today some of these boreal plants remain as relics of former conditions still persisting in parts of Big Basin. Especially characteristic are certain species of *Sphagnum, Polytri-*

chum and Vaccinium. When the ice slowly retreated with warming climate, other species of plants must have slowly crowded in and occupied most of the area, leaving only small islands of boreal plants, such as we now find them, in glacial lakes of the region. We have seen, again, that plant succession gradually took place in most parts of the country through a series of steps which we can now only dimly conjecture, because of changing climatic conditions, until the present mesophytic forest was established. This forest was dominated by Beech, Sugar Maple and Hemlock trees, but there were many White Pine, Ash, Black Cherry, Cherry and Tulip trees scattered throughout these woods. At some time during the centuries the Indian came to make these mountains his home. He lived so completely as a part of his natural surroundings, and so well protected them from destruction that when the white man first saw them, these forests were beautiful almost beyond description. In one short century the white settlers have cut and burned these magnificent tracts of timber. In part this destruction has been legitimate but too much of it has been done in a most wanton and wasteful manner.

These facts have been studied in some detail, and now we can view the present, in which man has voluntarily removed his interfering hand from this, a considerable tract of land. We see that natural forces, now no longer restrained in great degree, are bringing in a secondary succession of forest vegetation which bids fair to approach the primeval glory of its predecessor if left unmolested for a few centuries. We can only look to the future in the hope that nature, allowed to follow her own course without serious interruption from man, may heal these wounds and contribute to the enjoyment of future generations such inspiration as only a forest can give.

FIELD EXCURSIONS IN BIG BASIN

EXCURSION 1 THE BIG TREES AND SECOND-GROWTH BEECH-MAPLE-HEMLOCK FORESTS

From the Allegany School of Natural History travel eastward to the junction of the Bradford and Salamanca roads. Go northward on the Salamanca road 3.6 miles to the Bay State road, which leaves the Salamanca road turning at a right angle toward the left (west). Camp 12 lies somewhat obscured in the woods immediately to the northwest. Follow the meanderings of the Bay State road to Hill Crest, the highest point on the road. The distance from Camp 12 is three miles. From this highest point, which can not be mistaken, tramp directly northward into the woods. Do not fail to watch your compass in these woods unless directed by someone familiar with the place.

This is the best place in Big Basin to study the comparisons between the Big Trees and second-growth forest. The line between these can be found by turning sharply westward after penetrating into the open growth of the big trees. Within a few rods the line between the two will be found. The difference will be readily recognized by noting the stumps and logs and smaller sizes of the trees as you enter the second-growth.

By reference to my map it may be possible to find the little group of White Pine, Black Cherry, big Chestnut trees etc., which appear to belong to the primitive forest. Figure 32 is marked on the map near this point. It is possible that this immediate region may become in the near future easily accessible by means of the new road, one survey of which passes near this spot.

When leaving this Big Trees area the return may be made by retracing the route by which you came, or if the

road is followed westward from Hill Crest it will lead to the village of Red House. At the store, turn sharply to the right (eastward) and follow the road back to Camp 12, thus encircling Big Basin.

EXCURSION 2 THE SHEFFIELD HILL REGION AND THE NEW HEADQUARTERS

Go to Camp 12 as directed in excursion 1. From this point continue northward on the Salamanca or Red House road to Camp Yowochas, a distance of four miles. Sheffield hill lies south and southwest of this camp. On the north-facing slope there is a fine young forest. Many species of ferns can be found along Red House creek and on the hillside. Farther to the west, after crossing the pasture fence, are to be found numerous examples of the various types of lichens, also *Polytrichum, Sphagnum* and blueberries. All of these have boreal affinities. See pages 114 to 126 in this handbook for descriptions of other interesting features here.

From this point the new headquarters can be seen toward the west.

EXCURSION 3 LONKTO KNOB AND FRANCE'S HILL

Follow the same route as in excursion 1 to Hill Crest but continue westward over the crest to the only large bald knob on the right side of the road. The distance from Hill Crest is about one mile. The place is so conspicuous that it can not be mistaken.

After climbing the hill a fine view of surrounding mountains can be seen. In the hollow beyond (north of) the knob are a few big trees. Mostly, however, the interest lies in the various stages of return of the forest in the forms of sun-tolerant trees and shrubs.

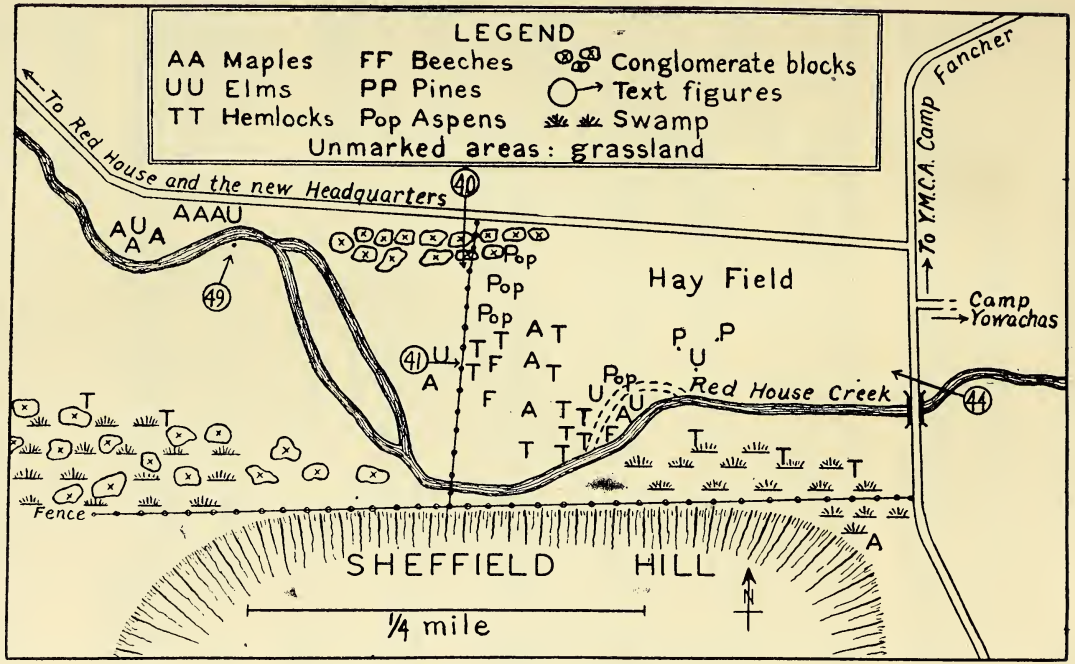

Figure 55 Map of the Sheffield Hill region

Having seen these stages it is well to return over Hill Crest to France's hill to find other stages in a similar succession. Reference to the map is the easiest way to locate France's hill, a mile and a half southwest of Halls.

EXCURSION 4 THE PEAK AND CHEMICAL WORKS

Follow the same route as in excursion 2 to the new headquarters. Travel two miles farther westward to the abandoned plant of the A. B. Smith Chemical Company. Over most of the distance from the headquarters, the Peak can be seen a little to the left, as a very conspicuous part of the landscape. The dismantled wood-distilling plant of the chemical company is worth a brief visit.* By climbing the northeast side of the Peak a considerable area of carefully managed big trees can be traversed. These have been kept under the personal management of the owners from the first and have not been subjected to the destructive treatment of the companies that have lumbered all around this place. Within this Big Trees area is a small "rock city." On top of the Peak there has been much destructive activity occasioned by both the ax and chestnut bark disease. From this hilltop an unusually instructive view of surrounding country can be seen.

* Editor's Note: Since the above excursions were planned in 1928, the chemical works has been removed by park authority. The new English-Stoddard road was opened through Big Basin in 1930, making it easy of access. The Sheffield Hill region east of the artificial lake at Red House has been less disturbed. Camp Yowochas was occupied in 1936 by a new group camp known as Sprucelands.

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A BOTANICAL SURVEY OF A PORTION OF ALLEGANY STATE PARK

From Allegheny River to Road Along Upper Red House Creek and from Bay State Road to Quaker Run Road

(Figures 56–90)

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CONTENTS

This section of the handbook is a report of a detailed botanical study of that part of the Allegany State Park which lies between Allegheny river on the west and the road along upper Red House creek on the east, and between Bay State road on the north and Quaker Run road on the south. It is about five miles wide along the river,

narrowing to about three miles on the east, and is some ten miles in length. The general trend is southeastward from the river for about five miles, then eastward for about five miles. The strip lying next to the river bank and extending from one-half to three-fourths of a mile from the river on the park side belongs to Allegany Indian Reservation rather than to the park, but since it is a part of the same floristic area, is largely wild, and is accessible to students in the park, it is included in this survey. We are thus dealing with an area of some 30 square miles, a rather typical sample of the park area, extending from low river bottom to the highest portion of the park and including river bottom and creek bank formations as well as considerable areas of Oak and Beech land in various stages of secondary succession from clearing, burning or cutting to mature forest.

GENERAL DISCUSSION OF TYPES

Three main forest types characterize the area. Disregarding disturbances that have led to secondary successions, the distribution of the 30 square miles included in the survey might be computed roughly as 5 per cent river bottom forest, 20 per cent Oak forest and 75 per cent Beech forest.

The first of these borders the river, occupies the islands in its course and ascends the lower portions of its principal tributaries, Quaker run and Bay State creek. It consists mainly of Willows and Alders along the edge of the water, with Silver Maple, American Elm, Butternut and Sycamore on somewhat higher ground.

The Oak forest is found principally on the hills next to the river. Factors determining its distribution will be discussed in the following section. In the designation of

Figure 56 Interior of mature Beech-Maple forest near head of Red House creek. A large Beech is in foreground at left of figure, and a smaller Hemlock behind. In background are Maple, Beech and Hemlock. The principal undershrub is Hobble-bush. This forest covers an area of about one-half by one-fourth mile

Figure 57 Interior of mature Beech-Maple forest near head of Red House creek. Yellow Birch is prominent in the foreground. The trunk at the left is a dead stump and bears the fruiting bodies of the pore fungus, *Fomes*. Beyond the cap is a Sugar Maple, and to the right of the big birch is a Beech. Undershrubs are *Lonicera canadensis* and *Viburnum alnifolium*.

the forest that is prevailingly oak, many ecologists use the term "Oak-Hickory forest." This is quite appropriate, no doubt, for many parts of eastern North America. Others, speaking more particularly of the Allegheny region, use the term "Oak-Chestnut forest." My counts indicate in the region that is prevailingly oak, nine species of trees more frequent than Chestnut or than any one of the three hickory species. Taylor's studies indicate that five tree species are present in a typical area in greater numbers than is Chestnut or any one of the hickories. Therefore, so far as this region is concerned, it seems better to speak of this type simply as "Oak forest."

The climax forest—the one variously designated as "Beech-Maple," "Beech-Maple-Birch," or "Beech-Maple-Hemlock"—is clearly dominated by Beech, Sugar Maple, Yellow Birch and Hemlock. The first two of these clearly prevail over the others. The following table will give a rough idea of their relative importance, the first estimate being from Taylor, the others based on the writer's work.

TABLE 1

	SUGAR MAPLE	BEECH	YELLOW BIRCH	HEM-LOCK
1 Many counts, mature forest, Big Basin, average per cent of all trees	40	36	8	6
2 Belt transect, mature forest, Upper Red House, per cent of all trees	31	40	18	11
3 26 sample areas, mature forest, Big Basin, frequency	92	100	42	88
4 50 sample quadrats, typical second growth, frequency	100	54	24	22
5 Frequency in entire Beech area, 389 quadrats	57	28	26	16

The areas in (3) were selected along the new road that crosses Big Basin by stopping the car at .1 mile intervals and listing the trees that were visible from it. Those in (4) and (5) constitute a part of the frequency survey described later, (4) including quadrats not beside a road or path hence having few clearing forms, and (5) including all of the quadrats studied in the Beech area.

Weaver and Clements regard Hemlock as a postclimax tree, occurring regularly in deep moist valleys and on north slopes. Lutz finds that in Heart's Content, a virgin forest in northwestern Pennsylvania, Hemlock as a relatively pure stand forms a stable community which may be regarded as a physiographic climax, owing its existence primarily to the moist nature of the site. Jennings considers Hemlock a hydrarch pioneer, making up the forest in moist cool ravines, but giving way to Beech and maple as erosion widens the ravine. On the other hand, Taylor says that the tree is perfectly at home in the Beech-Birch-Maple forest, consequently is found everywhere in the park, both in the present stand and formerly as very large trees, which were ruthlessly felled and stripped of their bark. In my observation the tree is rather generally scattered, but relatively pure stands of it are confined to the valleys. Further work should be done on this problem, preferably in a region where the tree has held its own better than was possible here, in as much as Salamanca was once the center of an extensive tanbark industry. In view of its doubtful status, however, it seems better not to include the name of Hemlock in the designation of the forest type as it here exists. Yellow Birch, and also its less frequent relative Black Birch, seem to figure more largely in the earlier stages of succession than in the mature forest. It is true that large birches occur

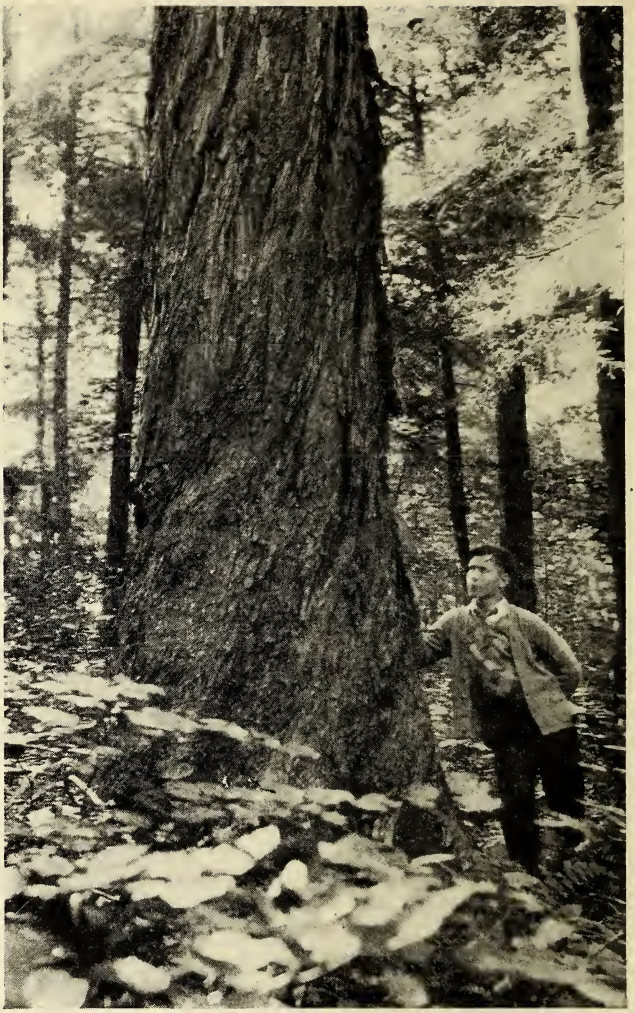

Figure 58 Trunk of large Sugar Maple in mature forest near head of Red House creek. The diameter of this tree is about four feet. The principal undershrub is Hobble-bush. Few trees of this size remain in Allegany State Park.

Figure 59 Herbs on floor of primeval forest near head of Red House creek. *Oxalis acetosella* is most frequent. A blossom of this is visible near the center. Next in frequency is *Lycopodium lucidulum,* shown at right and left. A plant of *Aspidium intermedium* is in the foreground, and one of *Medeola virginiana* at the rear.

Figure 60 Second growth Beech-Maple timber near Bradford-Salamanca road. This is characteristic of most of the central portion of the park. Trees visible are *Prunus serotina, Acer saccharum, Betula lutea* and *Tsuga canadensis.* Stumps of former large trees are visible.

in the mature forest, but they, like the cherries, may be regarded merely as holdovers from pioneer days. Sugar Maple is both the most abundant and the most frequent tree in the region. It extends into all of the association types. My frequency surveys of some 500 plots show Beech only four times in sections prevailingly oak, while oak occurs but ten times in sections where Beech is a dominant. Although Sugar Maple is an important dominant in the climax association, Beech is the indicator of preeminent value. In other words, the presence of Sugar Maple tells far less about the real nature of the forest in its reaction to habitat conditions than does the presence of Beech. I shall henceforth speak of the two forest types simply as Beech and Oak.

FACTORS INFLUENCING DISTRIBUTION OF TYPES

Taylor locates the Oak forest in the warmer and lower parts of the area. "While the Beech-Birch-Maple is predominantly northern and consequently of cooler regions," he says, "the Oak-Hickory forest finds its home farther south and consequently in the warmer parts of America. It is not surprising then to find it along the Allegheny river, the hills bordering it, especially in the south side of such hills, and in other places of lower elevation in the park." It seems to me that he has placed the emphasis in quite the wrong place. The zones of Beech-Maple and Oak-Hickory in eastern North America are in general longitudinal zones based on the ratio of rainfall to evaporation rather than latitudinal zones based on temperature. So far as the park is concerned we have no assurance that the higher areas are as a rule the cooler. Certainly killing frosts, such as occurred July 20 and again August 20,

1929, are most severe in the lower valleys. Taylor brings into play a sort of climatic inversion to account for the presence of oak on some of the higher hilltops. He says that a clearing, followed by fire, admits the sunlight to such areas, and this raises the temperature of the forest floor to such an extent as to favor oak.

Do the facts of distribution in the park adjust themselves to explanation on the basis of temperature differences? On north slopes Beech and its associates almost invariably extend to or nearly to the river. In the area of my survey this was noted on the north flank of Huckleberry hill, also on the north flank of the hill between Creek's run and Bay State creek. It was observed at other places in the park, and on the southern bank of the westwardly flowing portion of the river near Warren, Pa. At the sides of valleys paralleling the river, such as Holt's run and Cain hollow, Beech usually occurs at the lower and oak at the higher altitudes. After one has made a preliminary survey of the park by driving along the roads, most of which follow the streams, it is a real revelation to begin climbing the hills and observe the extent of oaks along their ridges and summits. On looking at these ridges and summits from below, one can generally detect the cylindrical forms of oaks, contrasting with the more conical Beeches and maples below, usually with some dead Chestnuts scattered among them. The profile (Figure 90) cutting the surveyed area lengthwise over the tops of the higher hills, indicates that as one proceeds away from the river, Beech gradually comes to hold a more prominent place in the valleys, while oak becomes more restricted to the hills and ridges. After one has passed English creek, which cuts through the middle of the area surveyed, the oak has become negligible and practically the entire

Figure 61 Second-growth Beech forest in winter condition. Some cherry and aspen persist in this forest, birch is abundant, and Beech, Sugar Maple and Hemlock are rapidly becoming established. With its present protection the former glory of the forest should in time be restored.

Figure 62 Typical floor cover in second-growth Beech-Maple forest. *Dalibarda repens* is the dominant herb in this view. *Oxalis acetosella* is intermixed. *Aspidium novaboracense* is shown in the center and *Aster cordifolius* below.

area is Beech forest. Even an extensive burned area in this portion, such as Stony brook, offers no inducements to the advent of oak. This fact is, however, apparently not due to any difference in altitude. It may be noted on the profile that the altitudes of the oak-covered portions are but little less than those of the beech-covered portions. The average of the former is, roughly estimated, 1940 feet, while that of the latter is 2065 feet. The difference is only 125 feet, too slight to be significant. The portion of the dissected plateau inclosed by the great bend of the river forms a rather isolated block, separated from the outlying hilly region by a flat valley a mile or more in breadth. The outer portion of this block, because of relatively greater exposure to the winds that sweep over the valley, might be expected to have a lower relative humidity and support a rather more xerophytic plant association than does the more protected inner portion. Especially would this be true of the portion of this block in the face of the prevailing westerlies, which happens to be the portion of this survey. The northern and eastern edges of the park area, so far as my observation goes, do not show such extensive stands of oak. The humidity theory of oak distribution seems to be borne out by the lesser details as I observed them. Oak is generally more abundant on the south than on north slopes, more abundant on west than on east slopes, and generally prevalent on peaks and exposed ridges. Beech tends to occupy depressions, valleys, sheltered benches favored by seepage, as well as north slopes. Since a forest develops, to a large extent, its own condition of humidity, we should naturally expect to find the Beech succeeding the oak. At a number of places along transition zones between the two associations, this is clearly

indicated, Beech and Sugar Maple seedlings being abundant among large trees of oak and its associates.

The area surveyed is rather uniformly rolling except for the floodplains of the river and of the lower courses of its larger tributaries. These level areas, being of arable land, have had their vegetation much disturbed. Farm settlements were also made for five or six miles up Quaker Run, for the same distance up Bay State creek, and to a lesser extent along the other streams. Many of these, proving unprofitable, were long ago abandoned, and others have recently been purchased by the State and left fallow. The area has suffered extensively from lumbering. First the White Pines were taken, then the Hemlocks, then much of the hardwood, then the chemical plant at Red House almost completed the work of forest destruction. Where farms were established, the weed pioneers or ruderals came in greatest numbers; therefore they show up extensively along the roads that pass through the settled portions. Road building itself opens the way for ruderals, often permitting them to spread for a distance back into the forest. The newer roads, like English Creek road and particularly the new road through Big Basin, give excellent opportunity for studies of cross sections of the timber. The former road passes through second growth from cutting, a small portion only near the north end of the road being relatively mature. The extension of this road northward, after one crosses Bay State road, passes through the Big Basin area, and affords the best view of practically mature timber to be obtained in the park. There is an excellent tract of big timber, about one-half by one-fourth mile in extent, along the upper waters of Red House creek. It has been well located and described in the handbooks by House and Taylor. There is a small patch of mature

Figure 63 Second growth of Oak forest east of Holt's run. In front, Black Birch, in rear, mostly White Oak. According to Mr Holt, who is shown in photograph, this area was entirely cleared and cultivated by Mr Holmes 80 or 90 years ago. The trees, therefore, have come from seed. They are occasionally disturbed by fire.

Figure 64 Floor of Oak forest on bench west of Holt's run. *Aster macrophyllus* is the dominant herb. *Sanicula marylandica* and *Solidago juncea* are seen on right, *Phegopteris hexagonoptera* on left.

maple near the fork of Creek's run, an old sugar camp not more than one-fourth mile across. But most of the original Beech area is in various stages of recovery from denudation, cutting or burning back to mature forest. When cutting is not followed by fire, sprouting from the stumps of Beech, maple and birch hasten recovery to the original condition. But if the cutting is followed by fire, the recovery is much delayed. About two decades ago the park area was extensively worked by the chemical company which had its headquarters at Red House, and practically everything was cut down to sapling size. Brush was left lying in the forest and, on drying, led to extensive fires. The largest burned portion of the surveyed area is probably along Stony brook. This is well described by Taylor. His description compared with the present aspect, and the observations of a student who studied the area in 1925 and again in 1929 indicate that it is being reclaimed rapidly by timber. Under its present protection we may expect ultimate complete recovery. There is evidence of fire at the southeast corner of my area, where the Quaker Run road intersects the Bradford-Salamanca road, also at various places along the Quaker Run road and the Bay State road, and other spots in the interior of the forest. The most extensive burn in the Oak area is Huckleberry hill, much of which is nearly devoid of trees. Proximity to the railway has doubtless encouraged fires here.

CONCLUSIONS FROM ORIGINAL LAND SURVEY

Through the courtesy of the clerk of Cattaraugus county, I consulted the field books of the original land survey which was made in 1798 by Joseph Ellicott, surveyor for the Holland Land Company. This portion of New

Figure 65 Remnant of former mature Oak forest near Holt's run. The large White Oaks are shown in front and a large Red Oak in rear. The presence of the grasses and herbs is due to pasturage.

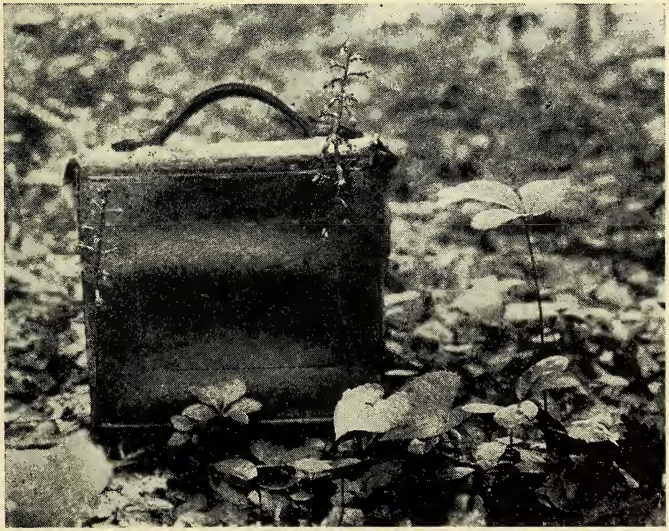

Figure 66 Herbs on floor of Oak forest near Holt's run. Two specimens of the Coral-root Orchid, *Coralorrhiza maculata,* are in front of the camera case, *Fragaria virginica, Gaultheria procumbens, Polygala pauciflora* and *Viola* sp. are also shown.

York was divided into townships which were subdivided into sections, quite in line with the practice followed later in the states to the west. It seems not to have been worked out, however, on the uniform basis that was later used, for while some of the sections are a mile square, others are approximately but three-fourths of a mile square. Still others, jutting on the Indian Reservation, are irregular in size and shape. The field books were consulted primarily with the purpose of learning something of the original character of the vegetation. The trees mentioned are those of the region today. So far as can be learned, the distribution of associations is practically what it is today. The field book data, however, leave much to be desired. With an eye open to utilitarian aspects the surveyor stated the species of trees (using popular names) and the quality of timber (first, second or third). Names of the prevalent trees, together with quality, are given along boundary lines, the linear extent of each type being indicated in chains. Of about 4600 chains so indicated, 4 per cent was described as first class timber, 71 per cent as second class and 25 per cent as third class. It would indeed be interesting if we could form a picture of the three classes as they were rated by the surveyor. It seems safe to say, however, that timber such as exists in the small Heart's Content forest near Warren, Pa., today could not have covered a very large proportion of the Allegany Park region in 1798. There must have been much inferior timber.

In the surveyor's books, windfalls with brakes, briars and underbrush are mentioned as occurring in a number of places. Other places are stated to have been burned over recently. Such places are generally near the reservation, and fires may perhaps be attributed to the Indians.

A prominent hill alongside the river is now known as Huckleberry hill, for it supports an abundance of Blueberries (often popularly known as Huckleberries) and a few true Huckleberries. The soil is poor, and trees have apparently been kept in check by severe burns. The surveyor designates the vegetation on a line passing over this hill as consisting of Whortleberries (an old name for shrubs of the same type). So, whatever may have been its character at an earlier period, the timber of 130 years ago seems to have been of about as diverse a character as it is today.

Since lists of species are given along lines several rods in extent and not for definite spots, it is difficult to determine whether any succession or radical change of type has taken place since then. All indications are, however, that the lines demarking Beech from Oak are about the same of those of today. If, as is commonly claimed by ecologists, Oak is giving way to the Beech climax, this change is so extremely slow as to be scarcely recognizable in a century and a third.

Thinking that the mention of species in the survey may indicate roughly their importance in the forest, I checked the number of times which the surveyor mentioned each species and calculated the percentage which this number bears to the total number of times that all species are mentioned. To secure a basis for comparison with modern conditions I also determined the number of times that each species of tree is checked in my frequency survey, described in the next section, and determined its percentage of the entire number of checkings for all tree species. Manifestly the two sets of numbers are not obtained in the same way, and personal elements enter into

Figure 67 Effect of fire in Oak area. South flank of Huckleberry hill. On the steep slope at the left is fair second growth oak timber. On the gentle slope at the right fires have been severe. There are xeric herbs and shrubs, and only a few trees, among which Black Oak and Sassafras are conspicuous. The immediate foreground is used as a natural meadow. Just behind, aspens are conspicuous.

Figure 68 Large Hemlock stump on cleared area near Holt's run. This will give an idea of the size of the Hemlock trees which were formerly abundant in the park area. The herb growing from the pocket of soil is a Goldenrod.

both sets of data, so the comparison will be suggestive rather than definite. The leading ten species only of the surveyor's record are included in the following table:

TABLE 2

	PER CENT OF IMPORTANCE IN	
	1798	1929
Beech	22	6
Hemlock	15	4
Sugar Maple	12	14
White Pine	9	1
Chestnut	9	1
Red Oak	7	3
White Oak	7	2
Birch (probably Yellow Birch)	5	6
Basswood	3	3
Red Maple	2	8

Some of the apparent shiftings in importance are just what we should expect, knowing as we do the history of the forest since 1798. The decline in Beech may be due to the fact that Beech does not hold its own against cutting and clearing as well as do most other species of the mature forest. All studies indicate that the proportion of Beech in the mature forest is greater than in any of the stages of succession. The declines in Hemlock and in White Pine are due to the fact that these trees have been so much sought after for lumber and for tanbark. Chestnut has rapidly declined in recent years on account of the blight. Red Maple has doubtless increased somewhat with the increase of pioneer situations in which it is able to flourish. If left undisturbed it is probable that

Figure 69 Secondary succession on oak clearings. The cleared meadow in the foreground abounds in Wild Carrot. Through it flows a willow-lined stream. Just back of it is a zone recently cleared, now an aspen association. Oak and pine are conspicuous in the forest beyond, with some Hemlock in the moister depression. East of Holt's run, August 30, 1929.

Figure 70 Quaking Aspen as a burn pioneer. Undergrowth of *Solidago altissima* and grasses with some *Pteridium latiusculum*. Near upper Bay State road.

most of the species would tend to approach their former state of relative importance.

FREQUENCY STUDIES

Frequency is defined by Braun-Blanquet and Pavillard, leaders in the present European development of plant sociology, as a statistical expression obtained by arranging together the lists of species found on a number of sample areas of uniform but restricted size, which are spread as far as possible over the whole extent of a single example of an association. The frequency of a species is expressed by the percentage ratio between the number of sample areas which contain the species and the total number of sample areas analyzed in the example of the association.

Believing that a numerical analysis of this sort would throw interesting light on the relative abundance and importance of different species in the area as a whole and in the different associations included in the area, I carried it out in connection with the survey. At intervals of .1 mile beside all the roads that surround or cross the area there were taken samples or quadrats approximately 5 meters square, that is, having an area of 25 square meters. The locations of these quadrats were determined by the speedometer of a motor car. Along lines laid off arbitrarily across the area, and along the river bank, similar quadrats were taken, the distance apart being the same except in a few cases, in which, for special reasons, it is half as great. An effort was made to select from the various vegetation types somewhat in regard to the proportion they bear in the surveyed area as a whole. The attempt was not entirely satisfactory. Since the roads mainly follow valleys, and since along the roads are farm homes and fields, and since the roads themselves are ecological

disturbances favoring the introduction of ruderals, my data give rather undue emphasis to the plants of the moist valleys and to the ruderals. Quadrats were not taken where the land is actually in cultivation, but a considerable number represent early pioneer successions on reverting fields. Others include ruderal invaders from the roadside.

The plots selected in the whole surveyed area number 507. Of these, 389 represent Beech, or pioneer stages leading more definitely toward Beech. Hence in the following table of the 25 most frequent plants, the frequency is given, in percentages, both for the 507 plots representing the whole area and for the 389 plots representing the Beech forest and its pioneer successions.

TABLE 3

	PER CENT FREQUENCY, ENTIRE AREA	PER CENT FREQUENCY, BEECH FOREST
Acer saccharum	49	57
Solidago altissima	33	36
Rubus allegheniensis	32	33
Acer rubrum	31	28
Fragaria virginiana	27	22
Prunus serotina	26	31
Pteridium latiusculum	24	23
Fagus grandifolia	22	28
Betula lutea	21	26
Carpinus caroliniana	21	19
Aspidium intermedium	20	24
Mitchella repens	19	23
Aster cordifolius	18	18
Viola incognita	18	22
Solidago serotina	17	7
Aster macrophyllus	17	13
Hamamelis virginiana	17	13
Achillea millefolium	17	15
Populus tremuloides	16	16
Phleum pratense	16	17
Rubus strigosus	15	13
Tsuga canadensis	15	16
Prunus pennsylvanica	14	16
Aster prenanthoides	14	12
Aspidium novaboracense	13	14

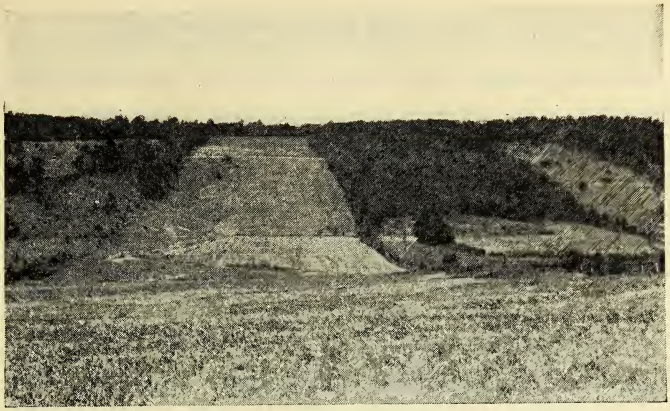

Figure 71 Effect of pasturage and cultivation on woodlands. Looking south from Quaker valley one mile below Cain hollow. The land here is still under private control. The aspect resembles that of much of the Allegheny plateau.

Figure 72 Suppression of forest by pasturing. Beech-Maple forest is in the rear. The trees of the pasture are mainly Hawthorns (*Crataegus*). Their thorns protect them against destruction by cattle, but they are browsed into fantastic forms. In the foreground a recently eroded bank of Quaker run supports a few ruderal weeds.

It will be seen that *Acer saccharum* far outnumbers the other species. It is found in mature forest, in second growth, in clearings, as a weed in fields and along roadsides, intermixed with oak, and even along the river bank. In the mature forest, Beech and Sugar Maple are competitors for dominance, while in all other situations the maple is easily in the lead.

Following maple we find *Solidago altissima,* the leading herb in secondary successions upon disturbed or open places, and then *Rubus allegheniensis*, the leading shrub in successions of the same sort. Mr Holt tells me that since the area has been under state protection, the latter is considerably less numerous than it was about ten years ago. Then the Indians gathered Blackberries by the wagon load and sold them for a cent or two a quart.

The following table represents the approximate position of the ten trees on the list of high frequency in their persistence from earliest colonization to climax.

TABLE 4

Species	*Early*	*Medium*	*Late*
Acer saccharum	———	———	———
Acer rubrum	———	———	
Prunus serotina	———	———	
Fagus grandifolia		———	———
Betula lutea		———	———
Carpinus caroliniana		———	
Hamamelis virginiana		———	
Populus tremuloides	———		
Tsuga canadensis		———	———
Prunus pennsylvanica	———		

Aside from *Solidago altissima* the following herbs of the list are distinctly pioneers: *Fragaria virginiana, Pteridium latiusculum, Solidago serotina, Achillea millefolium, Phleum pratense.* The ones of the list which are most conspicuous on the floor of the mature forest are *Aspidium intermedium* and *Mitchella repens.*

Fifty quadrats from typical second growth Beech forest, mostly reverting from lumbering were selected from portions of the survey not on roads or paths, and hence comparatively free from early pioneer ruderals. The most frequent species are: *Acer saccharum* 100 per cent, *Viola incognita* 64 per cent, *Fagus grandifolia* 54 per cent, *Aspidium intermedium* 52 per cent, then in order, ranging down to 22 per cent, *Aster cordifolius, Prunus pennsylvanica, Laportea canadensis, Galium triflorum, Disporum lanuginosum, Arisaema triphyllum, Tilia americana, Prunus serotina, Fraxinus americana, Carex radiata, Betula lutea, Osmorrhiza Claytoni, Mitchella repens, Solidago altissima, Tsuga canadensis, Rubus allegheniensis.*

The area of the survey does not contain enough mature forest to permit of selection of an adequate number of sample plots in the same manner that was used in selecting the others. A belt transect 100 by 10 meters in the forest at the head of Red House creek was found to include 102 trees, of which there were 39 Beech, 30 Sugar Maple, 18 Yellow Birch, 11 Hemlock, three Wild Black Cherry, one Pin Cherry. A frequency survey in which sample plots of .1 square meter were used, a size which would naturally put more emphasis on the undergrowth forms, the following were found to be the more frequent species: *Oxalis acetosella* 72 per cent, *Lycopodium lucidulum* 44 per cent, *Aspidium intermedium* 36 per cent, *Mitchella repens* 36 per cent, *Maianthemum canadense* 32 per cent, *Viola in-*

Figure 73 *Pteridium latiusculum* on ridge resulting from decay of a wind-fallen tree. *Pteridium* and *Dennstaedtia* are frequent pioneers on soil newly made in this fashion. *Carpinus,* a common pioneer tree, is shown in the rear.

Figure 74 Hay-scented Fern (*Dennstaedtia punctilobula*) on decaying stumps. This fern at times forms conspicuous clumps on the stumps of Hemlocks and other trees, probably being favored by the acid that results from their decomposition. Pasture on Bay State road .6 mile from English road.

cognita 24 per cent, *Acer saccharum* 16 per cent, *Hypnum* sp. 16 per cent, *Fagus americana* 12 per cent, *Clintonia borealis* 12 per cent, *Tiarella cordifolia* 12 per cent. Comparative studies of a cut-over or second growth area near-by showed that trees are three times as numerous and are, in order of abundance, Beech, Yellow Birch, White Ash, Sugar Maple, Pin Cherry, Red Maple. The whole number of species present is about twice as great, and percentages of frequency run considerably lower for individual species. The leaders are: *Hypnum* sp. 48 per cent, *Aspidium intermedium* 24 per cent, *Acer spicatum* 24 per cent, *Aster acuminatus, Dennstaedtia punctilobula, Maianthemum canadense* and *Viola incognita* each 20 per cent.

From that part of the surveyed area prevailingly Oak forest 78 sample quadrats were taken. The frequency of species on this portion is shown by the following table:

TABLE 5

	Per cent		Per cent
Fragaria virginiana	60	*Solidago juncea*	35
Acer rubrum	51	*Prenanthes trifoliata*	32
Quercus rubra	45	*Solidago altissima*	32
Quercus alba	41	*Prunella vulgaris*	32
Hamamelis virginiana	41	*Amphicarpa monoica*	32
Pteridium latiusculum	38	*Acer saccharum*	31
Aster macrophyllus	38	*Sassafras officinale*	31
Helianthus divaricatus	38	*Potentilla canadensis*	31
Carpinus caroliniana	37	*Geranium maculatum*	31
Solidago serotina	36		

Red Maple is so common a pioneer that it outplaces Red Oak and White Oak, which are the dominant trees as the forest approaches maturity. Witch-hazel, Blue Beech and Sassafras may also be regarded as pioneers, the first two in relatively moist, the last in dry situations. A com-

parison of the herbs of this zone with those of the Beech forest shows that *Aspidium intermedium, Mitchella repens* and *Viola incognita* have practically dropped out in the Oak; *Fragaria virginiana Pteridium latiusculum, Solidago serotina* and *Aster macrophyllus* are more frequent in the Oak than in the Beech, while a few forms scarcely found in the Beech are prominent in the Oak. Under the last category are *Helianthus divaricatus, Solidago juncea, Amphicarpa monoica* and *Geranium maculatum.*

From along the bank of the Allegheny river, 40 quadrats were surveyed. The more frequent forms on these quadrats are as follows:

TABLE 6

	Per cent		Per cent
Salix discolor	80	*Polygonum pennsylvanicum*	38
Solidago serotina	80	*Eupatorium urticaefolium*	35
Salix nigra	50	*Eupatorium maculatum*	33
Clematis virginiana	48	*Rubus strigosus*	30
Alnus incana	40	*Rumex obtusifolius*	30
Vitis vulpina	40	*Galium asprellum*	30
Steironema ciliatum	40		

The only plants on this list that may be rated as trees are Black Willow and Hoary Alder. Other trees are scattering. A number of characteristic shrubs and herbs will be noted which have not appeared on the other lists.

Certain extreme pioneer types are characteristic of burned areas. I shall give for comparison frequency lists from two recently burned areas, one in the Beech woods and one in the Oak. The former is the extensive burned area at the headwaters of Stony brook. The data, based on 30 quadrats, were obtained by Irene Sullivan. The latter is Huckleberry hill, the data for which are based on 14 quadrats.

Figure 75 Ruderals on a denuded area. An artificial levee along lower Quaker run. Here are species that thrive best in open places where the previous ground cover has been destroyed. Among them are *Ambrosia artemisiifolia, Chenopodium album. Polygonum hydropiperoides, P. lapathifolium, P. sagittatum, P. aviculare, Rumex obtusifolius, R. acetosella, Verbena hastata, Capsella bursapastoris, Solidago serotina, Phleum pratense, Echinochloa crusgalli.*

Figure 76 Composite pioneers on a denuded area. *Solidago altissima* at left, *Aster prenanthoides* at right. Near school dam, August 30, 1929.

TABLE 7

Beech Area—Stony Brook	Per cent	*Oak Area—Huckleberry Hill*	Per cent
Pteridium latiusculum...	70	*Sassafras officinale*.....	86
Prunus serotina.....	60	*Pteridium latiusculum*...	78
Solidago altissima.....	60	*Quercus alba*.....	71
Dalibarda repens.....	53	*Castanea dentata*.....	71
Rubus allegheniensis....	50	*Vaccinium vacillans*.....	64
Aster acuminatus.....	47	*Helianthus divaricatus*..	64
Acer rubrum.....	40	*Quercus rubra*.....	57
Potentilla canadensis....	40	*Acer rubrum*.....	57
Brachyelytrum erectum.	33	*Gaultheria procumbens*..	57
Carpinus caroliniana....	33	*Clintonia umbellulata*...	57
		Fragaria virginiana.....	57

Epilobium angustifolium, famed as the "fireweed," has a frequency of 7 per cent in the burned Beech forest, 0 in the burned Oak forest, and only 3 per cent for the region as a whole. Although conspicuous where it occurs, it is far less important as a burn pioneer than are the Brakes, Goldenrods, Sunflowers and other types.

The forest is by no means so monotonous as might appear from the study of the high frequency lists. A host of species of low frequency constantly invite one's attention as he passes through the woods. There seems to be something fundamental in the factors governing plant distribution that causes these low frequency sorts to outnumber by far those of high frequency. There are 232 species which were found ten or fewer times in the 507 quadrats. Sixty-one were found once only. If we were to plot a curve letting abscissas represent the successive species in decreasing order of frequence and the ordinates represent the frequency of each, we should have a hollow curve, or one of the hyperbola type. It would be interesting if we could unravel the story that this curve suggests as to the way in which species have adjusted themselves to habitat, the more vigorous all but crowding out the less

Figure 77 An abandoned road, showing successions on a denuded area. This road extends from the Bradford-Salamanca-Quaker Bridge junction to the mature woods on Red House creek. It has not been used for many years. In middle are *Scirpus, Poa,* and *Eupatorium perfoliatum.* At sides are *Solidago altissima, Solidago serotina, Eupatorium maculatum.* Farther out *Sambucus canadensis, Rhus typhina* and *Acer rubrum* are encroaching on the composite herb association.

Figure 78 Pioneers on eroding rock bluff. Chemung sandstone and shale, too friable to support much vegetation. The lichen *Amphiloma* grows on the sandstone. Rooted between the strata are *Rubus odoratus, Rubus strigosus, Clematis virginiana, Diervilla lonicera, Populus grandidentata, Betula lutea, Tsuga canadensis.* On talus at base are *Solidago caesia, S. juncea, Apocynum androsaemifolium, Eupatorium maculatum, Aster* sp., *Carex* sp.

vigorous. The plants that attract greatest attention are often the rare ones. The Indian-pipe, for example, has a frequency of only about 1 per cent. Four members of the orchid family are included in the survey. The combined frequency of the four is but 2.5 per cent. One is about ten times as likely to find a Brake or a Wild Strawberry as to find an orchid of any kind.

SUCCESSIONS

Successions in this region have been discussed by Taylor, Jennings and others, but it would seem appropriate to add a few words on the subject, representing by diagrams some of the outstanding successions. These diagrams of course do not represent invariable transitions from one plant society to another, but merely indicate what seems to be the usual procedure when development is normal and free colonization of possible forms permitted to occur.

It is commonly believed that the Beech forest (with its usual associates, particularly Sugar Maple and Yellow Birch) represents the climax for the region. As topography approaches maturity through the long continuation of erosional processes, and as shade and humus from plants accumulate, the proportion of the area occupied by Beech and Sugar Maple would certainly increase, the ultimate goal being such a forest over the entire area.

The two main types of succession toward the climax are known as hydrarch (wet beginning) and xerarch (dry beginning), the first being from more moist conditions to those of the climax state, the other from more dry conditions to those of the climax.

The hydrarch type might be represented by a stream gorge, such as we may see, for example, in Quaker run

beside the School of Natural History. Succession in such a gorge is somewhat as follows:

HERBS		SHRUBS	TREES		
Mosses → Liverworts Ferns	Touch-me-not → Turtlehead Bee Balm	Willows → *Clematis* Elder	Blue Beech → Red Maple	Yellow Birch → Hemlock	Beech Sugar Maple

As we go down Quaker Run to the broader valley near the river, we may add to the herb list, Cone-flower, Joe-Pye Weed and Turk's-Cap Lily; to the shrub list, Frost Grape. Following the shrubs instead of Hemlock there would probably be first Black Willow and Hoary Alder, then Silver Maple and Butternut.

A depositing island in Allegheny river shows the following hydrarch succession:

HERBS	SHRUBS		TREES		
Polygonum → *Cyperus* *Echinochloa*	Glaucous → Willow	Black → Willow	Silver Maple → Sycamore	Red Elm → White Elm Butternut	Beech Sugar Maple (probably

Oak might intervene between the Elm and Beech stages, depending, probably, on the amount of exposure.

A xerarch succession on a bluff next to the river and facing the prevailing westerlies would probably be about as follows:

HERBS		SHRUBS	TREES			
Grasses → Strawberry	Brake → Sunflower	Blueberry → Hazel Sumac	Sassafras → Red Maple	Black Oak → Chestnut	Red Oak → White Oak	Beech Sugar Maple

Figure 79 Pioneers on a sandstone block. Crustose lichens, foliose lichens, moss, *Polypodium virginianum* (at left) small Hemlock (at right) large Yellow Birch. Bank of Quaker run about two miles below Allegany School.

Figure 80 Aquatic successions in small ox-bow lake. Beside Quaker run near fire warden's hut. *Ludwigia palustris* with scattered *Mimulus ringens* in the water; next a sedge-rush zone, next a zone of shrubby willows. In the nonglaciated park area most of the lakes are of this type.

Secondary successions are those by which plant societies follow one another in returning to the climax state after the old vegetation on the site has been destroyed by denudation, fire or cutting.

Complete denudation, such as thorough cultivation, road making, levee building or excavating, if occurring in the Beech region, would be followed by successions in about this manner:

HERBS		SHRUBS		TREES		
Ruderal Weeds →	Grasses Sedges →	Goldenrods Asters Brakes →	Blackberry Sumac →	Aspen Cherry →	Birches Red Maple →	Beech Sugar Maple

After burning, a very similar succession would occur, with, perhaps, less emphasis on the grass-sedge stage.

After cutting we should get a similar series of stages, but the process would be more rapid. The sprouting of Beech and maple stumps would enable these trees to crowd out the pioneers and reoccupy the area more quickly.

If denudation, burning or simply cutting occurs in the Oak forest, the succession would be primarily to the Oak, following somewhat the course indicated above in the bluff xerarch succession. Only after a very long period would topographic changes and plant invasion cause Beech to occupy the site. A secondary succession in destroyed Beech forest near the Oak area would doubtless include oaks. If removed some distance from the oaks, it is doubtful whether weeding of the oaks would occur.

Clearing, after which pasturage is maintained would cause a site to take about the following course:

Ruderal Weeds → Grasses → Grasses With Scattered Hawthorns

In spite of state protection there are enough vicissitudes in the park area to cause a long continuance of the various

Figure 81 Cat-tail swamp on high bench. A rock layer resistant to erosion has caused a flat surface with poor drainage. A slight depression in this surface retains moisture enough to support swamp vegetation. *Typha latifolia, Eupatorium perfoliatum, Eupatorium maculatum* and *Scirpus* sp.

Figure 82 Successions about a glacial lake. Owlenburg bog north of Napoli. Next to water (on right) is White Water-lily (*Castalia odorata*). Then is a sedge-rush zone here dominated by Yellow-eyed-grass (*Xyris caroliniana*). Next is a heath or shrub zone dominated by Leather-leaf (*Chamaedaphne calyculata*) but also containing *Ledum groenlandicum* and *Andromeda glaucophylla.* Last is a zone of conifers (Tamarack, White Pine, Black Spruce, Hemlock) which contains an abundance of Rhododendron.

secondary successions, and the course of nature is so slow that it would doubtless require many centuries for the bottom forests and the Oak woods to be occupied completely by Beech and its associates. Perhaps it is best that this is the case. An extensive mature Beech-Maple habitat would present a somewhat limited and monotonous array of flowering herbs, shrubs and other plant types, and would support a limited number of types of birds, insects and other animals. A varied forest background will help to maintain the present variety of life which makes the park so attractive.

SUGGESTED FIELD STUDIES OF THIS AREA

1 MATURE BEECH FOREST: UPPER RED HOUSE CREEK

See excursion 2 in Taylor's Vegetation of Allegany State Park. Proceed on foot about a mile northward down the abandoned road that leads off from the junction point of the Quaker Run road with the Bradford-Salamanca road. The road itself serves well to illustrate the reclamation of a denuded area. The forest occupies an area of about one-half by one-fourth mile, mostly to the west of this abandoned road, and is excellent for its large specimens of Beech, maple, birch, and Hemlock (figures 56, 57, 58), its undisturbed forest floor vegetation (figure 59) and its streams with typical stream-valley formations (Clearweed, Jewel-weed, Manna Grass, Turtlehead, Beebalm). It may be reached, if preferred, from the north of the abandoned stretch of road by turning off the Bradford-Salamanca road past the Y.M.C.A. camp, driving as far as possible, then walking about one-fourth mile into the forest.

Figure 83 An extinct glacial lake in the conifer stage, Chamberlain bog. Here are found the five conifers of the region: White Pine, Black Spruce, Balsam Fir, Tamarack and Hemlock. Many species occur here which are not found outside the glaciated areas.

Figure 84 Streamside vegetation, Quaker run a mile below Allegany School. *Carex torta* forms a zone next to the water, then willows, outside of which are the characteristic trees of the Beech-Maple forest.

2 SECOND GROWTH BEECH FOREST

This is of very general distribution over the area, particularly the east half. It is well represented along the Bradford-Salamanca road (figure 60), along English Creek road and about the School of Natural History (figures 61, 62). Probably the widest variety of forest floor herbs, including ferns, that is obtainable in the park area may be secured on the south side of Quaker Run road near the first bridge east of Tunesassa Indian School. This section, known to the School of Natural History as "Red Salamander Woods," also contains an excellent patch (consociation) of Hemlock and a quantity of the rare Ground-hemlock or American Yew.

3 EFFECTS OF FIRE ON VEGETATION

Perhaps the best area is to be reached by following Stony Brook trail. (See Taylor's excursion 5). Here prevail such pioneer trees as cherries and aspens (figure 70), such shrubs as Blackberries, such herbs as the Bracken, Goldenrods, Asters, *Dalibarda,* Cinquefoils and Strawberries. A student who had visited this area in 1925 reports that spaces then open are now considerably encroached upon by young pioneer trees.

4 EFFECTS OF GRAZING ON VEGETATION

The outstanding example of a grazed area is the hill north of the junction of Cain Hollow road with Quaker Run road (figure 72). Hawthorn is the most conspicuous tree in such locations, for it is about the only tree that can establish itself on heavily grazed sites. Other such areas may be noted along the same road nearer the Indian School (figure 71) and along Bay State road. At

places along the latter road may be seen picturesque clumps of Hay-scented Fern growing in the humus which has been formed by decaying stumps (figure 74). Apparently this fern is not bothered by cattle. It is often associated in such habitats with Bracken (figure 73).

5 OAK FOREST

This is well illustrated on the hill between Holt's run and Allegheny river. (See Taylor's excursion 6. Note also figures 63, 64, 65, 66, 67, 68, 69.) The student will find it profitable to follow one of the ridges near the river and see how oak dominates the more exposed and drier situations. The ones between Cain hollow and Holt's run are very good for the purpose (see map). The presence of Beech and maple in the valleys and more sheltered situations may be seen by proceeding up Holt's Run road to a point about one-third mile north of Quaker Run road, then walking across the pastured area. Huckleberry hill illustrates a more xeric type of Oak forest with certain trees, as Black Oak, and certain shrubs, as Blueberry and Huckleberry, and herbs, as False Indigo and Bush Clover, which indicate more arid conditions than those found in most of the Oak. It also illustrates well the effect of fires in an Oak region (figure 67).

6 RIVER BOTTOM FOREST

This is well illustrated just north of Quaker Bridge. Portions of the bottom land are cultivated by the Indians, but enough of the original vegetation remains to give a fair idea of its nature. Almost a mile north of Quaker Bridge is a long island that shows very clearly the plant successions on depositing bottom land (figures 87, 88). If the road on the east side of the railway track is fol-

Figure 85 *Osmunda claytoniana,* a fern of moist ravines. Near Quaker run across road from Red Salamander Woods.

Figure 86 Bank vegetation of lower Quaker run. Beneath the prevailing herb, *Rudbeckia laciniata, are Eupatorium maculatum* and *Sambucus canadensis.* Above is *Juglans cinerea,* the Butternut, a frequent tree of the bottoms.

lowed one-half mile north from the Quaker Bridge railway crossing, a spring is reached which serves admirably as headquarters from which to study Oak forest, river bottom formations and ruderals of railway ballast. Ostrich Fern is a comparatively rare and very beautiful plant to be found in places along the river (figure 89). The lower valleys of the larger tributaries have plant societies similar to those of the river (figures 84, 85, 86).

7 MARSHES

A very interesting marsh lies just east of the Quaker Bridge railway crossing. Here are found Panicled Dogwood, Spicebush, Iris, Swamp Milkweed, Cardinal Flower and a number of interesting sedges.

Off Holt's Run road to the west in an open, pastured area are several small Cat-tail marshes. One is high on the bench between the run and the river (figure 81).

The ox-bow lake off Quaker run near the fire warden's station (1.6 miles west of English Creek road) gives an excellent idea of aquatic successions in a small way. Water Purslane, Monkey Flower and various sedges and rushes figure prominently here (figure 80). Farther down Quaker run, just across the road from Red Salamander woods, are small ox-bow lakes occupied by pondweed and water-starwort. As the surveyed area was scarcely touched by the glaciers, its marshes are practically restricted to the ox-bow type.

8 SUCCESSIONS ON DENUDED AREAS

Near School 2, just east of the intersection of Cain Hollow road with Quaker Run road, is an artificial creek bank which has become occupied by weeds of many kinds (fig-

ure 75). Near the School of Natural History where material was removed for the construction of the dam, similar studies may be made (figure 76). In the abandoned road leading down from the junction of Salamanca-Bradford and Quaker Run roads may be seen several stages in the succession process (figure 77). The roadsides and fields of the area afford an abundance of material for this study. It is interesting to compare the roadside vegetation of a new road, as the one along English creek, or, better, the one just constructed through Big Basin, with that of an older road such as those following Quaker run and Bay State creek. The steps can be followed whereby the ruderals force out the native vegetation and occupy the borders of these disturbed areas for themselves. Across the northwest end of the surveyed area, extending from Red House to Cold Spring, is a power line along which vegetation has been cut and then allowed to revert. This crosses both Beech and Oak areas, hence should be an excellent situation for a comparative study of secondary successions.

9 SUCCESSION ON ROCKS

One of the best places for this study is to be seen very near the school, in Quaker run below the dam. Here are found a variety of mosses and liverworts, and the rare Long Beech Fern. At various places along Quaker run and the bordering hills may be seen blocks of stone which are being occupied by the Common Polypody and other rock pioneers (figure 79). An eroding bluff with pioneer forms may be seen near the last bridge across Quaker run before the Tunesassa Indian School is reached (figure 78).

Figure 87 Early successions on depositing island, Allegheny river. Upper end of an elongated island one mile north of Quaker Bridge. On the newest portion are *Polygonum lapathifolium, P. pennsylvanicum, Cyperus strigosus* and *Echinochloa crusgalli.* Next is a zone of *Salix discolor* with scattered herbs.

Figure 88 Later successions on depositing island, just down stream from figure 87. At right, *Salix nigra* with large *Salix discolor* intermixed, and a young Sycamore at edge of view. At left, larger trees, mainly Silver Maple and Sycamore.

10 BOGS ON GLACIAL-LAKE ORIGIN

As the area surveyed is nonglaciated, these bogs must be studied to the north and west of it. One of these, not far from Steamburg, is described by House and Alexander as Keith's Bog (figure 83). A bog which still contains a deep glacial lake and therefore exhibits a more complete series of successional stages is within easy reach of the park. I have designated this as Owlenburg Bog, using the name of the owners of the land. It is about 25 miles from the school, and may be reached by going north from Napoli two miles to the Napoli School (Pigeon Valley School on the contour map), taking the road that proceeds northward on the west side of the school, and continuing a mile farther to the north. The bog (figure 82) may be reached by walking about one-fourth of a mile northeast from a small farmhouse on the east side of the road. Next to the lake is a well-marked zone of White Water-lilies. Bordering it is a sedge-rush zone in which Yellow-eyed-grass is conspicuous, a heath or shrub zone containing forms that are rare for the region, and a conifer zone in which the Great Rhododendron occurs.

Figure 89 Ostrich Fern (*Pteretis nodulosa*) in valley of the Allegheny river near Onoville. This, the largest fern of the Allegheny region, is characteristic of the bottom lands.

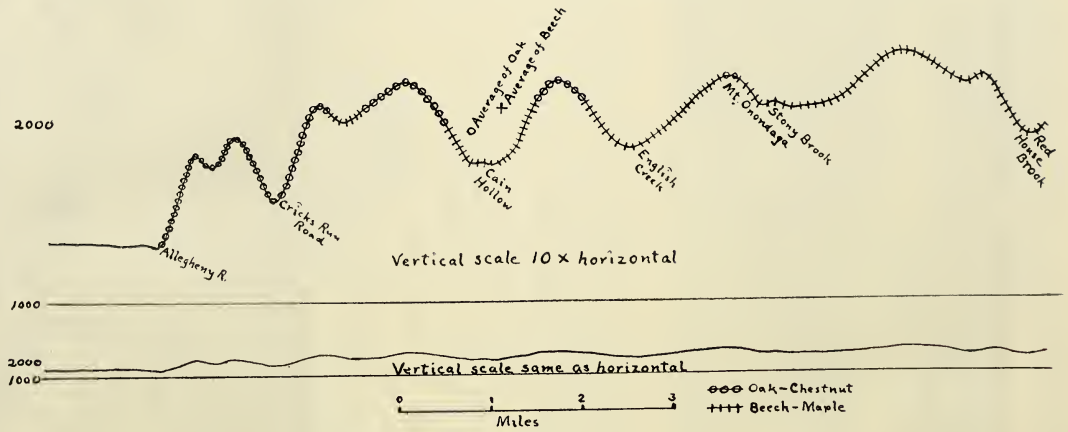

Figure 90 Profile, Allegheny river, southeast and east

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A BOTANICAL SURVEY OF THE SOUTHWESTERN SECTION OF THE ALLEGANY STATE PARK

(Figures 91–130)

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CONTENTS

INTRODUCTION

The area covered by this survey is located in the southwestern portion of the Allegany State Park, between Quaker run and the state line from the Bradford road to the Allegheny river, including part of the Allegany Indian Reservation (figure 92).

Aretas A. Saunders and William P. Alexander, members of the teaching staff at the Allegany School of Natural History, have been unsparing of important information which they had gained from many years of practical field experience in this region. Both of them accompanied me on some of my earlier reconnaissance trips. Mr Saunders has kindly lent me maps which he had prepared, showing various habitats which appear to influence bird life in the Quaker Run drainage area. These were of considerable value in preparing the vegetation map of this section of the Park. Dr Charles C. Adams, Director of the New York State Museum, suggested the botanical survey and has aided materially in furnishing necessary equipment for field studies.

GENERAL DISCUSSION OF RECOGNIZED FOREST TYPES

It is possible to recognize in the area covered by this summary five distinct types of forest vegetation. These are here designated as forest types, and have been mapped as "cover types" over the area as a whole. Cover types may be either permanent (climax) or temporary (those which follow windfalls, fires or lumbering operations). A cover type is recognized as the most serviceable kind of forest type for general use, and is based primarily on

composition and secondarily on moisture conditions of the habitat.

Species of forest trees which appear in the type named form a predominant part (50 per cent or more) of the composition, judged on the basis of the number of stems in the dominant or codominant classes combined. This procedure is in accordance with the most recent report of the Committee on Forest Types, Society of American Foresters (1932).

The following types have been recognized in the botanical survey of the southwestern portion of the park.

1 Sugar Maple-Beech (*cf.* Type 57, S.A.F.)
2 Hemlock-Beech (*cf.* Type 11, S.A.F.)
3 Oak (*cf.* Type 56, S.A.F.)
4 Mixed Mesophytic (*cf.* Type 55, S.A.F.)
5 Aspen-Red Maple (*cf.* Type 5, S.A.F.)

THE SUGAR MAPLE-BEECH FOREST TYPE

In the area surveyed this type is mainly second growth. Yellow Birch is associated with the predominant species on the more moist sites, where Hemlock occurred in the original forest. Of the 14,000 acres charted in 1930, nearly 6000 acres were mapped as this type. The amount of mature timber of this type now remaining in the area south of Quaker run is scarcely 100 acres (figure 97).

Blacksnake mountain, on which the Allegany School of Natural History is located, offers some splendid examples of the second growth Sugar Maple-Beech forest. In some places on this mountain nearly pure stands of Sugar Maple, mostly of sprout origin, may be found (figure 95). A preliminary study was made of the plant ecology of Blacksnake mountain by M. A. Rice, a student at the

Figure 91 View from fire tower on Mount Tuscarora, looking toward the Allegheny river at Quaker Bridge

Figure 92 A bend in the Allegheny river south of Quaker Bridge, in the Allegany Indian Reservation

Figure 93 Yellow Birches grow close to the trout streams; a pool on Wolf run during the drouth of 1930

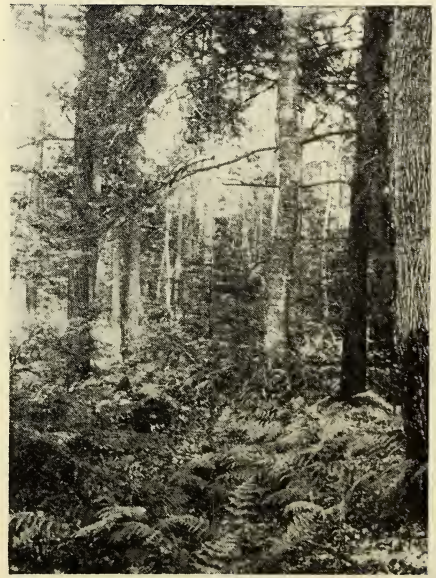


Figure 94 Luxuriant ferns carpet the forest floor beneath the Hemlocks and Beeches

School of Natural History in 1929. Although no detailed sociological studies were made, Mr Rice observed that the dominant species were Sugar Maple, Beech and Yellow Birch, while Hemlock was abundantly distributed among the undergrowth. Many of the maples had sprouted from old stumps, but there was also a thick stand of young saplings that had sprung up from seeds. Yellow Birch was much less abundant than Beech.

ASSOCIATED TREE SPECIES

The Rice manuscript (1929) states: Black Cherry, White Ash and Black Birch are fairly common associated species, which are scattered through the forest. In places where tree growth is not well advanced, Pin Cherry is abundant. The same . . . is true of the Large-toothed Aspen and the Quaking Aspen, especially in the more open spots. Where the dominant species are well-developed, the Aspens and Pin Cherry are largely absent.

Other tree species occupying a subordinate position in the forest association and occurring either as scattered specimens or in small groups are Cucumber Tree, Red Maple, Basswood, Shadbush, and American Elm.

To this list should be added Hop Hornbeam and Blue Beech, the latter sometimes occurring in small pure stands in swampy brookside habitats.

UNDERGROWTH VEGETATION

The undergrowth vegetation consists principally of young seedling trees, especially of the dominant species, Sugar Maple and Beech, and of shade-enduring shrubs. Hobblebush (*Viburnum alnifolium*) is by far the most common shrub in the Maple-Beech second growth, where there has been no destruction of undergrowth by fire. Other shrubs noted are the Striped Maple (*Acer penn-*

sylvanicum), which sometimes reaches the form and proportions of a small tree. Prickly Gooseberry (*Ribes cynosbati*), Arrow-wood (*Viburnum acerifolium*), and Red-berried Elder (*Sambucus racemosa*).

Herbaceous vegetation is not well-developed in the heavy shade of the Maple-Beech forest in summer. In the spring of the year the forest floor is nearly white with Trilliums (*Trilium grandiflorum* and *T. undulatum*), so I have been informed by persons who frequent the park at that season. In the summer months, the forest floor is carpeted with light brown leaf litter spotted with green foliage of herbaceous plants which persist throughout the growing season. The more important species are the following:

Spiny-toothed Shield Fern.	*Thelypteris spinulosa* var. *intermedia*
Shining Club Moss.....	*Lycopodium lucidulum*
Partridge Berry.....	*Mitchella repens*
Dalibarda, or False Violet...	*Dalibarda repens*
Wood Sorrel.....	*Oxalis acetosella*
New York Shield Fern....	*Thelypteris noveboracensis*
Stemless Yellow Violet.....	*Viola rotundifolia*
False Lily-of-the-valley.....	*Maianthemum canadense*
Yellow Clintonia.....	*Clintonia borealis*
False Mitrewort.....	*Tiarella cordifolia*
Indian Cucumber.....	*Medeola virginica*
Hairy Sweet-cicely.....	*Osmorrhiza claytoni*
Bearded Short-husk.....	*Brachyelytrum erectum*
Plantain-leaved Sedge.....	*Carex plantaginea*
Spreading Sedge.....	*Carex laxiculmis*

These plants, which can withstand heavy shade during the growing season may be either of two kinds. Either they are evergreen, and capable of manufacturing food when deciduous trees are leafless, or they are able to carry on photosynthesis at a much reduced light intensity.

Studies of the relation of photosynthesis (the first step in food manufacture) to intensity of illumination show some significant results. For all species of green plants

Figure 95 A dense growth of Sugar Maple saplings, resulting from clear-cutting for "chemical wood"

Figure 96 The tall columnar trunks of these Sugar Maples are an impressive sight in this primeval forest

Figure 97 A few trees of merchantable size remain in the forests of second-growth Sugar Maple. The majority of these large trees, however, are defective.

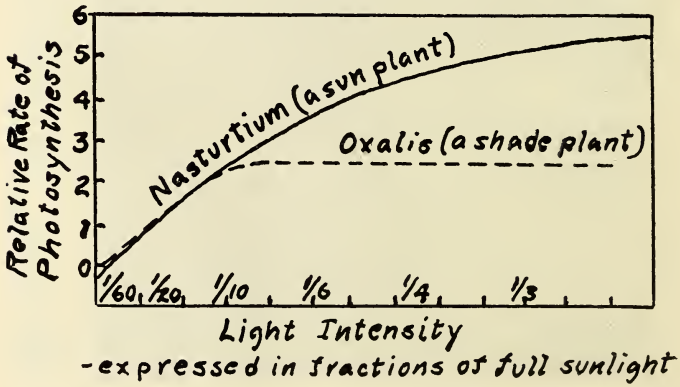


Figure 98 Curves showing the relative rates of photosynthesis in a sun plant and in a shade plant (after Lundegårdh)

there is at first a rapid increase in the rate of photosynthesis with a gradual increase in light intensity. A further increase of light may result in a corresponding increase in the rate of photosynthesis, but finally a point is reached for every species when a further increase of light is useless and no further increase in the rate of photosynthesis takes place. Leaves of shade-plants, such as *Oxalis acetosella* and *Circaea alpina,* show an early cessation in photosynthetic rate with increase in light intensity. Leaves of sun-plants, on the other hand, show a gradual lessening of the rate of photosynthesis as higher light intensities are reached. The curves in figure 98, illustrating physiological differences between a sun plant and a shade plant, are adapted from Lundegårdh (1931).

THE HEMLOCK-BEECH FOREST TYPE

Much of the region now mapped as Sugar Maple-Beech forest originally contained a very high percentage of Hemlock in its composition. At the present time there is scarcely 100 acres of the Hemlock-Beech forest in the park between Quaker run and the Pennsylvania state line. One of the best examples may be found in the Coon Creek valley just north of the state line. Here (figures 93, 94, 95, 96) Hemlock and Beech make up well over 50 per cent of the dominant species, associated with Sugar Maple and Yellow Birch. The ground cover consists practically of the same species that are found in the second growth Maple-Beech areas, but is not nearly so dense under the Hemlocks.

There are several reasons for the suppression of herbaceous ground cover under the Hemlocks. First, Hemlock trees are evergreen and furnish continuous shade the year round. Second, the Hemlock needles furnish a humus

Figure 99 A beautiful Hemlock-Beech forest, resulting from the removal of only the largest Hemlocks for tanbark

Figure 100 A second-growth woodland of the Sugar Maple-Beech type near the state line. Such forests result from the removal of merchantable timber for lumber.

layer of the type, called "greasy duff" by students of forest soils (Romell and Heiberg, 1931) in contrast to the "leaf duff" which accumulates under northern hardwood trees. During the growing season soils under the greasy duff have less moisture content than the soils under the leaf duff, due to the massing of Hemlock roots in the upper soil layers, as has been shown by Daubenmire (1930). This factor alone is distinctly unfavorable to the germination and early survival of tree seedlings as well as herbaceous plants. Third, greasy duff is more highly acid. Daubenmire's tests show that 22 per cent of the surface soils under Hemlock trees had an acidity indicated by the pH value of 4.4. On the other hand, 18 per cent of the surface soils under Beech-Maple forests had a pH value of 6.1, which is considerably less acid. A few measurements of soil acidity made by myself in Allegany State Park give comparable results. Under Hemlock, surface soils showed pH values of 4.0 to 4.5 consistently, while surface soils under Maple-Beech forests showed pH values of 5.5 to 6.0. These values were determined by a colorimetric method, using the Hellige Soil Tester. The acidity of the duff itself was quite comparable to that of the soil beneath. Such facts as these show that where Hemlocks make up a large part of the forest climax, they produce a condition of the humus and the upper soil layers which are decidedly unfavorable to the growth of their own seedlings or to those of their associates, Sugar Maple, Beech and Yellow Birch (figure 100).

Although Hemlock seedlings may be found in abundance wherever leaf litter is absent, most of them die at a very early age. Small Hemlock saplings are found growing most successfully on fallen, partially decayed tree trunks, or in seepage zones where springs keep the leaf

litter and moss mats wet or moist even in the driest summer (figure 125). Such species as *Mitchella repens* and *Maianthemum canadense* apparently tolerate these unfavorable soil conditions, because they are among the few species to be found in the greasy duff under Hemlock.

THE OAK FOREST TYPE

Nearly 4000 acres of the area included in this survey have been mapped as this type. Most of it lies in the extreme southwestern portion of the park, between Wolf run and the Allegheny river. In this portion nearly half of the forest vegetation is now Oak, extending southward into Pennsylvania. A transect was made along the state line from Wolf run to the Corydon road. From 60 records of the most abundant trees in the second-growth Oak forest, a table of frequencies was obtained. These results were compared with Kenoyer's determination of frequency based on a study of 14 quadrats on Huckleberry hill, which is similar to the area in which my studies were made. Apparently these areas were lumbered early and have been burned over repeatedly. See page 180.

TABLE I

TREES OF THE OAK FOREST	GORDON'S ESTIMATES WOLF RUN TO CORYDON ROAD	KENOYER'S ESTIMATES HUCKLEBERRY HILL
Species	*Frequency Per cent*	*Frequency Per cent*
White Oak	73	71
Red Oak	80	57
Chestnut	77	71
Red Maple	70	57

Figure 101 A trail on the summit of Mount Tuscarora, passing through a second-growth forest of the Mixed Mesophytic type

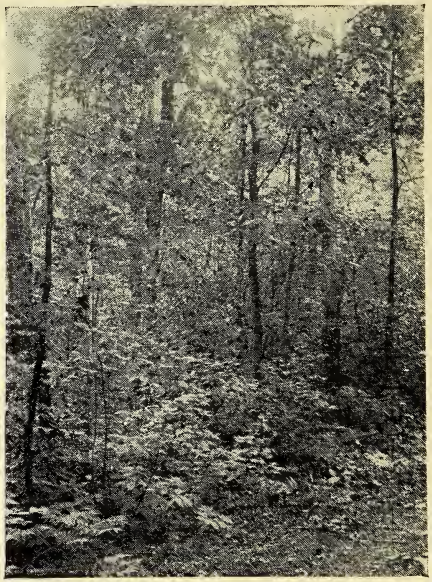


Figure 102 View in the Oak forest on Mount Tuscarora; all second-growth Red Oak, White Oak, Chestnut, Chestnut Oak and Red Maple

Seedling White Pines appear occasionally in the Oak forest, but are not numerous, due especially to a scarcity of tall "seed trees" in the area and to the unfavorable effects of fires on the young pines.

Originally the Oak forest was probably confined to the exposed rock outcrops and rough stony land of the ridge tops and upper slopes. Lumbering, fires and grazing activities have so disturbed the forests on the south and west slopes toward the Allegheny river that the species of the Oak forest have migrated down into the valleys. On the low terraces of the Allegheny river on the Indian Reservation, Oak thickets are developing in old fields which at one time were White Pine "flats." Here the oaks are apparently able to resist the ravages of fire and can withstand the higher soil temperatures and resulting desiccation which has occurred since the primeval forest cover was removed.

PLANT SUCCESSION ON A DRY SANDSTONE LEDGE

Near the top of the mountain at the head of Peter's run, the Olean Conglomerate crops out, forming ledges (figure 103). These rocks are covered with xerophytic vegetation, including crustose and foliose lichens, Broom Moss (*Dicranum scoparium*) and White Moss (*Leucobryum glaucum*), as well as the Common Polypody (*Polypodium virginianum*). With the slow accumulation of a thin mantle of soil, these lowly plants are succeeded by the False Lily-of-the-valley (*Maianthemum canadense*), Bracken Fern (*Pteridium latiusculum*) and Aromatic Wintergreen (*Gaultheria procumbens*) growing beneath a shrubby heath consisting of Blueberry (*Vascinium pennsylvanicum*) and Pinxter Flower (*Azalea nudiflora*). Leaves col-

lect every autumn and are retained by the closely branched shrubs, forming a loose layer of humus on the stony soil.

Sassafras and Witch-Hazel, which are taller shrubs, are next to enter the plant community; where they occur, Wild Sarsaparilla (*Aralia nudicaulis*) and Solomon's-plume (*Smilacina racemosa*) may be found beneath the shrubs. Next the larger trees invade these stony soils, which are derived from the atmospheric weathering of the sandstone plus the forming of a humus layer. The first trees in the succession are Black Birch, Red Maple and Shadbush. These are shortly followed by Chestnut, Chestnut Oak, Black Oak, White Oak and Red Oak, which form the Oak forest climax.

Figure 103 The plant covering of these rocky ledges consists largely of species which can withstand desiccation. Such plants are called xerophytes.

UNDERGROWTH IN THE OAK FOREST

The high peak between the head of Peter's creek and of Brown's hollow I have designated on my field maps as "Rattlesnake mountain." The peak to the west is known as "Old Roundtop" to local residents. An old lumber trail follows the ridge from Rattlesnake mountain northward to the long spur known as "Elko mountain." The ridge is covered with oaks, all second growth. A study was made of the undergrowth in an Oak woodland on the southwest spur of Rattlesnake mountain. It consisted principally of the following species:

SMALL TREES AND TALL SHRUBS

Red Oak	Shagbark Hickory	Red Maple	Flowering Dogwood
White Oak	Pignut Hickory	Striped Maple	Sassafras
White Pine	Hop Hornbeam	Witch Hazel	Pinxter Flower

DWARF SHRUBS

Blueberry (2 species)	Arrowwood	Huckleberry

HALF SHRUBS AND HERBS

Black Cohosh	*Cimicifuga racemosa*
Woodland Sunflower	*Helianthus divaricatus*
White Goldenrod	*Solidago bicolor*
Wild Sarsaparilla	*Aralia nudicaulis*
Bracken Fern	*Pteridium latiusculum*
Schreber's Aster	*Aster schreberi*
Wild Geranium	*Geranium maculatum*
Early Meadow Rue	*Thalictrum dioicum*
Aromatic Wintergreen	*Gaultheria procumbens*
Barren Strawberry	*Waldsteinia fragarioides*
White Clintonia	*Clintonia umbellata*
Wood Betony	*Pedicularia canadensis*
Shinleaf	*Pyrola americana*
Pipsissewa	*Chimaphila umbellata*

Of considerable interest was the finding of the larger Yellow Lady's-slipper (*Cypripedium parviflorum* var.

pubescens). Club Mosses (*Lycopodium* sp.) were entirely absent from the ground cover. The absence of *Lycopodium* may be attributed to the effect of frequent fires in the Oak woodland.

THE MIXED MESOPHYTIC FOREST TYPE

Little of this type of forest remains, but there is strong evidence that it constituted a recognizable primary type in this region. This type contained all of the valuable hardwood species of the region and was no doubt the source of much of the Yellow Poplar, Cucumber Tree and White Ash used for lumber in this region. The former boundaries are now difficult to trace, and it is likely that much of the original Mixed Mesophytic forest has now been transformed to a second growth Oak type.

In the classification of forest cover types of the Eastern United States (*loc. cit.*) the Mixed Mesophytic forest of this region would probably be included as a variant of Type 55, Yellow Poplar-White Oak-Red Oak. It has also been called the "cove hardwood" type and the "Oak-Chestnut-Yellow Poplar" type. Transeau (1927) and Sampson (1930) have referred to these types under the inclusive term of "Mixed Mesophytic forest." In extent, they range from northeastern Ohio and northwestern Pennsylvania to the lower slopes of the Great Smoky mountains, clothing many slopes throughout the dissected Allegheny plateau and the Appalachian Valley regions.

H. C. Sampson (*loc. cit.*) has made an ecological analysis of the Mixed Mesophytic forests in northeastern Ohio. His charts show that "it appears to be a special type of transitional community occupying a position between dry sites covered by Oak-Chestnut and moist sites

Figure 104 *Aster schreberi* seems to be a characteristic plant in the ground cover of the Oak forest

Figure 105 A colony of orchids, *Epipactis pubescens,* in a second-growth forest on Blacksnake mountain.

in which the complex of factors is favorable to the dominance of Beech-Maple."

A good example of this type of forest is found as one ascends the Tower Trail to Mount Tuscarora (figure 101). The lowest part of the climb (1400–1600 feet) is steep, with considerable Hemlock and White Pine, but most of the forest cover consists of Sugar Maple sprouts and saplings, Yellow Birch and Blue Beech. From 1600 to 1900 feet the slope is somewhat gentler. Here there is a splendid example of the second growth Sugar Maple-Beech forest (figure 97). At 1900 feet one encounters a very steep slope and a considerable mixture of tree species, no three of which could really be

Figure 106 A Chestnut tree, growing in a stony hillside pasture, has almost succumbed to the Chestnut Bark disease. Shrubs in the foreground are Smooth Sumac and New Jersey Tea.

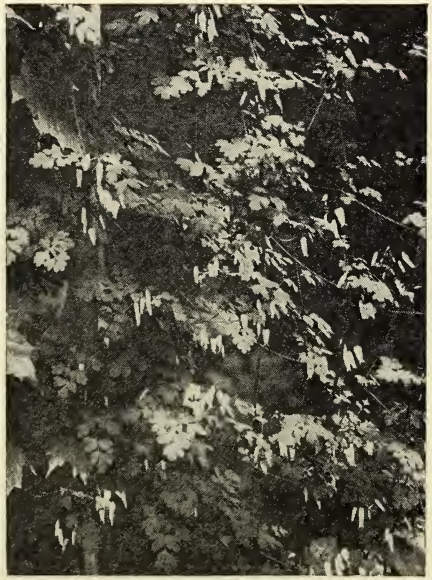


Figure 107 Allegheny-vine or Mountain-fringe (*Adlumia fungosa*) in a Mixed mesophytic forest

Figure 108 Joe-Pye Weed (*Eupatorium maculatum*) grows luxuriantly in moist meadows near the brooks.

said to make up 50 per cent of the dominant stand. In order of abundance, however, the trees are Chestnut, Yellow Poplar, Red Oak, White Oak, Cucumber Tree, Basswood, Beech, Sugar Maple, Hemlock, White Ash, Red Maple, Bitternut Hickory and Shagbark Hickory. Striped Maple, Sassafras and Witch-Hazel occur in the shrubby undergrowth, but the heath family is poorly represented. Club Mosses, orchids and other herbaceous plants are present in great variety in this type (figures 104–105, 107). Black Cohosh is a characteristic tall herb which invariably occurs in such an association. This forest can only be classified as a Mixed Mesophytic type. It is interesting to note that L. A. Kenoyer found a transition between the Maple-Beech and the Oak-Chestnut forest at about 1940 feet, on another slope to the north, although he did not recognize the Mixed Mesophytic forest as a distinct transition type (figure 101).

From 2000 to 2080 feet the Tower Trail leads through the Oak forest on the summit of Mount Tuscarora, where there is an abundance of Red Oak, Chestnut Oak, White Oak, Chestnut and Red Maple, with some Cucumber Trees (figure 102). Heaths are prominent in the undergrowth, being represented by Blueberries, Pinxter Flower, and Aromatic Wintergreen.

THE ASPEN-RED MAPLE FOREST TYPE

This type closely resembles No. 5, Pin Cherry Type, of the S.A.F. classification (*loc. cit.*) and next to Sugar Maple-Beech is the most extensive one in the southwestern portion of the park. About 1500 acres of this type may be found in the area surveyed. It is only a temporary forest, coming into old fields or clearings after abandonment, or replacing other types of forest after cutting and

Figure 109 View of Wolf Run valley from the fire tower on Mount Tuscarora. Photography F. T. Thwaites.

Figure 110 An extensive planting of Pines, established near the Barton Trailer Camp in lower Quaker Run valley. Photograph by F. T. Thwaites.

Figure 111 Aspens and Pin Cherry invading an old field dominated by Goldenrod (*Solidago rugosa*)

Figure 112 Interior of an aspen forest. The principal tree species are Trembling Aspen, Red Maple and Pin Cherry. The undergrowth consists of Bracken, Hay-scented Fern, Blackberry, Wild Sarsaparilla and Goldenrod.

burning of the vegetation. Its composition varies with local differences in soil characteristics, the activity of birds and mammals, and the factor of time (figures 110–111).

A statistical study was made July 15, 1930, on a transect along the state line from the Bradford road to a station 1.8 miles west, mostly above 2100 feet in altitude. A similar study was made just two days later on a state line transect from the Coon Creek road east, mostly below 2100 feet in altitude. Forty-five observations were made on each transect, to determine the frequency with which each of the trio of dominants appeared on the lists. The following table gives the results of these studies.

TABLE 2

TRIO OF DOMINANTS	ON STONY SANDY LOAMS (ABOVE 2100 FEET)	ON GRAVELLY LOAMS (BELOW 2100 FEET)
Species	*Frequency Per Cent*	*Frequency Per Cent*
Red Maple	93	68
Aspen (2 species)	58	78
Pin Cherry	38	42

It is obvious that in this region Red Maple has greater frequency on the stony sandy soils while the aspens have greater frequency on the loamy soils, of heavier texture. Pin Cherry has a lower frequency than either Red Maple or the aspens in the transects studied.

FARM LANDS, OLD FIELDS AND CLEARINGS

The broad bottomlands of the Allegheny river and the lower portions of the valleys of Quaker run and Wolf run are the principal farming areas in the section surveyed

Figure 113 Fire burning in a swampy thicket on the Indian Reservation south of Onoville Station, August 15, 1930. The severe drouth of that summer created fire hazards.

Figure 114 The immediate effects of fire in an aspen thicket

Figure 115 Fireweed (*Epilobium angustifolium*). These showy plants are most frequent along roadsides and in recent clearings. They are among the first wild flowers to cover a severely burned area.

Figure 116 Fireweed in fruit. At one end of each tiny seed is a tuft of long hairs, forming a parachute which is carried away by even a slight puff of wind.

(figures 117, 118, 119 and 120). A few clearings are to be found in the upper valleys, but these often prove to be former sawmill sites.

Crops which seem best adapted to this region are Potatoes, Buckwheat, Sweet Corn, Fodder Corn, Millet, Oats and Timothy. They give good yields in the valley farms in most seasons. The results of good farming practices, such as seed selection, use of fertilizers, and frequent cultivation, can be seen at Tunesassa, the Friends' Indian School in lower Quaker run, and on adjacent farms. Dairying is the chief agricultural industry, however, and much of the land is used for pastures. On fertile soils Kentucky Blue Grass, Orchard Grass, Red-top and Timothy furnish the best forage. On less fertile soils, often drier and more highly acid, Wild Oat Grass, Canada Blue Grass and Timothy are the only available grasses. Summer rainfall is usually distributed evenly enough to keep the pastures green throughout the growing season. Otherwise pasture feed is supplemented by Millet, cut green and fed during late summer.

EFFECTS OF OVERGRAZING

The effects of overgrazing can be seen everywhere, even in the more fertile valley farms, and are most evident in late summer. Some observations made in the lower Quaker Run valley show the following species composition in a closely grazed pasture:

GRASSES

Wild Oat Grass	*Danthonia spicata*
Red-top	*Agrostis alba*
Canada Blue Grass	*Poa compressa*
Timothy	*Phleum pratense*
Kentucky Blue Grass	*Poa pratense*
Fox-tail Grass	*Setaria lutescens*

Figure 117 Level farmland below the high terrace near the mouth of Quaker run. Photograph by F. T. Thwaites.

Figure 118 View showing clearings in Quaker Run valley, from the high terrace. Photograph by F. T. Thwaites.

WEEDS

Hair-Cap Moss	*Polytrichum commune*
Sheep Sorrel	*Rumex acetosella*
Yellow Wood Sorrel	*Oxalis europea*
Canada Thistle	*Cirsium arvense*
Heal-All	*Prunella vulgaris*
Pearly Everlasting	*Anaphalis margaritacea*
Oxeye Daisy	*Chrysanthemum leucanthemum*
Orange Hawkweed	*Hieracium aurantiacum*
Pussy-Toes	*Antennaria* sp.
Indian Tobacco	*Lobelia inflata*
Roman Ragweed	*Ambrosia artemisiifolia*
Common Plantain	*Plantago major*
Rib-Grass Plantain	*Plantago lanceolata*
Tall Buttercup	*Ranunculus acris*
Dandelion	*Leontodon taraxacum*
Common Cinquefoil	*Potentilla canadensis*

The pasture weeds not only make up a greater list of species than the grasses, but combined they make up over 50 per cent, sometimes 75 per cent of the ground cover in an overgrazed pasture. The composition noted above indicates high acidity and low fertility in general, as well as overgrazing.

Hawthorns, which have invaded the pasture from the neighboring Maple-Beech forest, have peculiar conical or "hour-glass" forms due to browsing by the cattle (figure 120). There is little evidence of pasture invasion by other tree species of the surrounding forest in these pastures.

SECONDARY SUCCESSIONS IN OLD FIELDS

A study of old fields near Onoville Station led to the following conclusions regarding changes which take place when cultivated fields are abandoned in this vicinity. A year or two after abandonment the following species appear on the fallow ground:

Fox-tail Grass	*Setaria lutescens*
Roman Ragweed	*Ambrosia artemisiifolia*
Sheep Sorrel	*Rumex acetosella*

Figure 119 Pasture and agricultural land in lower Quaker Run valley

Figure 120 A pasture in lower Quaker Run valley at the foot of Mount Tuscarora. Observe the Hawthorns browsed by cattle.

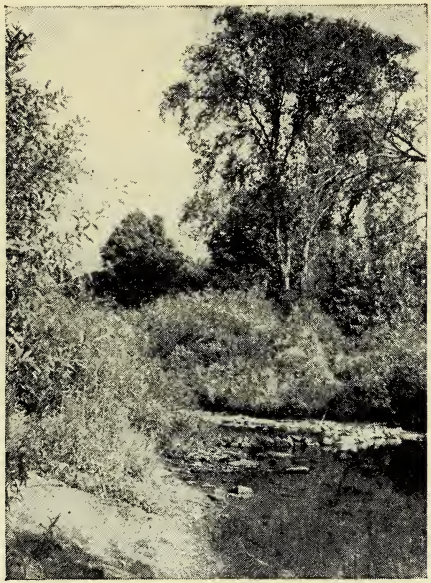


Figure 121 Streamside vegetation in the Quaker Run valley below Fox hollow. Notice the American Elm in the background and the fringe of willows along the stream.

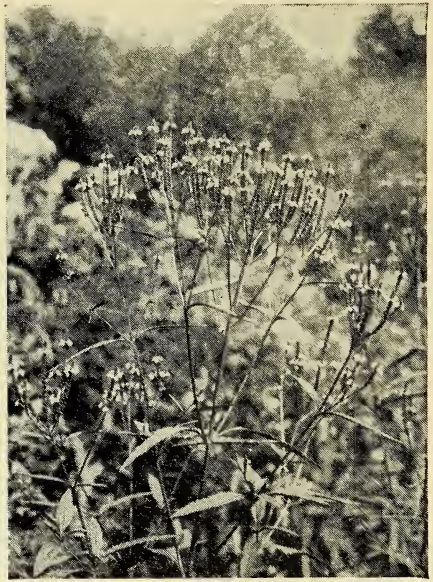


Figure 122 Blue Vervain (*Verbena hastata*) in a streamside habitat along Quaker run

Indian Tobacco	*Lobelia inflata*
Daisy Fleabane	*Erigeron annuus*
Oxeye Daisy	*Chrysanthemum leucanthemum*
Orange Hawkweed	*Hieracium aurantiacum*

After a few more years the following species, mostly perennials, make their appearance:

Virginia Strawberry	*Fragaria virginiana*
Grass-leaved Goldenrod	*Solidago graminifolia*
Common Milkweed	*Asclepias syriaca*
Pearly Everlasting	*Anaphalis margaritacea*
Tall Buttercup	*Ranunculus acris*
Red-top	*Agrostis alba*

A seminatural meadow develops in about five years' time, consisting of Wild Oat Grass, Canada Blue Grass, Timothy, Orchard Grass and Red-top, with a host of tall weeds which do not reach full development until late summer, when the old fields are yellow with Goldenrod.

Blackberry and Staghorn Sumac are among the first shrub invaders of old fields in the Onoville area (figure 106). New Jersey Tea, Hazelnut and Sassafras also stand among the woody pioneers, and usually precede the Aspen-Red Maple forest stage.

These invasions of taller forms of plant life are naturally slow. Old fields which have been fallow for periods varying from 15 to 30 years, especially in the vicinity of old farm dwellings, show no tendency to become forested by natural means because of the development of a grass sod. This is an unfavorable condition indeed for natural forestation.

FOREST PLANTINGS IN OLD FIELDS

Below Frecks, in the Quaker Run valley, old fields were planted with trees, in an attempt at reforestation. White Pine, Scotch Pine, Red Pine and Norway Spruce were the principal species planted. Plantings of various size extend

down the valley to the bridge across Quaker run below the Barton Trailer Camp. It is obvious to the observer that, of the four species planted, Red Pine is growing far more rapidly than either the White Pine or the Scotch Pine, while Norway Spruce shows the slowest growth of all. The White Pines, and, to a lesser extent, the Scotch Pines and Norway Spruces, have been damaged considerably by the White Pine Weevil (*Pissodes strobi* Peck). The Red Pines seem to be immune to its attacks.

In some parts of the plantings, especially in the moist valley bottom, some of the seedlings planted have suffered

Figure 123 Meadowsweet (*Spiraea alba*) thrives in an open sunny swamp along the Quaker Run road

severely in competition with tall herbaceous vegetation. On the northeast flank of Mount Tuscarora, opposite the Barton Trailer Camp, one can see an old field, which was planted with conifers, now well on its way to be covered with a dense and nearly pure stand of Trembling Aspen.

STREAMSIDE AND BOTTOMLAND SWAMP VEGETATION

Only about 250 acres have been mapped as bottomland swamps in the southwestern portion of the section surveyed. Most of the acreage is included in an extensive aspen thicket south of Onoville Station in the Allegheny River valley. The Pennsylvania Railroad has a right-of-way through this tract of wasteland, which originally must have been a White Pine "flat." During the summer drought of 1930 this swamp was dried out so much that 100 acres were burned by a fire which lasted several days (figures 113–14). It is a remarkable fact that the only serious fire of the 1930 season should have started in a swamp.

The Aspen swamp south of Onoville Station probably occupies an old cut-off channel of the Allegheny river. The ground is covered with frequent patches of Sphagnum Moss, sedges and ferns, Creeping Dewberry and Wood Horsetail. Young trees other than Trembling Aspen include Yellow Birch, Red Maple, Blue Beech, Black Ash and Eastern Hemlock. White Pine stumps are often encountered in the swamp.

Streamside vegetation is characterized by a Willow thicket association type. The principal species forming these thickets are *Salix discolor, S. sericea, S. cordata* and *S. lucidus.* An extensive Willow thicket has developed in

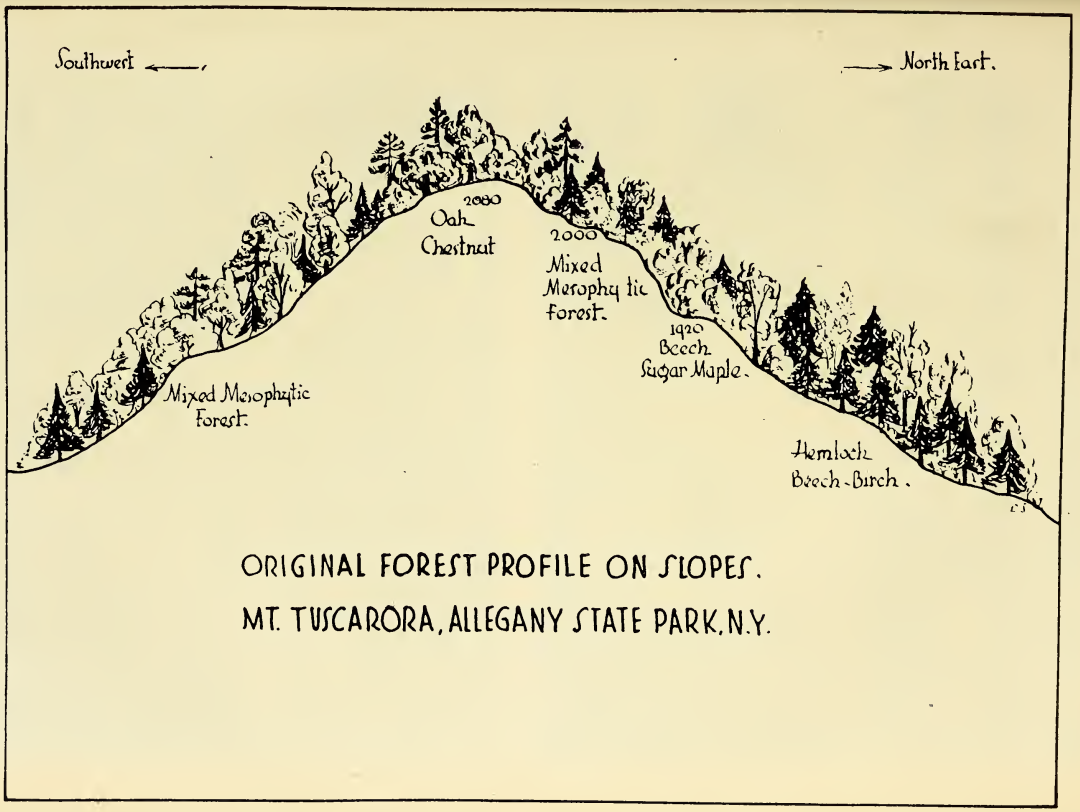


Figure 124 Original forest profile of Mount Tuscarora. Sketch by Louis Jacobson from data supplied by R. B. Gordon.

the broad valley of Quaker run below Fox Hollow (figures 121–122). Another one, which has been less recently disturbed, is located near the mouth of Quaker run just above the rusty iron bridge on the Elko road. At the stream margin the following species may be found:

Reed Manna Grass	*Glyceria grandis*
Rice Cut Grass	*Leersia oryzoides*
Monkey Flower	*Mimulus ringens*
Sneezeweed	*Helenium autumnale*
Boneset	*Eupatorium perfoliatum*
Joe-Pye Weed (figure 108)	*Eupatorium purpureum*
Goldenrod	*Solidago serotina*
Beggar's-Ticks	*Bidens frondosa*
Turtle-head	*Chelone glabra*
Water-Starwort	*Callitriche heterophylla*
Water-Purslane	*Ludvigia palustris*
Fringed Loosestrife	*Steironema ciliatum*
Blue Vervain (figure 120)	*Verbena hastata*
Water-Pepper	*Polygonum hydropiper*

On the "first bottom" or flood plain the Willow thicket is well-developed consisting of *Salix discolor*, *S. sericea* and *S. cordata*. Here the soil is a fine brown silt loam, the surface layer being slightly acid (pH 6.3) in contrast to the water of the stream, which is slightly alkaline (pH 7.8). Tall herbaceous plants formed the undergrowth and included the following species:

Green-headed Coneflower	*Rudbeckia laciniata*
Goldenrod	*Solidago serotina*
Upland Boneset	*Eupatorium urticaefolium*
Aster	*Aster tradescantii*
Knotweed	*Polygonum virginianum*
Pale Jewelweed	*Impatiens pallida*
Spotted Jewelweed	*Impatiens biflora*
Spotted Joe-Pye Weed	*Eupatorium maculatum*
Brome Grass	*Bromus altissima*
Turk's-Cap Lily	*Lilium superbum*
Sensitive Fern	*Onoclea sensibilis*
Crooked-stemmed Aster	*Aster prenanthoides*

A tangled growth of herbaceous "bind-weeds" grow among the tall herbs. They are as follows:

Virgin's-Bower ..... *Clematis virginianum*
Rough Bedstraw ..... *Galium asprellum*
Arrow-leafed Tearthumb..... *Polygonum sagittatum*

A few other species of vascular plants are present in the ground layer of vegetation. They are:

Marsh Blue Violet..... *Viola cucullata*
Enchanter's-Nightshade ..... *Circaea latifolia*
Mad-Dog Skullcap ..... *Scutellaria lateriflora*
Willow-Herb ..... *Epilobium coloratum*
False Nettle ..... *Boehmeria cylindrica*

There is evidence that the Willow thicket will be succeeded eventually by a deciduous swamp forest, consisting of the following species: Black Willow, White Elm, Red Elm, Basswood, Butternut and Bitternut Hickory.

A UNIQUE SPHAGNUM BOG ON THE PLATEAU

Sphagnum bogs in the glacial drift of western New York are numerous. House and Alexander have described the vegetation of glacial moraine bogs in the vicinity of Steamburg, which is outside the state park boundary. The occurrence of a small bog on the unglaciated plateau, however, is worthy of note. "Bear bog" is located on the New York-Pennsylvania state line, about one-third of a mile west of the Bradford road at an altitude of 2330 feet. The bog can be reached by following the state line trail due west from the road, or by means of an old lumber road which runs approximately S. 20° W. from the fork in the Bradford road. The distance from the main road is about four-tenths of a mile by the latter route. The bog lies immediately west of the intersection of the lumber road and the state line (figure 127).

Figure 125 A dense stand of Yellow Birch at the head of Murray brook, between Blacksnake mountain and Mount Mohawk

Figure 126 Ledge of sandstone at southwest border of Bear bog, near the New York-Pennsylvania state line

The vegetation of the surrounding area shows the effects of lumbering and repeated fires. Aspen, Red Maple and Pin Cherry are abundant, with the characteristic undergrowth of Bracken and Goldenrod. The flora of the ridge near the state line has been described by House and Alexander (1927, p. 202–3). The soils are derived from the Olean Conglomerate, which outcrops in several places, forming ledges (figure 126). The soils are largely coarse, sandy loams, and are well podsolized.

The bog is small, scarcely four acres in extent, but has a distinctive flora. The most abundant plants are the Sphagnum Mosses, belonging to the *acutifolia* group. These plants do not form deep peat, seldom over six inches thick. Beautiful clumps of Cinnamon Fern are scattered throughout the central and more open portion of the bog. Creeping Dewberry (*Rubus hispidus*), Aromatic Wintergreen

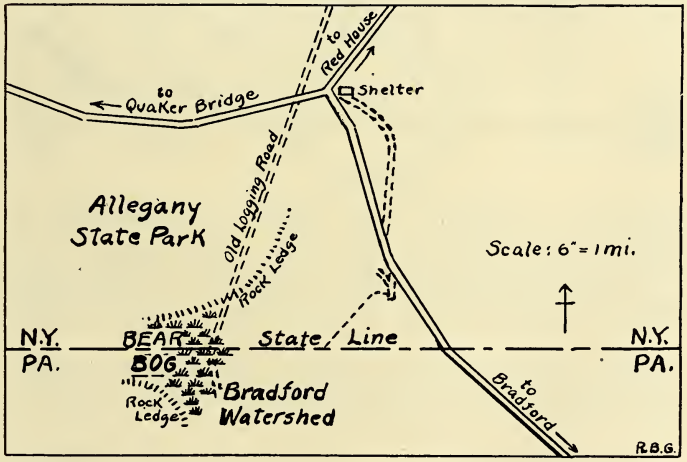
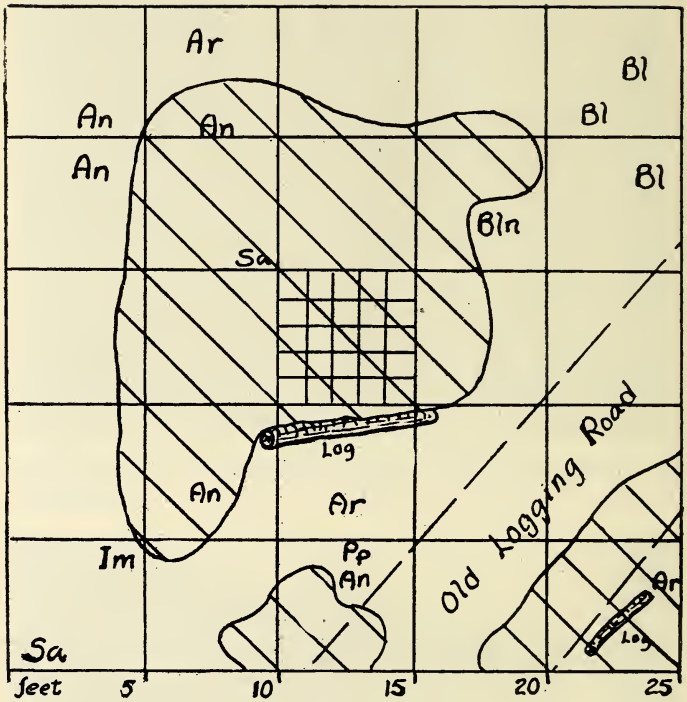


Figure 127 Map showing the location of Bear bog with reference to the Bradford road and the state line



Legend:

Bl: Betula lutea
Bln: Betula lenta
Ar: Acer rubrum
An: Azalea nudiflora
Sa: Sorbus americana
Im: Ilex monticola
Pp: Prunus pennsylvanica
Cross-hatched: Sphagnum

Figure 128 Chart showing location of grid quadrat, in center of larger quadrat, and surrounding trees and shrubs. Original by Homer Jack.

(*Gaultheria procumbens*), and False Violet (*Dalibarda repens*) are particularly abundant in the bog. On a quadrat, five feet square, loose tufts of a slender sedge (*Carex canescens*) were found on every square foot.

In 1930, Homer Jack, then a student at the Allegany School of Natural History, made a detailed study of vegetation structure at Bear bog, under the author's direction. After looking over the whole area, a small portion was selected as typical of the Sphagnum-covered portion, and a grid quadrat five feet square was selected within a larger quadrat 25 feet square and the position of every plant large enough to see with the naked eye was recorded in one foot squares (see figures 128–30). The percentage of ground covered by each species on the quadrat could then be determined. A soil profile in the quadrat showed the following condition: Top four inches of Sphagnum Moss; one and one-half inches of peat or raw humus; three inches of gray sand; 24 inches of mottled subsoil, gray, sandy loam with orange-brown and yellow streaks and mottlings, to bedrock (Olean Conglomerate).

A quantitative study of the species listed in the quadrat gives the following results:

GROUND COVER	PER CENT	GROUND COVER	PER CENT
Gaultheria procumbens.	30	*Cornus canadensis.....*	5
Carex canescens.....	20	*Trientalis borealis.....*	3
Dalibarda repens.....	20	*Lycopodium clavatum..*	1
Rubus hispidus.....	10	*Osmunda cinnamomea.*	1
Clintonia borealis.....	8	*Aster acuminatus.....*	1

Other species listed on the grid quadrat of 25 square feet and in the surrounding bog were the following:

Cucumber Tree..... *Magnolia acuminata*
Shadbush ..... *Amelanchier intermedia*
Blueberry ..... *Vaccinium pennsylvanicum*
Goldenrod ..... *Solidago rugosa*

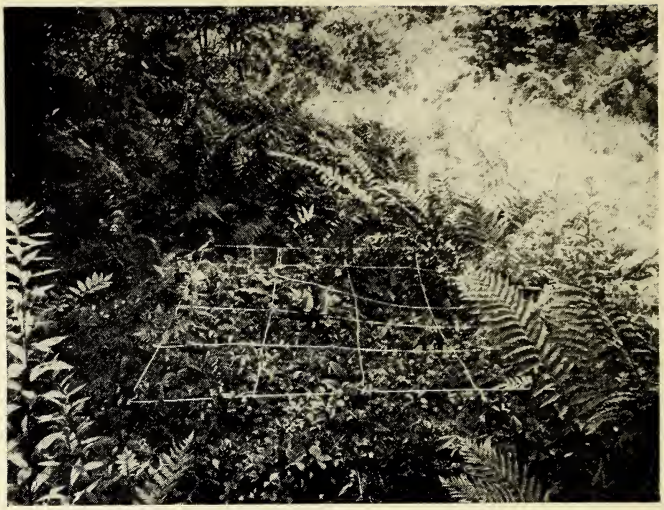


Figure 129 Grid quadrat, marked off in one-foot squares, used in determining percentage composition of ground cover plants in Bear bog, July 31, 1930

Figure 130 Characteristic ground cover in Bear bog. Sphagnum Moss, Swamp Dewberry and tufts of a sedge are shown.

Bracken Fern	*Pteridium latiusculum*
New York Shield Fern	*Thelypteris noveboracensis*
Goldthread	*Coptis trifolia*
Broom Sedge	*Carex scoparia*
Small Green Wood Orchis	*Habenaria clavellata*

The surrounding woodland contains Chestnut and White Pine stumps, and young specimens of White Ash, Yellow Birch, Red Maple, Mountain Ash, Sugar Maple, Sweet Birch, Hemlock and Red Oak, indicating the present mixed character of the forest on the top of the plateau.

A SURVEYOR'S DESCRIPTION OF THE TIMBER IN 1799

The following description is copied from records in the county clerk's office at Little Valley. These records are copies, in beautiful longhand, of the original survey made by Joseph Ellicott, surveyor for the Holland Land Company, on June 22, 1799. His notes contain references to the species of forest trees, the quality of the timber, the steepness and stoniness of the hills, and the mossy character of the ground in such places as Bear bog. Measurements are given, of course, in surveyor's chains (and links). There are 80 chains to the English mile.

Range 7

Remarks on that part of Township No. 1 which includes only Holland Land Company Lands.

Beginning at a monument stone marked on the west side "Holland Land Co." on the east side "W.d J. W." and on the south "P" being the southwest corner of a tract of land granted by Robert Morris and Mary his wife to Herman Le Roy, William Bayard, and Matthew Clarkson by Deed dated the twentieth day of July one thousand seven hundred and ninety three, containing fifty four thousand acres from which stone three bounded trees bear a birch S 20° W 23 links, a hemlock N 22° E 9 links and

another hemlock N 43° W 54 links. Thence running from the aforesaid stone West bounding south on the north boundary line of the State of Pennsylvania aforesaid and commencing with

Intervale of the 2d Quality
6″32 Timber, beech, birch, elm, and hemlock to a hemlock post and to the commencement of

Intervale of the 3d Quality
40″ Timber, beech, birch, hemlock, and shinwood covered with moss ["Bear bog"] to a hemlock post and to the commencement of

Upland of the 3d Quality
40″ Timber, hemlock and beech Stony and mossy to a hemlock post and to the commencement of

Upland of the 2d Quality
40″ Timber, hemlock, beech, chestnut and cucumber to the descent of a hill facing northwesterly to a sugar maple post at the bottom of said hill not too steep for cultivation and to the commencement of

Upland of the 3d Quality
20″ Timber, beech, hemlock, birch and chestnut Stony, rocky, and mossy to a spring run running northwesterly to the commencement of
Upland of the 2d Quality

This brief account of about 150 chains (nearly two miles) surveyed along the state line from the Bradford road across Blacksnake mountain to the headwater of Murray brook, is the only description we have of this area as it existed before 1800. Now the entire route traversed by Joseph Ellicott has been altered to such an extent by lumbering and fires that only a vestige remains of the great forest he encountered 130 years ago. This

vestige is a group of big trees at the head of Murray brook (figure 96). Magnificent as they now appear they would have been considered as "2d or 3d Quality Timber" in 1799.

SUMMARY

The southwestern section of the Allegany State Park offers opportunity for one to observe a wide variety of vegetation covering all sorts of habitats from a dry sandstone ledge to a Sphagnum-covered swamp. A statistical summary of the vegetation types mapped in this section of the park follows:

	ACRES
Sugar Maple-Beech forest, mainly second growth (including nearly pure stands of Sugar Maple)	5 800
Oak forest, mainly second growth	3 880
Farm lands, old fields and clearings	2 340
Aspen-Red Maple forest	1 550
Bottomland swamps	250
Hemlock-Beech forest (mature timber)	100
Beech-Sugar Maple forest (mature timber)	100
Total	14 020

At one extreme are the sunny farmlands of the lower valleys; at the other extreme are the shady forests of Hemlock, Beech and Sugar Maple which sunlight scarcely penetrates.

A true appreciation of the beauty in this forest-clad plateau can be gained only by spending a few days or a few weeks in the park woodlands. If one keeps to the trails there is really not much chance of getting lost. With the two topographic maps and a pocket compass in one's field equipment, it is possible to travel directly through the densest part of the forest and to return to the starting

point. Some of the best bits of scenery and of beautiful woodland can be seen here without straying far from a road or well-worn trail.

The following trips are recommended:

1 From the Ranger Station at Frecks a road follows up Coon run to the Pennsylvania state line. To the east of the road on the New York side of the line is a splendid example of the Hemlock-Beech forest. Just below is a lovely brook bordered with picturesque Yellow Birches. The undergrowth of Wood Ferns here is truly beautiful (figures 93–94, 99–100).

2 From the Allegany School of Natural History a hiking trail leads along the old railroad grade up Blacksnake mountain to the state line at the head of Murray brook. The forest vegetation is of varying character all along the trail. Bits of the Aspen-Red Maple type, Sugar Maple Beech and Mixed Mesophytic second-growth offer great variety in plant habitats. Near the state line, the trail passes by some "big trees" of the primeval forest. Six species of Club Mosses (*Lycopodium*) can be found within a single mile along this trail.

3 The Tower Trail up Mount Tuscarora is a steep one, but if taken slowly gives the hiker an opportunity to see the variation in forests as he proceeds from the lower well-watered slopes to the comparatively dry ridge covered with Oak forest at the summit (figures 101–2).

From the top landing of the fire tower there is a splendid view for miles around. Wooded hills, open farm lands and clearings create a splendid panorama. An idea of the vastness of the wooded expanse which covers the plateau south of the Allegheny river can best be obtained by viewing the country in such a way (figures 109–10).

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A BOTANICAL SURVEY OF THE EASTERN SECTION OF THE ALLEGANY STATE PARK, NEW YORK

(Figures 131–62)

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CONTENTS

INTRODUCTION

During the summer of 1931 I completed a survey of vegetation in the eastern portion of the Allegany State Park. The section surveyed in 1931 is an area of approximately 35 square miles lying north of the Pennsylvania-New York state line, west of Tunungwant creek, south of a line connecting Carrollton with the junction of Red House brook and Bova creek, and east of Red House brook. During the months of July, August and early September, 31 whole days were spent in vegetation studies in this area; 318 miles were covered on foot and 347 miles by automobile in surveying the region. Every section of the park was also visited during the summer, for purposes of checking and correlating work on the newly surveyed area with that which had been done previously. A herbarium of vascular plants and a moss garden were started at the Allegany School of Natural History, and plant specimens were collected from the park region (figures 150 and 151).

Reports of previous workers have summarized most of the important general characteristics of the Allegany State Park and the surrounding region, including its geology and physiography, flora and vegetation, as well as its vertebrate animals. Reference works relating to the region are given in the bibliography accompanying this report. This account of the portion surveyed is confined largely to notable features of its vegetation. The various types of vegetation encountered in this area have been plotted on a map. The vegetation map, together with the numerous photographs and their accompanying legends, make a rather complete record of the important features.

ACKNOWLEDGMENTS

Dr Charles C. Adams, William P. Alexander, Aretas A. Saunders and Dr Robert E. Coker, because of their many years of experience in the park region, were able to give me much information which greatly aided in this work. To them I acknowledge particularly an indebtedness. The reports of Dr F. W. Emerson, Dr. L. A. Kenoyer and Dr. Robert B. Gorden, who preceded me in mapping other portions of the part, were also helpful. Thus it was possible to continue the botanical survey upon the same general plan, by comparable methods, reducing the time required for orientation to a minimum. Many of the early settlers of the region, who were interviewed, furnished much information of historical value. Dr Robert B. Gordon has read, criticized and revised the original manuscript of this report, bringing it to its present state of completion.

VEGETATION COVER TYPES OF THE AREA

The various portions of this area which differ from each other as to vegetation cover can be rather definitely classified into one of the following six types:

1 **Land in cultivation or pasture; old fields and clearings beginning to revert to forest** (figure 148). On account of the uses to which such land has been put, these areas may contain pioneer weed communities or grass communities of varied composition. Old fields are likely to be covered in midsummer with Wild Oat Grass (*Danthonia spicata*), Canada Blue Grass (*Poa compressa*), Timothy (*Phleum pratense*), and Red-top (*Agrostis alba*), which constitute the bulk of the forage grasses. These are mixed with common pasture weeds,

Figure 131 Large-toothed Aspen (*Populus grandidentata* Michx), the remains of a pure stand, now being crowded out by a thick stand of Sugar Maple (*Acer saccharum* Marsh) and Beech (*Fagus grandifolia* Ehrh.). North slope of Rice Brook valley, August 28, 1931.

Figure 132 A mixed stand of Yellow Birch (*Betula lutea* Michx), Sweet Birch (*Betula lenta*), Black Cherry (*Prunus serotina* Ehrh.) and Red Maple (*Acer rubrum* L.) with a forest floor sufficiently illuminated to support a luxuriant growth of ferns, mostly Common Wood Ferns (*Thelypteris spinulosa* var. *intermedia*). South slope of Irish brook, one-half mile south of the Ranger Station, July 23, 1931

Figure 133 A stand of Red Maple (*Acer rubrum* L.), Sweet Birch (*Betula lenta* L.) and Black Cherry (*Prunus serotina* Ehrh.) being succeeded by a pure stand of Sugar Maple (*Acer saccharum* Marsh), showing a forest floor strewn with the remains of branches and smaller trees starved out due to the decreased amount of sunlight. South slope of Irish brook, one mile south of the Ranger Station, July 18, 1931.

Figure 134 Looking north from the fire tower located one and one-half miles northwest of the junction of Irish and Rice brooks. Showing in the near foreground an Aspen-Cherry-Red Maple growth, a belt of dead Chestnut saplings beyond and a sparse second growth of mixed species along the dry ridge in the middle distance. September 20, 1931.

Figure 135 Weather-worn rock outcrops like this one are numerous near the pipe line on ridges of upper Limestone Brook valley. Plant habitats about these rocks are of a xerophytic type. Common forms are lichens, mosses, Common Polypody ferns (*Polypodium virginianum*), Fringed Black Bindweed (*Polygonum cilinode*) and Pale Corydalis (*Corydalis sempervirens*). August 4, 1931.

Figure 136 A stand of White Ash (*Fraxinus americanus* L.) being succeeded by Sugar Maple (*Acer saccharum* Marsh). Near pipe line and headwaters of Irish brook, July 28, 1931.

such as Oxeye Daisy (*Chrysanthemum leucanthemum*), Pearly Everlasting (*Anaphalis margaritacea*), Sheep Sorrel (*Rumex acetosella*), Devil's-Paint-Brush (*Hieracium aurantiacum*), Indian Tobacco (*Lobelia inflata*), Tall Buttercup (*Ranunculus acris*), Common Cinquefoil (*Potentilla canadensis*), and Yarrow (*Achillea millefolium*). Clumps of Pearly Everlasting are most conspicuous in late summer (figure 149) in the hayfields.

2 **Aspen-Red Maple-Pin Cherry forest.** Such areas have been recently burned or otherwise denuded, and are in various stages of reversion to more permanent types (figures 131, 133 and 143). Black Cherry and Cherry Birch are frequent members of this type. On account of their high reproductive capacity and shade tolerance, Sugar Maple and Beech are most likely to invade the aspen forest and eventually to replace it (figure 138). The secondary forests are likely to contain a considerable mixture of species, which are characteristic of certain stages in forest succession, and are therefore particularly difficult to classify.

3 **Oak forest, including Chestnut coppice.** Red Oak, Chestnut, White Oak, Chestnut Oak, Red Maple, Large-toothed Aspen and Cherry Birch are either frequent or characteristic members of this type of second-growth forest. The Chestnut sprouts, which were everywhere numerous in this type, are either dead or dying from bark disease, and therefore can be recognized readily from a distance (figures 134, 139 and 140). On account of the destruction of this species, most areas covered by Chestnut coppice a few years ago must be mapped now with the Aspen-Red Maple-Pin Cherry type (figure 139).

Figure 137 A south-facing ridge slope along the pipe line in upper Limestone Brook valley where Trembling Aspen (*Populus tremuloides* Michx) has succeeded an almost pure stand of Chestnut (*Castanea dentata*). July 16, 1931.

Figure 138 A stand of Large-toothed Aspen being succeeded by Sugar Maple (*Acer saccharum* Marsh), two miles south of Halls, near Red House Brook road, August 4, 1931.

4 **Swamp forest.** In the Tunungwant and Allegheny River valleys, these types contain Silver Maple, Black Willow, American Elm, Basswood, Red Maple, Butternut, Blue Beech, and Hoary Alder in nearly pure stands or in mixtures. They occupy flood-plain habitats (figures 156 and 158). The majority of such forests are secondary rather than original types in this region, although the species were formerly present to a limited extent on the islands and stream banks.

5 **Sugar Maple-Beech forest.** In the area surveyed this type includes numerous pure stands of Sugar Maple and occasional pure stands of young Beech. It appears to be entirely second growth. No original forest of this type was found in the eastern section of the park. Associated with the dominants are such species as Red Maple, Basswood, Black Cherry and White Ash (figures 131, 133 and 136).

6 **Hemlock-Beech forest.** Such a forest is characterized by the presence of a large proportion of Hemlock, which in some places may form nearly pure stands. It also includes the forests of the Hemlock-Yellow Birch type, which occur mainly on lower slopes near streams, in moist coves or at the spring level on the slopes (figures 145, 146, 152, 161 and 162).

GENERAL CONSIDERATIONS OF THE AREA

The portion surveyed contains but few large areas covered by a *single* forest type. Numerous other areas represent transitions between the several types listed above (figures 131, 132, 134, 138 and 147). The detailed vegetation map of this section certainly presents a patchwork of types not to be duplicated elsewhere in the park

except perhaps the portion between the northern boundary of this section and the town of Salamanca.

Forest operations in this section of the park have been suspended only recently. This means that large portions are young in respect to the ecological successions which will eventually take place. Where early forest operations have occurred, large areas of homogeneous constitution are found today. Where cutting was delayed until more recent years, where second cuttings have been made or where fires have denuded areas at frequent intervals, a heterogeneous assortment of forest communities now occur. Their composition may be determined by one or more of the following conditions which are known to affect forest development:

1 Height above the water table
2 Direction of slope
3 Degree of slope
4 Water-holding capacity of the soil
5 Extent of erosion
6 Nitrogen content of the soil
7 Soil acidity
8 Light intensity and periodicity
9 Rate of evaporation in the habitat
10 Type and extent of cutting operations
11 Reproductive capacity of tree species included
12 Shade tolerance of tree species included.
13 Drought resistance of tree species included
14 Frequency of forest fires and violent storms
15 Activities of animal life in the forest
16 Activities of non-green plants in the forest (figure 141)

For further considerations of these factors of the forest environment, the reader is referred to a recent textbook

Figure 139 In the foreground a scattered stand of Trembling Aspen (*Populus tremuloides* Michx) which has replaced the original Chestnut forest killed by the blight. In the distance on the ridge tops are extensive areas of cleared land which are being invaded by the same species. Upper Irish Brook valley, August 8, 1931.

Figure 140 In the foreground a few diseased Chestnut sprouts, the survivors of an original pure stand or Chestnut ridge type, now succeeded by Trembling Aspen. In the distance, cleared land near the pipe line in upper Irish Brook valley being invaded by Trembling Aspen. August 11, 1931.

Figure 141 *Clitocybe illudens* growing at base of stump, South Carrollton creek, August 12, 1931.

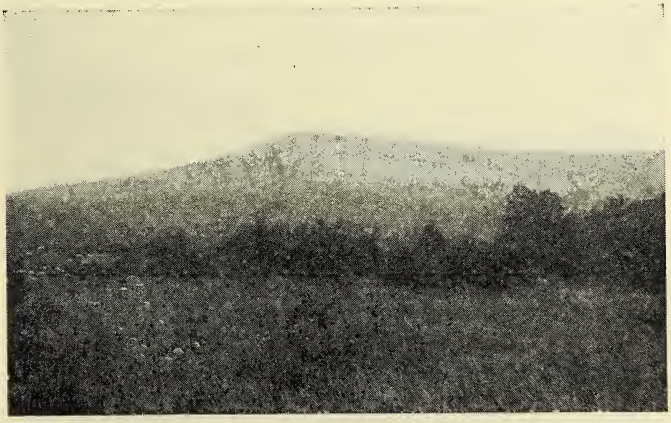

Figure 142 A ridge top in upper Irish Brook valley, cleared about 1905, reverting to the original forest type (80 per cent Chestnut, 20 per cent oaks). The Chestnuts are now being wiped out by disease and many of the oaks by fires, and Trembling Aspen is invading rapidly. August 12, 1931.

Figure 143 An outcropping rock of Salamanca Conglomerate near Bova creek, which has been split by the root development of a Red Maple (*Acer rubrum L.*). August 29, 1931.

Figure 144 A ridge in upper Limestone Brook valley strewn with outcropping conglomerate rocks, covered by a sparse stand of Trembling Aspen which has replaced the original almost pure stand of Chestnut. July 19, 1931.

on the subject of plant ecology (Weaver and Clements, 1929).

In most of the area there seems to be a rapid trend toward a more homogeneous forest composition, in the drier portions to an Oak forest, in the remainder of the area to almost pure stands of Sugar Maple.

PHYSIOGRAPHIC CONDITIONS

About 15 peaks or ridges in the area exceed 2200 feet in height and eight exceed 2300 feet. The highest altitude in the park (about 2465 feet) is reached at the peak a mile and a quarter northwest of the junction of Rice brook and Irish brook. Many of these peaks and ridges have steep slopes, with descents of 500 to 700 feet in the distance of a quarter-mile. Many of the steep banks bordering the Tunungwant and the Allegheny River valleys are therefore excessively drained. The lowest point in the area surveyed is about 1390 feet near Carrollton, thus making a maximum altitude range of about 1075 feet. Every degree of exposure to solar radiation is found on the slopes, which face all points of the compass to about an equal extent. Differences in porosity of various rock strata result in a well-defined spring level at an altitude of about 1900 feet. The area therefore exhibits, often within the distance of a few hundred feet, great variations in the supply of water available for plant growth.

HISTORICAL CONSIDERATIONS

This section once supported a relatively large rural population. For instance, about 26 families lived at one time in the valleys of Irish and Rice brooks. Today only a forest ranger's home and that of a carpenter, who works in Bradford, are occupied. Nearly all the early pioneer houses are vacant today or have been removed by the

Figure 145 Moss-covered rocks of a small stream in upper Limestone Brook valley. Hemlock, Yellow Birch and Beech are the dominant trees of the locality but only the Yellow Birch and an occasional Witch Hazel or Red Maple are found near the stream banks. July 8, 1931.

Figure 146 A Yellow Birch-Hemlock stand in upper Limestone Brook valley, July 10, 1931.

park authorities. The first settlers either cleared the forest or practised some form of selective cutting. In the early days of the lumber industry White Pine, Hemlock and hardwood (mostly cherry and hard maple) lumber from the southeastern portion were readily transported to Limestone, N. Y., or to Bradford, Pa. Forest products, especially Hemlock tanbark, were floated in great quantities down the Allegheny river to Salamanca, N. Y.

The romantic story of the Hemlocks and the tanbark industry is well told by H. A. Haring in his book, Our Catskill Mountains. From 1830 to 1870 the Catskills were throbbing with life and activity. The industry naturally declined as the mountains were denuded of Hemlock. Allegany State Park experienced the same boom of prosperity a few decades later. The bulk of the Hemlock was cut during the 15-year period from 1890 to 1905.

When the timber was depleted most of the people moved west or became engaged in the oil industry which has flourished in this locality. Thus these areas, once exploited by man, were deserted one by one and today exist in all stages of reversion to more permanent types of vegetation. Many of the cleared portions, now partially covered with aspens, oaks and Chestnuts, have been ravaged by fire again and again, prolonging the time required for the forest cover to reach maturity, and adding to the variations in forest cover to be seen at the present time.

BARK DISEASE OF CHESTNUT AND ITS EFFECTS

This portion of the park was unique in having unusually large stands of native Chestnut. Certainly Chestnut was much commoner originally than all the oaks combined, which was probably not the case elsewhere in the park,

excepting a few small tracts. In general, nearly pure stands of Chestnut occurred on dry ridges or slopes overlying sandy conglomerate rock farthest from the Tunungwant and the Allegheny river. On the east-west ridges, from one to two and a half miles back from the river, mixtures of Chestnut and oak occurred, interspersed with smaller pure stands of Chestnut. On the excessively drained and often stony slopes, within a mile of the river and creek, the oaks predominated, except for occasional patches of Chestnut on sandy loam.

The exact date of the first appearance of the Chestnut bark disease in the area is not known, but apparently most of the mature trees gradually died between about 1920 and 1928. Today large trees little affected by the blight are rare, and living Chestnut trees more than four inches in diameter form an unimportant part of the forest. Sprouts from dying trees are numerous, but usually show blight effects by the time they reach two inches in diameter (figures 139 and 140). In some places two or more generations of sprouts have been found killed by the disease, or else by repeated forest fires. Occasionally such sprouts are so numerous that they prevent the development of other tree species.

The destruction of Chestnut over large areas by the bark disease has had a determining effect upon the present appearance and composition of the forest. The future forest composition will also be greatly influenced. The original forest type will not reclaim the area, and a new climax forest will eventually become established, different from the old climax merely because of the absence of a single species.

When the pure stands of Chestnut were destroyed, an extremely interesting succession began. The first trees to

invade were either those which could become established in exposed, barren and dry areas, or those which could compete for sunlight with the dense undergrowth of shrubs and herbs. Presence of seed trees certainly was important in many cases in determining what species should replace the Chestnut.

The greater number of Chestnut stands, where repeated fires occurred, were quickly invaded by Trembling Aspen. Especially could this be said of forests on very dry ridge tops and upper slopes (figures 137, 139 and 142). At lower elevations, away from the river, Chestnut was sometimes replaced by a forest of the Aspen-Red Maple-Pin Cherry type. The Trembling Aspen forest on dry sites is now being succeeded by an Oak forest, especially in the eastern part of this section. Away from the river, where the oaks have not become established, the aspen forest is being succeeded by nearly pure stands of Sugar Maple (figure 132). Usually where Trembling Aspen is followed by Sugar Maple, an intermediate Red Maple-Pin Cherry stage has been observed. Forests of the latter type usually contain a fairly large proportion of Black Cherry (figure 133).

In some of the former Chestnut areas an Oak forest will ultimately succeed, but at present the oaks are becoming established very slowly, as the ground is covered with a dense tangle of Sassafras, Dogwood, Red Maple and berry bushes, which produce considerable shade on the forest floor. In a few instances the shrubby undergrowth has so shaded the ground as to bring about the virtual starvation of oak seedlings. Here we find seedling Sugar Maples well established in an area which formerly was an Oak-Chestnut forest.

Many of the areas formerly covered by Chestnut or by mixed oaks and Chestnut are now covered by a temporary

forest of a Mixed Mesophytic type. For example, an area near the Fire Tower, a mile and a quarter northwest of the junction of Irish and Rice brooks, was formerly covered by a forest consisting of about 60 per cent Chestnut and 40 per cent mixed oak species. The oaks were removed in lumber operations or destroyed by fire; the Chestnut was lumbered or destroyed by bark disease and fire. A count in this area in 1931 gave the following results as to abundance:

Large-toothed Aspen (*Populus grandidentata*)	28%
Red Maple (*Acer rubrum*)	26%
Beech (*Fagus grandifolia*)	19%
Sugar Maple (*Acer saccharum*)	6%
White Ash (*Fraxinus americana*)	5%
Cucumber Tree (*Magnolia acuminata*)	4%
Oaks (all species of *Quercus*)	4%
Pin Cherry (*Prunus pennsylvanica*)	3%
Basswood (*Tilia americana*)	3%
Tulip Tree (*Liriodendron tulipifera*)	2%

DETAILED DESCRIPTION OF AREAS SURVEYED

LIMESTONE BROOK VALLEY

Much of the lower slopes of this valley, from the Tunungwant to within a half-mile of the present pipe line, was formerly occupied by a dense forest of giant White Pines and Hemlocks such as those at Heart's Content, Pennsylvania (figure 159). In the lower portions White Pine was much the commoner of the two. The White Pines were also the taller, but the Hemlocks probably attained a greater diameter. The remains of many old stumps can be found everywhere along the course of Limestone brook, some in excellent condition of preservation. Many of them exceed four feet in diameter, and one Hemlock stump measured six feet seven inches in diameter three feet above the ground.

Figure 147 Scene along the pipe line south of upper Limestone brook showing a dense stand of Black Cherry, Basswood, Blue Beech, Cherry, Birch, Yellow Birch and Red Maple which has developed following lumbering operations. The taller timber on the far hillside shows a later stage in the succession where these species have been replaced by Sugar Maple and Beech. July 11, 1931.

Figure 148 An open area at the head of Limestone Brook valley showing a planting of pines and conspicuous clumps of Pearly Everlasting (*Anaphalis margaritacea*). In the distance the ridge top, formerly occupied by Chestnut, has been succeeded by Trembling Aspen. On the slope to the left, the aspens have been quickly replaced, first by Red Maple, then by Sugar Maple. August 23, 1931.

Figure 149 A clump of Pearly Everlasting (*Anaphalis margaritacea*) in a field at the head of Limestone Brook valley, August 23, 1931.

Figure 150 A clump of American Burnet (*Sanguisorba canadensis*) near Randolph, Cattaraugus county, N. Y. First time recorded in the Allegany State Park region. August 6, 1931.

A mile and three-quarters west of Limestone there is a grove of 115 White Pine trees ranging from 10 to 20 inches in diameter and from 35 to 65 feet in height. John J. Walker, who has lived in the valley for 37 years, said that these trees became established following the original cutting and were from eight to 15 feet high in 1900, and that the whole valley, for some distance up the slopes, was originally forested with mammoth trees (30–40 per cent Hemlock and 60–70 per cent White Pine). The Hemlocks were cut first, for tanbark, between 1870 and 1890. The south slopes were originally covered with almost pure Sugar Maple forest, containing a small amount of White Ash. The forests on these slopes were not cut until 1915. A knoll near the Walker homestead was covered with about three acres of Black Cherry, of large size. Following cutting, the cherry was replaced by Sugar Maple.

Another stand of young White Pines is to be found farther up the valley. Mature Hemlocks occur in a cove one mile east of The Forks, and splendid remnants of Hemlock forest occur at the spring level and along the branches of Limestone brook for a mile east and a mile west of the pipe line. Near the place where the pipe line crosses Limestone brook are some fine colonies of American Yew (*Taxus canadensis*) and dense clumps of Stiff Club Moss (*Lycopodium annotinum*) (figures 145 and 153).

The ridge south of Limestone brook, from its eastern end west to the pipe line, was capped with a forest of Chestnut and oaks in about the ratio of 7 to 3. The majority of the Chestnut trees were cut or, more recently, killed by the bark disease. Most of this ridge type of forest, especially to the east, has been replaced by nearly pure stands of oaks, mostly White Oak, but in some places

Figure 151 A moss garden built by L. E. Hicks at Allegany School of Natural History, west of Cabin No. 9. Here rare plants collected during field work were transplanted and studied in a living state. August 20, 1931.

Figure 152 A Hemlock-Yellow Birch-Beech forest along Leonard run showing a Yellow Birch which has become established on a decaying Hemlock stump. August 24, 1931.

any one of the secondary types listed as following Chestnut may be found (see page 267).

Just east of the ridge a considerable area of temporary forest exists. Completion of the succession to an ultimate Sugar Maple forest has been delayed by repeated forest fires. A summary of ten counts in this area gave the following variations in abundance: Red Maple, 40 per cent; Aspen (two species), 5 to 80 per cent; Yellow Birch, 10 to 35 per cent; Beech, 10 to 40 per cent; Sugar Maple, 5 to 20 per cent; and Cherry (two species), 5 to 35 per cent. The height of this forest ranges from 20 to 40 feet.

About one mile east of The Forks an area of big trees two to three feet in diameter, is located. This forest consists principally of Beech (about 80 per cent), Hemlock (5–25 per cent) and Sugar Maple, (0–15 per cent), with an undergrowth of Hobble-bush (*Viburnum alnifolium*).

Along the road and stream east of the place where the pipe line crosses Limestone brook is a large forest area of mixed and variable composition. Species in order of abundance from 20 per cent to 5 per cent, determined from ten counts, are as follows: Red Maple, Black Cherry, Yellow Birch, Pin Cherry, Blue-Beech, Sugar Maple, Cherry Birch, Large-toothed Aspen, and Beech (figure 147).

Most of the remainder of the south slopes in Limestone Brook valley are covered with stands of Sugar Maple (60–95 per cent), Beech (5–40 per cent), Yellow Birch (5–20 per cent), Red Maple (5–15 per cent), and smaller proportions of Basswood, Tulip Tree, Black Cherry and White Ash (1–5 per cent).

In moist depressions along the streams, where the ground is strewn with rock fragments, Yellow Birch

replaces the Sugar Maple and Beech with almost a pure stand. In many parts of this forest, Moosewood or Striped Maple is quite common, and numerous specimens three to four inches in diameter have been noted.

A number of old homesteads were located at the head of the valley, and the cleared areas have been reclaimed by forests of the Aspen or Aspen-Red Maple-Pin Cherry types (figures 148, 149 and 160). The south-facing slopes of Limestone Brook valley present a mosaic of forest types due to excessive drainage and evaporation in part, but more particularly due to the historical factors of occupation, clearing, selective cutting, etc. The cleared land is rapidly being replaced by forests of the Aspen-Red Maple-Pin Cherry type in the lower portions of the valley. Where soils are moist, such temporary types are succeeded by Sugar Maple and Beech (figures 131, 133 and 138). At the spring level on the slopes a well-marked band of Hemlock occurs. The upper slopes and the ridge tops are occupied by oaks, aspens and the many successional variants previously described as following the disappearance of Chestnut. A fruiting specimen of American Spikenard was photographed at the time of this survey, near the head of Limestone Brook valley (figure 154).

Just south of the pumping station and near the pipe line is Allegany Park Rock City (now called Thunder Rocks), which consists of huge blocks of Olean Conglomerate covered with an abundance of Chestnut sprouts and a mixture of other trees (figures 135, 139, 140 and 144).

IRISH BROOK VALLEY

The same temporary types previously described as following the destruction of Chestnut occur on the ridges and higher slopes south of Irish brook, east of the pump-

Figure 153 A bed of Stiff Club Moss (*Lycopodium annotinum*) growing along a stream bank, upper Limestone Brook valley, August 16, 1931

Figure 154 Spikenard (*Aralia racemosa*) in fruit along old road at the head of Limestone brook, August 12, 1931

ing station, and on the high sharp ridge north of Irish and Rice brooks (figures 137, 139, 140, 142 and 144). Several coves on the south slopes contain fine colonies of Hemlock, some of rather large size.

Above the junction of Rice and Irish brooks, there was a considerable amount of timber cutting, pasturing, and cultivating, followed by reversion to forests which have been repeatedly subjected to fire. As a result, large areas of sun-baked uplands are found, covered with Trembling Aspen and other temporary species. On the north-facing slopes the temporary Aspen-Red Maple-Pin Cherry forests are rapidly being converted to stands which will contain 80 per cent or more of Sugar Maple (figures 131, 132, 133, 134, 136 and 138). The north slopes of Irish Brook valley present nearly the same combination of species as the north slopes of Limestone Brook valley, except that more extensive stands of Sugar Maple are found, due to a higher water content in the soil.

SOUTH CARROLLTON BROOK VALLEY

Several families lived in this valley until recently, and much of the wood-cutting was done within the past 20 years, so that a large area of temporary Aspen-Red Maple forest occurs, which is gradually developing into a Sugar Maple-Beech type, with Sugar Maple particularly abundant, about 80 per cent or more. In coves near the headwaters, and at the spring levels, areas of Hemlock remain (figure 161). The south-facing slopes have been repeatedly burned, and are now covered with thickets of Aspen.

LEONARD RUN VALLEY

This valley was cleared of its original forest of Hemlock, Sugar Maple and Beech many years ago. For the most part there has been a development from the tempo-

Figure 155 Looking west from the Observation Tower south of Bova creek toward the artificial lake near Headquarters, August 29, 1931.

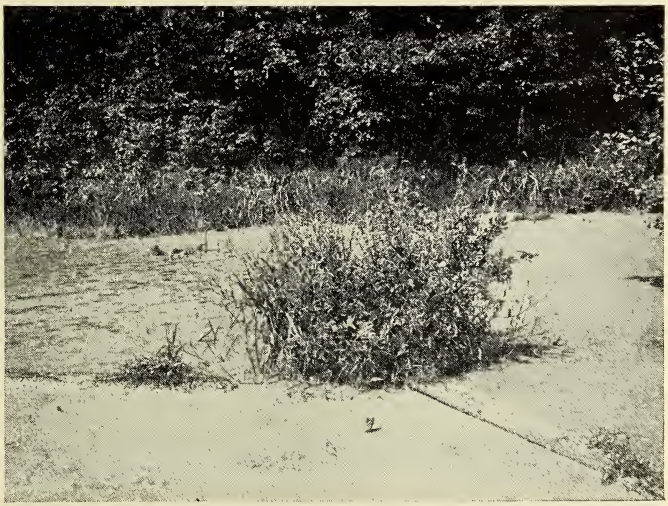

Figure 156 Aquatic vegetation with water surface covered with Duckweeds (*Lemna minor* and *Spirodela polyrhiza*). Stagnant water along Tunungwant creek near Limestone, August 26, 1931.

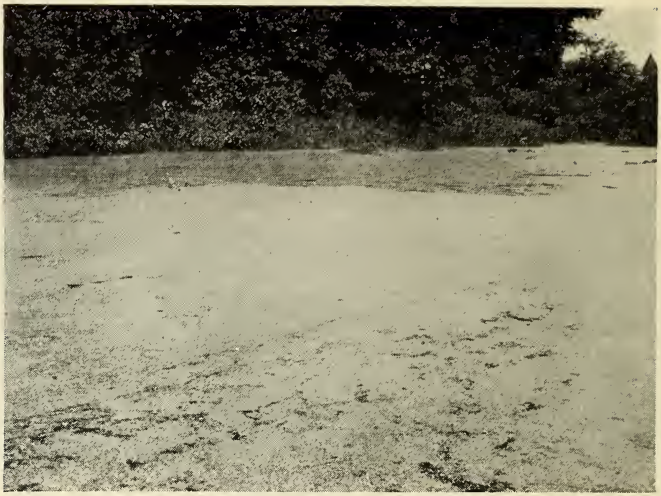

Figure 157 A floating layer of Duckweeds (*Lemna minor* and *Spirodela polyrhiza*) on Pope's pond, two miles north of Randolph, Cattaraugus county, N. Y., August 16, 1931.

Figure 158 A mass of tangled vines of Wild Cucumber (*Echinocystis lobata*) on willows near mouth of Tunungwant creek, August 16, 1931.

rary Aspen-Red Maple stage to a forest of the Sugar Maple-Beech type, with the following composition: Sugar Maple, 60 to 80 per cent; Beech, 10 to 25 per cent; Red Maple, 5 to 35 per cent; Yellow Birch, 5 to 35 per cent.

The south-facing slopes west of Carrollton are covered with an Aspen thicket, as a result of repeated fires, especially at higher altitudes. Here the Aspen thicket gives way to a nearly pure Oak forest type. In the moist areas along the stream and its branches are forests of Hemlock-Beech type. Many of the Hemlocks are of merchantable size, 20 to 32 inches in diameter (figures 152 and 162).

RED HOUSE BROOK VALLEY

This portion of the area surveyed can be readily observed from the road which follows Red House brook from the junction of the Bradford road to the sharp bend near Camp Yo-wo-chas. Considerable cleared land still exists. A number of fine colonies of Hemlock may be seen east of the road from Halls to a point one mile and a half south. Other colonies occur in the valley of Bova creek and east of the road about a mile southeast of the new artificial lake (figures 143 and 155).

TUNUNGWANT CREEK VALLEY

This area includes also the Allegheny River valley north to Carrollton. From the New York-Pennsylvania state line to Carrollton, a distance of eight miles, Tunungwant creek and the Allegheny river have a fall of only about 20 feet, and through this valley a stream meanders. There are numerous bayous, and a large area of swampy bottomland containing vegetation of a type not found elsewhere in the area surveyed. The preglacial Upper Allegheny river was formerly blocked by a glacial moraine. As a result

Figure 159 Giant White Pines with undergrowth of small Hemlocks. Heart's Content, south of Warren, Pa., July 5, 1931.

Figure 160 Looking eastward down the whole length of Limestone Brook valley to Tunungwant creek. Abandoned road and old field in foreground. August 24, 1931.

glacial lakes were produced in the valleys of the Allegheny river and its tributaries. New drainage lines were established, which are now difficult to determine, due to subsequent events. During a long interglacial period which followed, deepening of the river channel took place, with the result that the floor of the Allegheny valley was worn down 300 feet or more below its present level. Filling of this deep channel with outwash occurred during a more recent glaciation, perhaps the Wisconsin, and the present streams have cut new channels in the filled valleys. (Note: This explanation is somewhat different from that given by Lobeck, 1927, who apparently disregarded the effect of drainage changes by a glacier older than the Wisconsin. That there was such a glacier in this region is attested by older deposits of drift and outwash in the vicinity of Warren, Pa.)

The original forest of the valley would be difficult to reconstruct. Today about half of the valley area is in cleared land, pastures, cultivated land and hayfields. The remainder, mostly in the lower valley, is occupied by various swamp forest, bottomland or streamside plant communities. The tree growth consists largely of Willows (*Salix nigra, S. cordata,* and *S. sericea*), Silver Maple, White Elm and Red Maple. Occurring in smaller numbers are the following: Boxelder, Sycamore, Swamp White Oak, Black Ash, Black Gum, Basswood, Blue Beech, Sweet Birch, Butternut and Bitternut Hickory. Numerous thickets of tangled shrubs and vines are to be found. These contain the following species: Arrow-wood, Hoary Alder, High-bush Blackberry, Wild Clematis, Virginia Creeper, Wild Black Currant, Red Osier Dogwood, Silky Dogwood, Panicled Dogwood, Common Elderberry, Hazelnut, Nannyberry, Summer Grape, Fox Grape, Poison Ivy, Red

Figure 161 Hemlock forest with decayed stumps of former veterans of the same species. Leonard brook, August 27, 1931.

Figure 162 Fine Hemlock forest on slope near headwaters of the south branch of South Carrollton creek, August 20, 1931.

Raspberry and several species of shrubby Willows. The scientific names of these and other species of woody plants found in the area surveyed can be learned by consulting the list which follows this discussion.

Some of the best examples of aquatic vegetation in the park region have developed here, including areas of *Scirpus, Typha, Sagittaria, Eleocharis, Carex, Juncus* etc. In pools of stagnant water may be found the Yellow Water Lily (*Nymphaea advena*), Pondweed (*Potamogeton epihydrus*), and two species of Duckweed (*Lemna minor* and *Spirodela polyrhiza*) (figures 156, 157 and 158).

LIST OF WOODY PLANTS FOUND IN THE AREA SURVEYED

Taxus canadensis Marsh	American Yew
Pinus strobus L.	White Pine
Larix laricina (DuRoi) Koch	Tamarack
Tsuga canadensis (L.) Carr	Hemlock
Populus grandidentata Michx	Large-toothed Aspen
Populus tremuloides Michx	Trembling Aspen
Salix nigra Marsh	Black Willow
Salix lucida Muhl	Shining Willow
Salix bebbiana Sarg	Beaked Willow
Salix cordata Muhl	Heart-leaved Willow
Salix sericea Marsh	Silky Willow
Salix discolor Muhl	Pussy Willow
Salix humilis Marsh	Prairie Willow
Juglans cinerea L.	Butternut
Carya cordiformis (Wang.) K. Koch	Bitternut
Carya glabra (Mill.) Sweet	Pignut
Carya ovata (Mill.) K. Koch	Shagbark Hickory
Corylus americana Walt	Hazelnut
Corylus cornuta Marsh	Beaked Hazelnut
Ostrya virginiana (Mill.) K. Koch	Hop Hornbeam
Carpinus caroliniana Walt	Blue Beech
Betula lenta L.	Sweet Birch
Betula lutea Michx	Yellow Birch
Alnus incana (L.) Moensch	Hoary Alder
Fagus grandifolia Ehrh	Beech
Castanea dentata (Marsh.) Borkh	Chestnut
Quercus alba L.	White Oak

Quercus montana Willd.	Chestnut Oak
Quercus bicolor Willd.	Swamp White Oak
Quercus rubra L.	Red Oak
Quercus velutina Lam.	Black Oak
Ulmus americana L.	American Elm
Ulmus fulva Michx.	Slippery Elm
Magnolia acuminata L.	Cucumber Tree
Liriodendron tulipifera L.	Tulip Tree
Sassafras officinale Nees. & Eb.	Sassafras
Benzoin aestivale (L.) Nees	Spicebush
Hamamelis virginiana L.	Witch Hazel
Platanus occidentalis L.	Sycamore
Malus coronaria (L.) Mill.	Wild Crab Apple
Amelanchier canadensis Spach	Shadbush
Rubus allegheniensis Porter	Common Blackberry
Rubus strigosus Michx.	Red Raspberry
Rubus odoratus L.	Flowering Raspberry
Rosa carolina L.	Dwarf Wild Rose
Crataegus punctata Jacq.	Thorn Apple
Crataegus coccinea L.	Scarlet Thorn
Prunus americana Marsh.	Wild Plum
Prunus pennsylvanica L.	Pin Cherry
Prunus virginiana L.	Choke Cherry
Prunus serotina Ehrh.	Wild Black Cherry
Rhus typhina L.	Staghorn Sumach
Rhus glabra L.	Smooth Sumach
Rhus copallina L.	Dwarf Sumach
Rhus toxicodendron L.	Poison Ivy
Ilex monticola Gray	Large-leaved Holly
Ilex verticillata (L.) Gray	Winterberry
Nemopanthus mucronata (L.) Trel.	Mountain Holly
Acer saccharinum L.	Silver Maple
Acer rubrum L.	Red Maple
Acer saccharum Marsh.	Sugar Maple
Acer pennsylvanicum L.	Striped Maple
Acer spicatum Lam.	Mountain Maple
Acer negundo L.	Box-Elder
Psedera quinquefolia (L.) Greene	Virginia-Creeper
Vitis aestivalis Michx.	Summer Grape
Vitis vulpina L.	Frost Grape
Tilia americana L.	Basswood
Dirca palustris L.	Leatherwood
Cornus florida L.	Flowering Dogwood
Cornus amomum Mill.	Silky Dogwood
Cornus stolonifera Michx.	Red Osier Dogwood
Cornus candidissima Marsh.	Panicled Dogwood
Cornus alternifolia L.	Alternate-leaved Dogwood
Nyssa sylvatica Marsh.	Black Gum
Azalea nudiflora L.	Pink Azalea

Gaultheria procumbens L.	Creeping Wintergreen
Vaccinium stamineum L.	Deerberry
Vaccinium pennsylvanicum Lam.	Low-bush Blueberry
Vaccinium vacillans Kalm.	Late Upland Blueberry
Gaylussacia baccata (Wang.) C. Koch.	Black Huckleberry
Fraxinus americana L.	White Ash
Fraxinus nigra Marsh	Black Ash
Diervilla lonicera Mill	Bush Honeysuckle
Viburnum alnifolium Marsh	Hobble-bush
Viburnum opulus L.	Cranberry Tree
Viburnum acerifolium L.	Maple-leaved Viburnum
Viburnum dentatum L.	Arrowwood
Viburnum cassinoides L.	Withe-Rod
Viburnum lentago L.	Nannyberry
Sambucus canadensis L.	Elderberry
Sambucus racemosa L.	Red-berried Elder

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A BOTANICAL SURVEY OF THE NORTHERN SECTION OF THE ALLEGANY STATE PARK

(Figures 163–92)

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CONTENTS

INTRODUCTION

The botanical survey of Allegany State Park was started in 1928, when F. W. Emerson spent the months of July and August in a survey of "Big Basin," an area of approximately 11,500 acres, of which 1500 acres were covered with a mature forest of "Big Trees." The following summer L. A. Kenoyer engaged in a similar project covering the central portion of the park, lying north and west of "Big Basin."

In 1930, when I first came to Allegany State Park, I followed the example of the botanists who had preceded me, and selected the southwestern section of the park to survey. The next summer (1931) L. E. Hicks replaced me on the State Museum staff working in the park, and continued the botanical survey to include the eastern section, between Red House brook and Tunungwant creek. In 1932 there remained only the northern section to be surveyed, and the field work in this section was completed by myself during July and August of that year.

During these studies the members of the State Museum staff served as instructors in the Allegany School of Natural History. Forest type maps, photographs and field notes, however, were made in each section as matters of record, so that a fairly complete report could be prepared.

The botanists have been greatly aided by the State Museum Handbooks on the geology (Lobeck, 1927), the flora (House and Alexander, 1927), and the vegetation (Taylor, 1928). Members of the teaching staff at the school and local residents have been exceedingly courteous and helpful to the botanical investigators. It is hoped that the results of this survey will prove valuable to the administration of the Allegany State Park, to the students of

the Allegany School of Natural History, and to naturalists everywhere. Dr Charles C. Adams, Director of the New York State Museum, has directed the botanical work from the beginning, and it has been through his untiring efforts that the survey has been brought to completion.

GENERAL DESCRIPTION OF THE SECTION

The northern section of the park is bounded on the north, east and west, by the Allegany Indian Reservation, bordering the Allegheny river; and on the south by lower Red House brook, Bova (pronounced Bo-vay) creek, and Leonard run. It is part of a maturely dissected plateau, varying in elevation from 1340 feet, in the Allegheny River valley near the mouth of Red House brook, to 2375 feet on the summit of Parker hill, which is the highest elevation in this section. The total area surveyed in 1932 was slightly over 14,000 acres. About one-third of this area consists of open farmland, old fields and clearings. Another third is covered with second growth, in which aspens, Red Maple and Pin Cherry are the most abundant tree species. The remaining third is forested with hardwoods of the Sugar Maple-Beech and the Oak forest types, all second growth, except for about 70 acres of mature timber.

Drainage is directly into the Allegheny river with the exception of Bova and McIntosh creeks, which flow into Red House brook. Steep slopes are the rule, especially those bordering the river. Soils are derived from the weathering of sandstones, siltstones and shales, and have an acid reaction. Mature soils of the region are represented by shallow podzols, but in general the soils of this section do not show well-developed profiles characteristic of maturity. Much of the land is rough and stony, but the

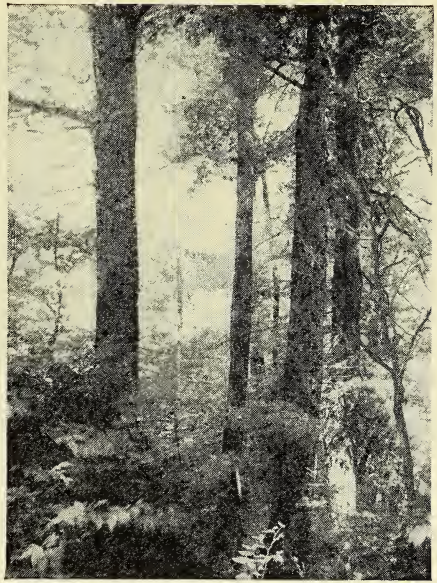

Figure 163 Group of Yellow Birches (*Betula lutea*) in forest along Bova creek, near Y.M.C.A. Camp Fancher (now called Sprucelands).

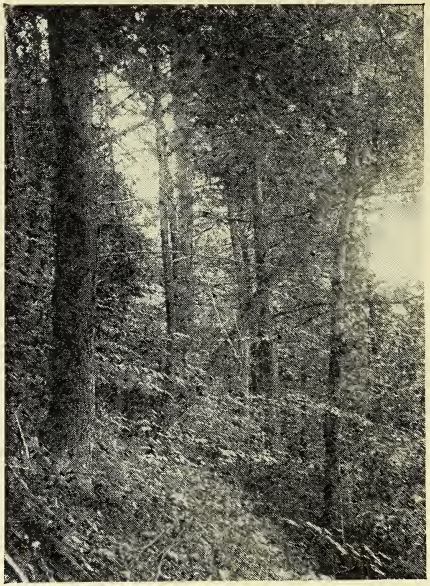

Figure 164 Small stand of Hemlocks (*Tsuga canadensis*), associated with Beech, on steep slope above Bova creek. A leaning trunk, undermined by erosion, is shown.

lower valleys have deeper and finer textured soils. Farming is practised chiefly in the valleys, but there were also a few farms on Parker hill, where the head of McIntosh creek forms a broad valley, not too steep for agriculture. All but one of these farms are now abandoned.

FOREST COVER TYPES IN THE AREA

The forest cover types recognized in the northern section of the Allegany State Park are the same as those noted elsewhere. In brief they may be described as: (1) Sugar Maple-Beech type; (2) Oak type; (3) Aspen-Red Maple type; and (4) bottomland forest, of varying composition.

SUGAR MAPLE-BEECH TYPE

In Allegany State Park this is now the most extensive cover type (figure 165). It is mainly second growth and has replaced the primary forest of the Hemlock-Beech type after the mature trees were removed for lumber, cordwood and tanbark. This type should not be confused with the climax association of the same name in southwestern Pennsylvania, which has been described by Jennings (1927). The composition of these forests and the character of their undergrowth will serve to distinguish the two types of second growth, in which the dominant species include a large portion of Sugar Maple and Beech.

Following destruction of a primary forest of the Hemlock-Beech type in the Allegany State Park, the dominant tree species of the *secondary* type are usually Sugar Maple, Beech, Black Cherry, Yellow Birch, Hemlock, White Ash and Basswood. Oaks and Hickories are entirely absent or infrequent. The shrub layer contains Hobble-bush (*Viburnum alnifolium*), Red Raspberry (*Rubus strigosus*) and

Figure 165 Second-growth forest of the Sugar Maple-Beech type along Bova creek, near Y.M.C.A. Camp Fancher.

Figure 166 A sprout forest of Blue Beech (*Carpinus caroliniana*) in the moist bottomland of Bova creek.

Red-berried Elder (*Sambucus racemosa*). The following species of herbaceous plants persist to a considerable extent in the ground cover, where it has not been disturbed by fire or grazing.

Spiny-toothed Shield Fern	*Thelypteris spinulosa*
New York Shield Fern	*Thelypteris noveboracensis*
False Mitrewort	*Tiarella cordifolia*
Painted Trillium	*Trillium undulatum*
Indian Cucumber	*Medeola virginica*
Wood Sorrel	*Oxalis acetosella*
Round-leaved Violet	*Viola rotundifolia*
Mountain Aster	*Aster acuminatus*
Partridge Berry	*Mitchella repens*
Shining Club Moss	*Lycopodium lucidulum*
False Violet	*Dalibarda repens*

Where the primary forest was the Sugar Maple-Beech climax type, as described by Jennings, the dominant tree species of the secondary forests include Sugar Maple, White Oak, Beech, White Ash, Shagbark Hickory, Red Oak, Black Cherry, Basswood, Hop Hornbeam, and a considerable number of less common trees. The shrub layer contains Arrow-wood (*Viburnum acerifolium*), Gooseberry (*Ribes cynosbati*), Blackberry (*Rubus alleghaniensis*) and Black Raspberry (*Rubus occidentalis*). The herbs and half-shrubs, which form the ground cover, include the following species:

Christmas Fern	*Polystichum acrostichoides*
Maidenhair Fern	*Adiantum pedatum*
Wild Blue Phlox	*Phlox divaricata*
Honewort	*Deringa canadensis*
Bloodroot	*Sanguinaria canadensis*
May-apple	*Podophyllum peltatum*
Sweet-cicely	*Washingtonia claytoni*
Greek Valerian	*Polemonium reptans*
Twinleaf	*Jeffersonia diphylla*
Trout Lily	*Erythronium americanum*

From the above description it is evident that the second-growth forest which follows the cutting or destruction of

Figure 167 Undergrowth of Wood Ferns (*Aspidium spinulosum*), Wood Sorrel (*Oxalis acetosella*), and Club Moss (*Lycopodium lucidulum*) in a forest of the Hemlock-Yellow Birch type near Y.M.C.A. Camp Fancher.

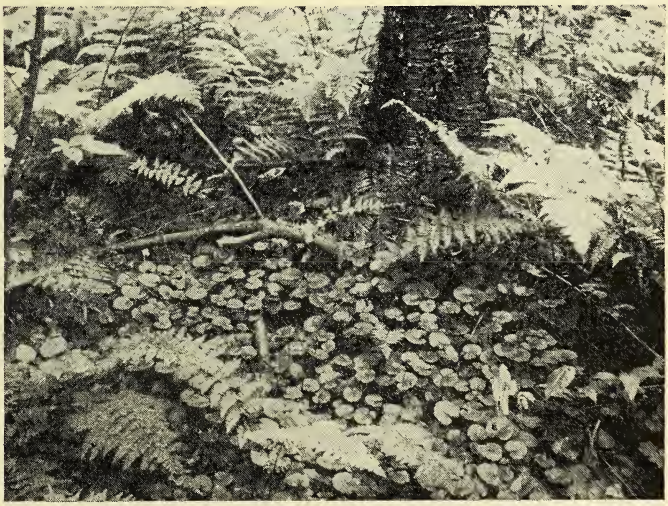

Figure 168 A society of *Dalibarda repens* and *Aspidium spinulosum* in a forest of the Hemlock-Yellow Birch type.

mature Hemlock or Hemlock-Beech stands is quite similar in composition to type 12, Sugar Maple-Beech-Yellow Birch, as described by the Committee on Forest Types, Society of American Foresters (Hawley, and others, 1932). It is interesting to note that this type is considered to be the most extensive commercial saw-timber type remaining in the northern forest. Variants and synonyms are given as Maple-Beech, Birch-Beech-Maple, Maple-Beech-Hemlock-Yellow Birch, Northern Hardwoods, Beech-Birch-Maple, and Hard Maple-Yellow Birch.

Because this type occupies loamy soils of good moisture condition and because it produces a heavy shade second to no other deciduous forest type, it is regarded as a climax type; that is, there is no likelihood that it will be replaced by any other type of forest when the trees reach maturity. Approximately 2200 acres of second-growth Sugar Maple-Beech forest have been mapped in the northern section in 1932. Only 70 acres of mature timber were located in this portion of the park, which has suffered most severely from the lumber, tanbark and chemical wood industries.

OAK FOREST TYPE

So many species of oaks occur in the eastern United States that there are relatively a large number of forest types in which oaks predominate. Among the many primary types which have been recognized are the White Oak-Black Oak-Hickory type of the prairie states, the Post Oak-Black Jack type of the "flatwoods" or barrens of Missouri, Tennessee and western Kentucky, and the Oak-Chestnut type of the ridges and upper slopes in the Appalachian region (Gordon, 1932). It is therefore necessary to define or describe just what is meant by the oak type

in the Allegany State Park. The following list of species will give a fair idea of its floristic composition:

Trees

Dominant Species	*Associated Species*
White Oak	Black Oak
Red Oak	Large-toothed Aspen
Red Maple	Pignut Hickory
Chestnut	Black Birch
Chestnut Oak	White Pine

Small Trees and Shrubs

Flowering Dogwood	*Cornus florida*
Shadbush	*Amelanchier canadensis*
Sassafras	*Sassafras variifolium*
Witch Hazel	*Hamamelis virginiana*
Beaked Hazelnut	*Corylus cornuta*
Glaucescent Honeysuckle	*Lonicera glaucescens*
Pinxter-flower	*Azalea nudiflora*
Prairie Willow	*Salix humilis*
Maple-leaved Viburnum	*Viburnum acerifolium*
Pasture Rose	*Rosa carolina*
Low Blackberry	*Vaccinium vacillans*
Late Blueberry	*Vaccinium angustifolium*
Dwarf Huckleberry	*Gaylussacia baccata*
Bush Honeysuckle	*Diervilla lonicera*

Half-shrubs

Aromatic Wintergreen	*Gaultheria procumbens*
Trailing Arbutus	*Epigaea repens*
Trailing Club Moss	*Lycopodium complanatum*
Running Club Moss	*Lycopodium clavatum*

Herbs

Black Cohosh	*Cimicifuga racemosa*
Wild Spikenard	*Aralia nudicaulis*
Lousewort	*Pedicularis canadensis*
Woodland Sunflower	*Helianthus divaricatus*
Bracken	*Pteridium latiusculum*
Wood Strawberry	*Fragaria virginiana*
Fringed Milkwort	*Polygala paucifolia*
White Clintonia	*Clintonia umbellata*
Wild Geranium	*Geranium maculatum*
Blue Violet	*Viola triloba*
Shinleaf	*Pyrola elliptica*
Whorled Loosestrife	*Lysimachia quadriflora*
Schreber's Aster	*Aster schreberi*
Tick-Trefoil	*Desmodium grandiflorum*

The Oak forest type in Allegany State Park is practically identical with that described by the same name by S. T. Dana (1930), and has undoubtedly replaced an Oak-Chestnut type throughout its range, partly due to lumbering, but largely due to the destruction of Chestnut by the fungus *Endothia parasitica.*

All of the Oak type in the park is second growth or third growth. Some of the areas which have been mapped as Oak forest approach in composition a Mixed Mesophytic forest type, in which species of the Sugar Maple-Beech type are associated with Oaks, Chestnut and Red Maple in almost equal proportions. Practical considerations made it necessary to map the Mixed Mesophytic type as Oak forest.

Other areas contain a large proportion of Aspen (two species), Red Maple and Pin Cherry, but are in an advanced stage of succession, where the dominant species of the Oak forest nearly equal in size and abundance the temporary dominants of the Aspen-Red Maple type. In the northern section of the park and on the adjacent reservation approximately 1650 acres have been mapped as Oak forest.

ASPEN-RED MAPLE TYPE

A total of 4860 acres, or more than one-third of the northern section, when surveyed in 1932, was covered with a young growth of Aspens, Red Maple and Pin Cherry, associated in some cases with species from the Maple-Beech forest, but more often with species from the Oak forest (figures 171 and 173). In composition the Aspen-Red Maple type approaches closely the Pin Cherry (type 5) described by the S. A. F. Committee on Forest Types (Hanley and others, 1932). The following list of species will give a fair idea of its composition:

Trees

Dominant Species	*Associated Species*
Trembling Aspen	Chestnut
Red Maple	White Ash
Pin Cherry	Sugar Maple
Large-toothed Aspen	Black Birch
Black Cherry	Red Oak

Shrubs and Half-Shrubs

Blackberry	*Rubus alleghaniensis*
Staghorn Sumac	*Rhus hirta*
Bush Honeysuckle	*Diervilla lonicera*
Prairie Willow	*Salix humilis*
Maple-leaved Viburnum	*Viburnum acerifolium*
Aromatic Wintergreen	*Gaultheria procumbens*
Trailing Club Moss	*Lycopodium complanatum* var. *flabelliforme*

Herbs

Bracken Fern	*Pteridium latiusculum*
Rough Goldenrod	*Solidago rugosa*
Late Goldenrod	*Solidago serotina*
Early Goldenrod	*Solidago juncea*
Spreading Dogbane	*Apocynum androsaemifolium*
Schreber's Aster	*Aster schreberi*
Barren Strawberry	*Waldsteinia fragarioides*
Wood Strawberry	*Fragaria virginiana*
Wild Sarsaparilla	*Aralia nudicaulis*
Partridge Berry	*Mitchella repens*
Fringed Milkwort	*Polygala pauciflora*
Fireweed	*Epilobium angustifolium*

BOTTOMLAND FORESTS

About 850 acres of bottomland forests remain in the broad valley of the Allegheny river on the Indian Reservation in the section surveyed in 1932 (figure 173). These forests are principally of a deciduous swamp type characterized by an abundance of such species as American Elm, Butternut, White Ash and Blue Beech. Ecologically it represents portions of type 51, Red Oak-Basswood-White Ash, and type 60, Silver Maple-American Elm, of the S. A. F. classification (1932). Bottomland forests are

Figure 169 Stem-tips of *Lycopodium lucidulum,* showing the heart-shaped axillary buds or gemmae. These are readily detached and produce new plants like their parents in the raw humus of the forest floor.

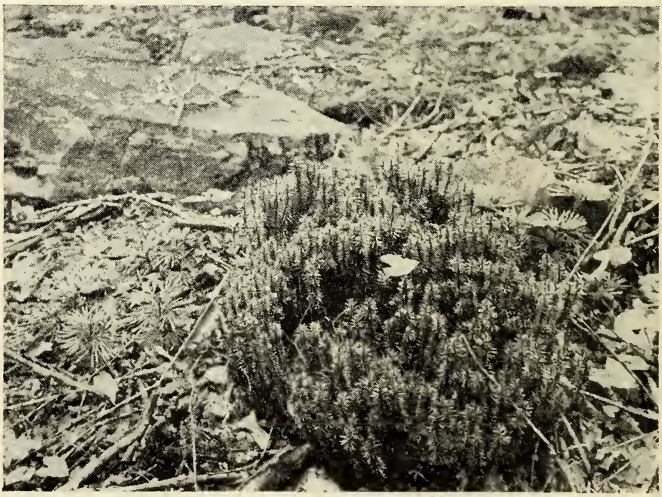

Figure 170 A clump of *Lycopodium lucidulum.* This is one of the five most abundant species forming the ground cover in the Hemlock forest.

admittedly difficult to classify, due to variations in composition within short distances. The presence of undergrowth species characteristic of the Hemlock-Yellow Birch type indicates that some of the bottomland forests are secondary. On the other hand, forests of similar composition occupy islands in the river, where they apparently represent an early stage of primary succession (figure 174).

About three miles north of Carrollton is a bottomland forest which has apparently developed naturally to the deciduous forest climax of the Beech-Sugar Maple type on well-drained sites. The two dominants are associated with White Ash as a codominant and with Blue Beech in the understory. The undergrowth of ferns is most luxuriant here, including Ostrich Fern (*Pteretis nodulosa*), Silvery Spleenwort (*Athyrium angustum* var. *elatius*). Goldie's Fern (*Thelypteris goldiana*), and Sensitive Fern (*Onoclea sensibilis*). In addition to the ferns are some conspicuously large specimens of Skunk Cabbage (*Spathyaema foetida*), Jack-in-the-pulpit (*Arisaema triphyllum*), White Snakeroot (*Eupatorium urticaefolium*), and Coneflower (*Rudbeckia laciniata*) (figures 175 and 176).

DESCRIPTION OF VEGETATION BY STREAM VALLEYS

VALLEY OF BOVA CREEK

Bova creek is a mountain stream a little over two miles in length, flowing in a southwesterly direction from Parker hill into Red House brook. Like other streams of its size in the park, it is fed by springs, and the water is clear and cold; it is a typical trout stream. Except in the lower third of its course, the stream is bordered on both sides

Figure 171 Ridge west of Brougham hollow, viewed from the New York State highway southeast of Salamanca. The recently burned area on the upper slopes will soon be covered with an aspen thicket.

Figure 172 Valley of Leonard run, in the Allegany State Park, from a point above the New York State highway at Carrollton; view westward across the Allegheny River valley.

of the valley with forests. In the lower portion, open farmlands are now occupied by Camp Yowochas and by Y. M. C. A. Camp Fancher. Scotch Pines have been planted extensively in these open areas.

Northeast of the Y. M. C. A. camp is a small tract of primeval timber consisting chiefly of Hemlock, Yellow Birch, Beech and Sugar Maple (figure 163). The tract is probably not more than 40 acres in extent and forms the nucleus of a beautiful woodland which extends for nearly a mile up the creek. It can easily be reached by a hiking trail from the Y. M. C. A. Camp. On the steep north bank of the creek is nearly a pure stand of Hemlock, associated with Beech as a codominant. Here the excessive steepening of the slope due to undercutting of the stream has loosened the siltstones and shales. Active landslides have thus occurred. The Hemlocks are slowly but surely being removed by erosion and their places are being taken by young hardwoods. According to M. M. Moffitt, of Salamanca, the valley of Bova creek was originally covered on both sides with nearly a pure stand of Hemlock. Only a small remnant remains here as an example of the primeval forest type (figure 164).

The trail in the valley of Bova creek leads for about half a mile through a narrow strip of forest dominated by Hemlock and Yellow Birch. Where the Hemlocks have been removed the forest becomes a Beech-Sugar Maple-Yellow Birch type, on moist colluvial soils. In one small area there is a sprout forest of Blue Beech associated with Sugar Maple, all of small diameter (figure 166). The forest appears to have replaced a stand of Hemlock and Yellow Birch. The undergrowth in this type of forest includes

practically all of the characteristic shade tolerant plants of the region (figures 167 and 168). These are as follows:

Thelypteris spinulosa var. *intermedium*
Oxalis acetosella
Trillium undulatum
Maianthemum canadense
Medeola virginica
Mitchella repens
Lycopodium lucidulum (figures 169 and 170)
Dalibarda repens
Monotropa uniflora

The last named species is the familiar Indian-pipe. Its scaly white or pinkish stem is only a few inches high and bears a single flower at the summit. The flowers at first are nodding, but as they mature, they become erect, in which condition they "go to seed." This species is described in most botanical literature as a saprophyte. As a matter of fact, the root system is reduced to a few short white rootlets, with which fungi are closely associated. The mycelium of this "root fungus" extends in all directions through the leaf mold. The mycelium resembles a mass of tiny white branching threads, which digests portions of the organic matter or humus and supplies *Monotropa* with predigested foods. Obviously the reduced root system of the Indian-pipe is not adequate for food absorption without the aid of the root fungus or "mycorrhiza." In other words, the Indian-pipe is not strictly a saprophyte, but is probably a true parasite, depending for foods upon the living fungus plants with which it is so intimately associated.

The upper portion of Bova creek flows through a forest of the Aspen-Red Maple type, which covers the entire south-facing slope of Parker hill and grades into a forest of oaks and Chestnut at the summit.

Figure 173 View northward toward Riverside Junction in the Allegheny River valley, from the hillside opposite Carrollton, in the Allegany Indian Reservation

Figure 174 View of the Allegheny river about three miles north of Carrollton, showing a willow thicket on the gravel bar. Allegany Indian Reservation

VALLEY OF McINTOSH CREEK

McIntosh creek flows in a southwest direction toward Red House brook about a mile west of Bova creek, which is approximately parallel to McIntosh. Since the construction of the lake in Red House valley, near the Administration Building, McIntosh creek now empties directly into it. In the lower portion of its course the stream passes through pasture land; the middle portion is flanked on both sides with a second-growth forest of the Sugar Maple-Beech type, which extends nearly to the summit of Parker hill on the east and to the Scenic road on the west. Above the road, which parallels the creek, the forest growth is mostly of the Aspen-Red Maple type. Sugar Maple and Black Cherry are numerous among the aspens, and it appears that they will ultimately succeed the relatively short-lived "Popple," which is less tolerant of shade. McIntosh creek heads in the highland farms on Parker hill, of which more will be said in the pages which follow.

CHRISTIAN HOLLOW

Christian hollow and its branch, Brougham hollow, to the east, are two of the most inaccessible valleys in the whole park. Although these were the last portions of the region surveyed, they were found to be of considerable interest. The drainage is northward and somewhat easterly into the Allegheny river just above the city of Salamanca. Except for a recently burned area on the ridge between Brougham hollow and the Allegheny river, the vegetation of Christian hollow is principally Sugar Maple-Beech forest. Near the head of Christian hollow is some mature timber, in which Beech, Sugar Maple, Yellow Birch and Hemlock make up the dominants; their rela-

tive abundance is indicated by the order in which they have been listed. The forest contained originally a much greater proportion of Hemlock, as shown by the presence of decaying stumps and logs. Many of the trees now are living with a "cat face" or broad triangular cavity at their base, on the up-hill side of the trunk. Such a defect is generally considered to be the result of ground fires or brush fires, probably following early lumbering operations. The undergrowth in this forest of mature trees consists mostly of Sugar Maple and Beech saplings, with occasional specimens of Striped Maple (*Acer pennsylvanicum*) and Hobble-bush (*Viburnum alnifolium*). Herbaceous plants form the ground cover and include the following species:

Thelypteris spinulosa intermedium
Trillium undulatum
Tiarella cordifolia
Mitchella repens
Viola blanda
Polystichum acrostichoides
Aster acuminatus
Clintonia borealis
Lycopodium lucidulum
Viola rotundifolia
Oxalis acetosella
Maianthemum canadensis
Monotropa uniflora
Habenaria orbiculata

Decaying logs of Hemlock and Beech are covered with light green mats of moss (*Stereodon imponens*) in which Hemlock seedlings have started to grow. Locally, small but nearly pure stands of Hemlock can be found, associated with Beech. Beneath the Hemlocks, Beech seedlings are found to be more abundant than those of Sugar Maple.

In contrast to the moist shady forests in Christian hollow is the vegetation on the west-facing slope of the ridge between Brougham hollow and the river (figure 172). This area was apparently burned over sometime during the summer of 1929. A few fire-resistant trees, White Oak, Red Oak and Chestnut, were scattered through this brushy stand of burned aspens (mostly *Popu-*

Figure 175 Luxuriant growth of Sensitive Fern (*Onoclea sensibilis*) in a deciduous forest on the floodplain of the Allegheny river opposite Carrollton, N. Y.

Figure 176 Colony of Tall Meadow Rue (*Thalictrum polygamum*) along a roadside opposite South Carrollton, Allegany Indian Reservation

lus grandidentata). A majority of the aspens had sprouted. The sprouts themselves were three to six feet high, although only two years of age. They originated from the base of the main stem, or "crown," of the burned trees and from the roots which spread seemingly everywhere through the stony soil.

Bush Honeysuckle (*Diervilla Lonicera*) is the most prevalent shrubby species in the ground-cover. Aromatic Wintergreen, a half-shrub, forms with it a distinctive *Diervilla-Gaultheria* society, among which are Bracken and Hay-scented fern, patches of *Polytrichum commune, Lycopodium obscurum* and *Lycopodium complanatum* var. *flabelliforme, Aster schreberi, Solidago juncea, Solidago bicolor, Rubus alleghaniensis, Viburnum acerifolium,* and sprouts of Prairie Willow (*Salix humilis*), Pin Cherry (*Prunus pennsylvanica*), and Red Maple (*Acer rubrum*).

It is of interest to note that the following species had recovered from the fire or had successfully withstood the burning: *Polygala pauciflora, Medeola virginica, Mitchella repens, Trillium undulatum, Achillea millefolium* and *Apocynum androsaemifolium.* Seedlings of what were taken to be *Polygala pauciflora* were positively abundant, and in places almost covered the ground to the exclusion of other species.

VALLEY OF TITUS RUN

The valley of Titus run has long served as the chief route of travel from Salamanca to the summit of Parker hill. Before the building of the Scenic road, automobile travel was routed over this road, which leads from State Park avenue and follows close to the run until an altitude of 1800 is reached. Here the road curves to the northeast

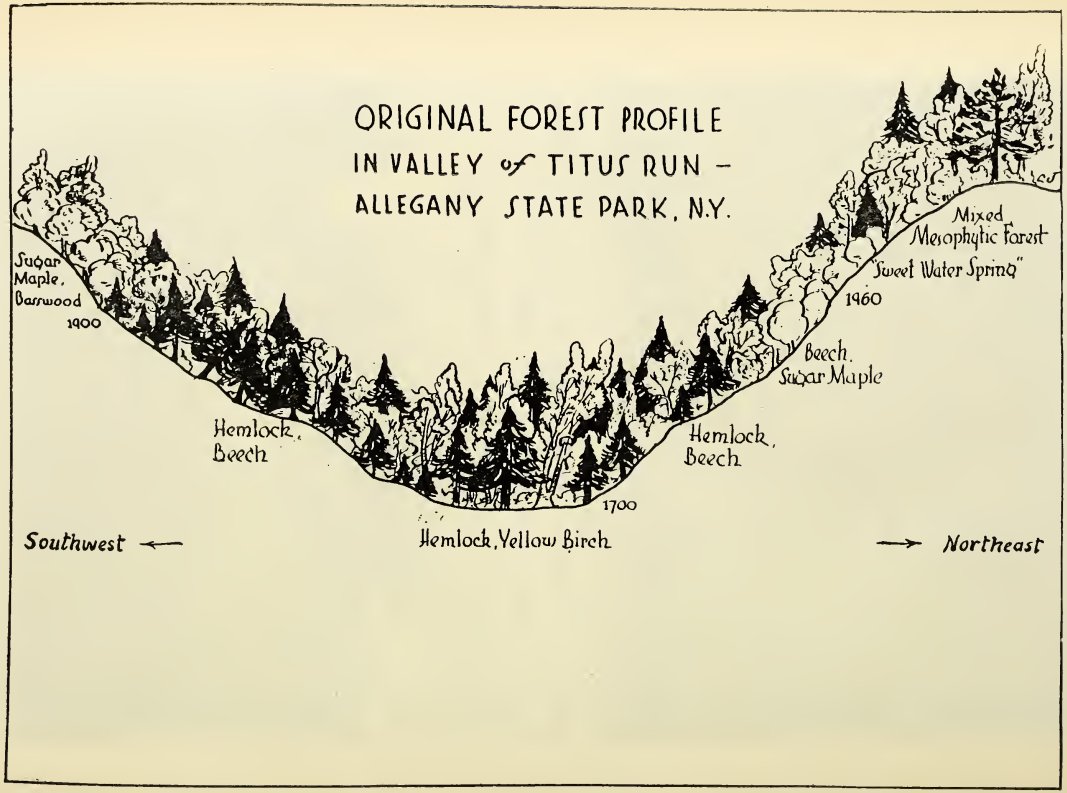

Figure 177 Original forest profile. Valley of Titus run. Sketch by Louis Jacobson from data furnished by R. B. Gordon.

and leads up a very steep slope to the summit of the hill. Most of the lower slopes are clothed with hayfields or pastures, but the steep upper slopes are still in forests. On the north and northeast-facing slope we find today a forest of the Sugar Maple-Beech type, and on the southwest-facing slope a thicket of the Aspen-Red Maple type. According to M. M. Moffitt, of Salamanca, whose farm is located in the valley of Titus run, the hollow on both sides was formerly covered with a solid stand of Hemlock, with Sugar Maple, Beech, Basswood and White Ash on the upper slopes facing north and northeast. On a spur above the site of Sweetwater Springs, on the Scenic road, Chestnut and Red Maple grew in mixture with Red Oak and Hemlock. The evidence strongly indicates that originally a Mixed Mesophytic forest covered the summits and slopes with a southwest aspect, above the spring horizon, about 1900 feet in altitude (figure 177).

The northern hardwoods, Sugar Maple, Beech, Basswood and White Ash, were situated above the spring horizon on north-facing slopes, where they were temporarily not under the influence of the water table. The Hemlock stand was located below the "springy places," where soils were cold and water-logged. Even today these soils support chiefly timber or sparse pasturage.

VALLEY OF BREEDS RUN

Breeds run also has its source on Parker hill, flowing westward for about a mile and then northwestward, emptying into the Allegheny river at the Indian village of Shongo. The upper portion of the valley lies outside the Indian Reservation. The distribution of vegetation on its slopes illustrates an important principle of mountain geography. The *north-facing slope* is entirely forested

Figure 178 Colony of Trembling Aspen invading an old field of Wild Oat Grass and Goldenrod. West-facing slope of Breed's Run valley, looking northward.

Figure 179 Thicket of aspens, with characteristic undergrowth of Bracken Fern and Goldenrod.

with a Sugar Maple-Beech forest which merges into a Hemlock-Beech-Yellow Birch type on the lower slopes. The *south-facing slope* is covered with open hayfields below, and with forests of the Aspen-Red Maple and Oak types above. Primarily these differences in vegetation are brought about by differences in solar radiation on the two slopes. In summer the sun's rays strike the south-facing slope almost perpendicularly. The effect is that of the sun in a tropical region. The north-facing slope always receives the slanting rays of the sun or no direct sunlight at all, and therefore is always much cooler and moister. In winter, snows melt rapidly on the south-facing slopes, but remain long on the north-facing slopes.

Irving J. Nies, of Salamanca, states that the valley of Breeds run originally contained a great amount of White Pine, as indicated today by Pine stumps of considerable size scattered in the woodlands. Many of them have been badly charred at the base, but have been preserved for at least 40 years.

A hayfield at Mr Nies's camp (To-nis-cah) faces the southwest. When observed on August 27, 1932, the field contained principally the common meadow grasses such as *Phleum pratense* and *Danthonia spicata,* mixed with Goldenrods and other weed species. These included *Solidago juncea, S. bicolor, S. caesia* and *S. rugosa, Pteridium latiusculum, Aster schreberi, Anaphalis margaritacea* and *Waldsteinia fragarioides.* The Goldenrods and Bracken are followed, where fields lie fallow, by Prairie Willow (*Salix humilis*) and an aspen thicket (figures 178 and 179).

Near the head of Breeds run is an interesting rock slide of sandstone conglomerate, which approaches in appearance a "petran" or rock desert (figure 180). Haircap

Figure 180 Soil in the making. A rock slide near the head of Breed's run.

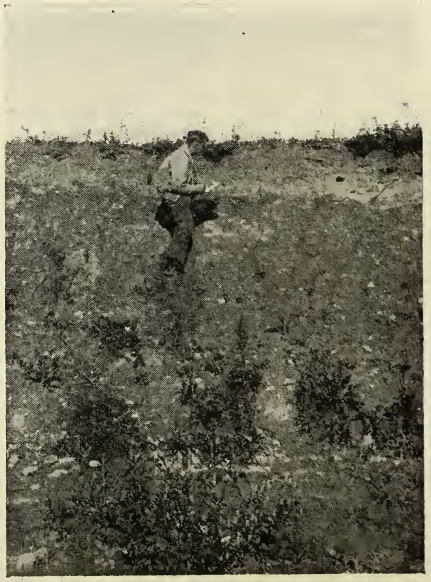

Figure 181 Soil in the making. A gravel terrace in the Allegheny River valley near Red House.

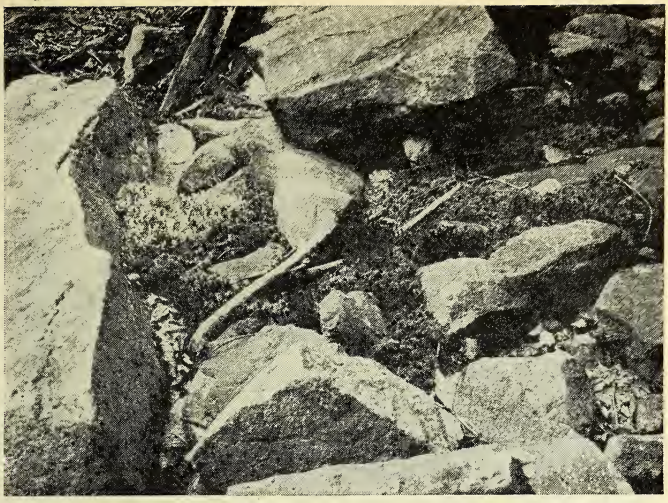

Figure 182. Pioneer plants on a miniature rock desert. Xerophytic mosses and lichens begin growth in the crevices. Such plants may dry out so completely that they may be crumbled into powder. With the coming of rain, they readily absorb water and grow.

Figure 183 The whitened thalli of the Reindeer Lichen (*Cladonia rangiferina*) forms a striking contrast to the dark mats of Haircap Moss (*Polytrichum commune*) with which they are frequently associated

Moss (*Polytrichum commune*) and Reindeer Lichen (*Cladonia rangiferina*) grow in abundance on these rocks (figures 182 and 183). The vascular plants here are *Lycopodium annotinum, Pteridium latiusculum, Rhus typhina, Betula lenta, Castanea dentata, Magnolia acuminata, Populus tremuloides* and *Acer rubrum.*

LOWER RED HOUSE VALLEY

The valley of Red House brook broadens out perceptibly below the mouth of Bova creek. This marked change in physiography is explained by the fact that the lower portion of the valley was once the bed of a glacial lake (Lobeck, 1927), due to the blocking of its outlet by glacial débris carried by the Allegheny river. As a natural consequence, the valley was silted up in the temporary slackwater stage of the brook at that time. The silts appear to be underlaid with gravels, which fill the valley to a considerable depth (figure 181).

The original forest in the lower Red House valley must have contained considerable White Pine, if one can judge by the stumps to be seen in the wet meadow surrounding the Balsam swamp (figure 186). Practically the entire valley bottom is now cleared. Some of the best farmland within the limits of the park can be found here today.

A splendid dam has recently been built across the valley, just north of the Administration Building. A beautiful artificial lake now occupies the valley above the dam (figure 184). It is about three-quarters of a mile in length and about half a mile across its widest portion. Altogether it covers perhaps a little over a hundred acres. The lake receives drainage from upper Red House creek and its major tributaries, Bova, Bee Hunter's, Stoddard and McIntosh creeks. Due to grading operations, its margins

Figure 184 View across the western end of the artificial lake in Red House valley, near the Administration Building

Figure 185 View of the artificial lake in Red House valley. The valley of Bova creek can be seen in the distance. An Aspen forest covers the slopes on the left.

are practically bare of vegetation, excepting a few ruderal species which are beginning to colonize the banks of shaly gravel (figure 185).

The north-facing slopes of lower Red House valley are within the area surveyed by L. A. Kenoyer in 1929, and are covered principally with a Sugar Maple-Beech forest. The south-facing slopes are covered for the most part by forests of the Aspen-Red Maple type and, nearer the Allegheny river, by forests of the Oak type, all second-growth.

THE BALSAM SWAMP

What is perhaps the most unique community within the Allegany State Park boundaries is the little Balsam swamp in lower Red House valley. It can be readily recognized from the road by its distinctive appearance, given by a small group of evergreens, including Hemlock, Balsam Fir and stunted specimens of White Pine (figure 187). A description of its flora has already been published by House and Alexander (1927) and the composition, by per cent, of the different trees in the swamp has been determined by Taylor (1928), who regarded it as "an interesting relic rather than a significant forest type."

The top soil in the swamp is black muck, formed of decomposed peat mixed with some fine silt or clay. Due to evaporation and to a lowered water table, the muck has dried out considerably; this organic layer is now only six to nine inches in depth; formerly it may have been one and one-half to two feet in depth. Below the black muck layer is a subsoil of gray silty clay about 18 inches in thickness. Beneath the silty clay layer is a bed of clay flecked with yellow and rust-brown, and containing small concretions of limonite or "bog iron ore."

Figure 186 White Pine stumps in a poorly drained "flat" east of the Balsam swamp in lower Red House valley. The Balsam swamp is the small colony of conifers in the background.

Figure 187 The Balsam swamp is only a remnant of a boggy strip of forest which extended for more than two miles westward and northward into the Allegheny River valley, in the vicinity of Red House, N. Y. (See map, figure 188)

The black muck in the Balsam swamp has the highest water-holding capacity of any of the soils which Taylor tested to determine the relation of soil moisture capacity to the distribution of vegetation in the park (*loc. cit.*). He found this organic soil capable of holding nearly twice (196.9 per cent) its own (oven-dry) weight of water. It was also acid in reaction. I found the clay subsoil very acid, also. As Taylor remarked, the occurrence of Balsam Fir . . . "is response to a soil condition observed nowhere else in the park."

My own observations of the vegetation in the lower Red House valley lead me to conclude that this Balsam swamp is a small remnant of a more extensive bog forest or White Pine "flat," such as those which formerly occu-

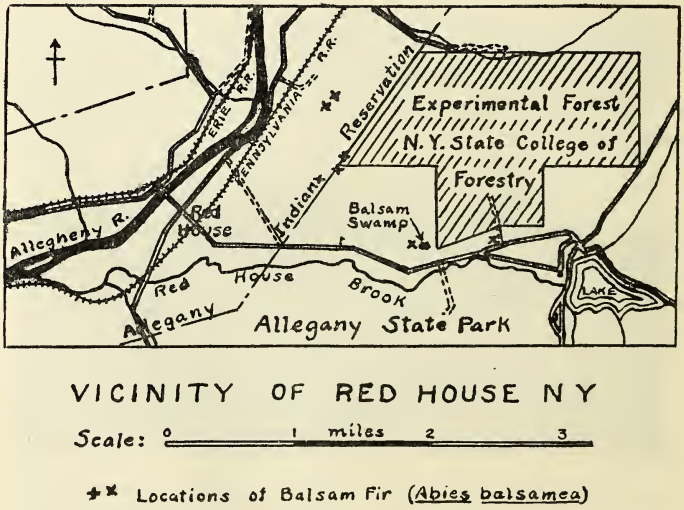

Figure 188 Map showing localities where Balsam Fir (*Abies balsamea*) occurs in the vicinity of Red House, N. Y. (1932)

pied poorly drained areas throughout the upper Allegheny River valley and the valleys of its larger tributaries. As evidence, one can see the charred stumps of White Pine in the wet sedge meadow adjoining, just east of the Balsam swamp. Furthermore, Balsam Fir trees can be found in other localities throughout a continuous swampy area more than two miles in extent, as shown in the sketch map (figure 188).

HIGHLAND FARMS ON PARKER HILL

As a general rule, farming in a dissected plateau region, such as Allegany State Park, is confined to the valleys and lower slopes, particularly on those with southern exposure. Where topographic features are favorable, however, farmlands are developed on rolling uplands as well. Such is the case on the summit of Parker hill, in the headwaters of McIntosh creek. The general slope is in a southerly direction, and several farms were located here. Ten are shown on the topographic sheet of the Salamanca quadrangle (edition of January 1900, reprinted December 1913). At the present time all but two have been abandoned; one of these is apparently used only as a residence. The last farm is devoted to dairying, but Oats, Potatoes and Hay are also grown on a restricted scale (figure 189). Some of the abandoned farmlands have been reforested with pines, Scotch Pine being used chiefly for planting (figures 191 and 192).

THE EXPERIMENTAL FOREST

In addition to the park property "the State owns slightly more than a thousand acres of land within the park purchase area south of Breeds run and at the head of a small stream flowing into Red House creek. This parcel of land

Figure 189 Summit of Parker hill, showing a typical upland farm in this area

Figure 190 A view of the extensive forests in the Allegany State Park, from the fire tower on Parker Hill summit, looking southward toward the headwaters of Red House brook

Figure 191 Parker Hill summit, the headwaters of McIntosh brook. Many of the abandoned farms have been reforested with pines.

Figure 192 A plantation of Scotch Pines on Parker Hill summit

is designated on the plan 'State Forest Experiment Station.' It is owned by the New York State College of Forestry, at Syracuse University, and is used as an experiment forest" (Francis, 1922) (figure 188).

The southern portion of this tract is covered with forests of the Aspen-Red Maple and oak types, containing scattered White Pine. These forests are mostly second growth, but a few small patches of mature timber are to be seen in the eastern portion of the tract. Improvement thinnings have been made as experimental projects, with the results that the stands appear to be in better condition than elsewhere in the park.

The senior camp of the New York State College of Forestry was located on this tract in 1926. Above the camp site the forest consists principally of Large-toothed Aspen, Trembling Aspen and Red Maple, with scattered specimens of White Oak, Red Oak, Chestnut, Shagbark Hickory, Pignut and White Pine. The aspens form a continuous crown cover and act as "nurse trees" to those of greater commercial value. The undergrowth consists of small trees and shrubs, including *Sassafras, Amelanchier, Crataegus, Ostrya virginiana, Hamamelis virginiana, Corylus rostrata, Azalea nudiflora, Viburnum acerifolium, Diervilla lonicera, Vaccinium vacillans* and *Smilax hispida.*

The ground cover consists of species characteristic of the oak forest elsewhere in the park. They are growing on stony soils derived from siltstones and shales, highly acid (pH5.0 or less), and exposed to the afternoon sun. A list of species found here include *Gaultheria procumbens, Pteridium latiusculum, Epigaea repens, Mitchella repens, Lupinus perennis, Pedicularis canadensis, Solidago bicolor, Cimicifuga racemosa, Chimaphila umbellata, Pyrola rotun-*

difolia, Pyrola secunda, Lycopodium obscurum, Dasystoma laevigata and *Lysimachia quadrifolia.*

The forests on the college property serve to illustrate beautifully the difference in forest types on north-facing and south-facing slopes. A steep ridge separates the tract into a northern portion, on the north-facing slope of Breeds Run valley, and a southern portion, on the south and southwest-facing slopes of the valley of Red House brook. The forest of the northern portion of the tract consists of second-growth hardwoods of the Sugar Maple-Beech type, and grades into a Hemlock-Beech type near Breeds run. The forests of the southern portion are the Aspen-Red Maple and Oak types.

SUMMARY

The northern section of the Allegany State Park includes within its boundaries an area of slightly more than 14,000 acres, of which one-third consists of open farmlands, old fields and clearings. Another third is covered with a temporary forest in which aspens, Red Maple and Fire Cherry are most abundant. The remaining third is forested with hardwoods of the Sugar Maple-Beech type and of the Oak type, mostly second growth. Statistically, these are distributed as follows:

Type of Vegetation	*Acres*
Aspen-Red Maple forest, temporary type	4 860
Farmlands, old fields and clearings	4 520
Sugar Maple-Beech forest, mainly second growth	2 200
Oak forest, mainly second growth, including also some Mixed Mesophytic forests	1 650
Bottomland Swamp forest (deciduous type)	850
Beech-Sugar Maple forest (mature timber)	70
Total	14 150

In order to obtain an adequate concept of the different kinds of vegetation in this portion of the park, the following excursions are recommended:

1 **Bova Creek valley.** From Y. M. C. A. Camp Fancher (now *Sprucelands*) in lower Red House valley, a trail leads through an old field for about a quarter of a mile into a small thicket of Willows and aspens which conceal a beautiful tract of primeval forest. Bova creek flows in a rocky bed through this woodland, which consists chiefly of Hemlock, Yellow Birch, Beech and Sugar Maple. The ground cover of Wood Ferns and *Lycopodium, Mitchella, Maianthemum* and *Oxalis* is especially luxuriant here, due to the presence of deep raw humus and the heavy shade under the Hemlocks and hardwoods. Good examples of the Sugar Maple-Beech type, which has resulted from cutting the original forest, can be found on the north-facing slope adjacent to this tract (figures 163–65).

2 **Parker Hill summit.** From Salamanca the Scenic road ascends Parker hill past Sweetwater Springs and the fire tower to an open area which was formerly all farmland. Extensive plantings of Scotch Pine have been made on the abandoned farms in this locality, with the idea of protecting the watersheds. From the fire tower on the summit, a splendid view can be obtained of the Allegheny River valley in the vicinity of Salamanca, and the forested expanse to the south and southwest, which is Allegany State Park (figure 190).

3 **The experimental forest.** From the Red House entrance to the park a road leads up the valley of Red House Creek to the Administration Building and the lake. About 1.5 miles from the boundary of the Indian Reservation the road forks. Just beyond, on the north fork (turn

left), an unimproved dirt road leads through a swamp thicket to the 1926 senior camp site of the New York State College of Forestry, which owns about 1100 acres to the northward (figure 188). A foot path leads westward from the camp site up the hill a short distance to an old lumber road. Here one can see examples of the Oak forest, which has apparently replaced an Aspen-Red Maple temporary type. The soil here is highly acid, and a number of (Ericaceae members of the heath family) are to be found in the undergrowth and on the forest floor.

4 **The Balsam swamp.** Lying north of the road in an open field just a half mile east of the Indian Reservation in lower Red House valley is the little patch of bog conifers which is known as the Balsam swamp. A short walk of an eighth of a mile across an open meadow will bring one to the swamp. Here one can find the bog conifers, Balsam Fir, Hemlock and White Pine, and a number of bog shrubs, beneath which are bog mosses, Creeping Snowberry, liverworts and lichens which find this a favorable habitat (figures 186–88).

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THE RELATION OF VEGETATIONAL SURVEYS TO A STATE PARK MANAGEMENT POLICY

(Figures 193–216)

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CONTENTS

INTRODUCTION

On May 2, 1921, Nathan L. Miller, then Governor of New York, attached his signature to a bill authorizing the establishment of a state park in western New York, to be known as the Allegany State Park. This park is located in the southern portion of Cattaraugus county, and comprises about 65,000 acres of unglaciated plateau, heavily wooded, the abode of such wild life as the White-tailed Deer, Black Bear, Porcupine, Varying Hare, Ruffed Grouse and Hermit Thrush. It is surrounded by the picturesque Allegany Indian Reservation, along the Allegheny river, where live the descendants of the Seneca Nation. The park is the largest area of state-owned land in western New York and is readily accessible from Buffalo and Rochester.

The bill establishing the Allegany State Park provided that "All of the lands . . . acquired by the state for such state park shall be forever reserved and maintained for the use of all people, but the said Allegany State Park shall not constitute a part of the forest preserve." (Section 1)

According to law, the State Park Commission has practically supreme power to acquire necessary lands and to maintain them for use as a public park. It is its duty to preserve, care for, lay out and improve the park, to construct and maintain roads and pathways over the park, to dam the streams therein, except the main stream of the Allegheny river (Section 9). The commission is further empowered to provide for the protection and propagation of fish and game and for the reforestation of the park. It can make regulations and rules for the purposes of fire, game and fish protection, including the establishment of

closed seasons for fish and game within the park. (Excerpts from the Laws of New York, chapter 468, 1921)

Aside from the rules and regulations which have been made by the Allegany State Park Commission to control hunting and fishing, to prevent forest fires, to preserve the native vegetation and wild life and to protect public health and safety, there are apparently no definite policies adopted to guide the commission in its administration of this great area. The object of this article is to offer certain suggestions which may serve as a guide to those who have it within their power to determine the policies which shall govern and protect nearly 100 square miles of heavily forested land as a playground, recreational and educational center for the thousands of vacationists who flock to its wooded hills.

It is the author's opinion that applications of technical and scientific studies should be made promptly, wherever possible, to benefit human society, particularly when society contributes to the support of such studies. For this reason certain recommendations will be made which bear upon park policies, particularly with regard to zoning. It is to be expected that *any management policy based on technical and scientific information should prove more substantial than one which may be based mainly on general opinions, guesses or traditional procedures.*

SCOPE OF THE BOTANICAL STUDIES IN ALLEGANY STATE PARK

Botanical studies in Allegany State Park have been carried on over a period of nine years. They have resulted in the publication of the Flora of the Allegany State Park Region (House and Alexander, 1927) and the Vegetation of the Allegany State Park Region (Taylor, 1928). A

more detailed ecological survey of the park has since been carried on by the New York State Museum for five seasons of two months each, July and August of each year from 1928 to 1932. A further season was necessary to correlate the studies of several persons engaged in the survey and to complete the necessary manuscript reports, maps and other illustrations for publication. The methods used were those in general use by botanists who are devoted to that particular branch of the science known as plant ecology.

"The most practical phase of biology is that which deals with the relations of other living organisms (both plants and animals) to man, and ecology is the study of those relations" (Kenoyer, 1933, p. 18). The general field of ecology is even broader, however, including the relations of plants and animals to their environment and to each other. By the application of ecological methods, using plants or plant communities as indicators of local conditions, ecologists can tell fairly well the uses to which many undeveloped lands are best suited (Gordon, 1932; Kenoyer, 1933). See also the first article in this handbook.

The present ecological survey has resulted in the preparation of a vegetational cover map of the Allegany State Park and part of the adjacent Indian Reservation to the Allegheny river on the north and west, and to Tunungwant creek on the east. The cover types recognized and mapped by botanists are described in this handbook. They are named as follows:

1 Sugar Maple-Beech type, mainly second growth
2 Hemlock and Beech-Sugar Maple type, mature timber
3 Aspen-Red Maple type, all secondary growth
4 Oak type, mainly second growth
5 Open areas, farmlands and old fields

Each one of these cover types not only has a different vegetational covering, but has had a different vegetational history, and differs especially from the others in the environment which it creates for plant life and animal life including human uses. It is therefore of much importance to take the cover types into account in every comprehensive plan involving forestry practice, wild life management and recreational uses. *There is no single system of wild life and park forestry management which can be applied successfully to all of these types of vegetation.*

The reasons are not difficult to find. Let us consider only two outstanding examples in the Allegany State Park. The Oak forest and the Sugar Maple-Beech forest types are decidedly different in respect to their conditions of soil moisture, temperature, shade, humidity, density and composition of the stand, and of the undergrowth. Plants and animals are extremely sensitive to such differences, much more so than is ordinarily supposed.

The Oak forests in the park and elsewhere are richer in the number of edible wild fruits than are the dense shady stands of second-growth Sugar Maple and Beech. Blueberries, blackberries, raspberries, wintergreen berries, acorns, hazel nuts and hickory nuts are practically limited to the Oak type of forest. On the other hand, the soils are subject to seasonal droughts. Springs are scarce or lacking, so that the water supply is an important phase of the problem. Extreme temperatures are the rule, as Taylor has shown (1928).

The Sugar Maple-Beech forests are poorer in variety and quantity of edible wild fruits, on account of the fact that most of the plants which produce them are not able to survive in the deep shade of the Sugar Maples. Even Partridge Berry (*Mitchella repens*), which is abundant

in the Sugar Maple-Beech type of forest, fruits more plentifully where it is exposed to increased light intensity. The soils in this type of forest have a higher moisture content, especially where Hemlock and Yellow Birch are found in the stand. Hemlock and Yellow Birch occur principally below the springs horizon, and these springs feed mountain brooks, where wild life can secure water. In the winter months Hemlock trees are important in furnishing cover for wild life, when the ground is elsewhere covered with snow. Any silvicultural or wild life management program should recognize this fact and should include plans for restoring the Hemlock as nearly as possible to its former abundance in areas now covered by the Sugar Maple-Beech forest.

APPLICATIONS TO THE SELECTION OF CAMP SITES AND PICNIC GROUNDS

At first thought it may seem rather out of place to take into account the vegetation in relation to the selection of recreational areas. Perhaps a division of park vegetation into fields and woods may be considered adequate. Observations on the choice of camp sites show that the majority of persons who come to the park for such purposes prefer to camp in or near the woods. For a *tent* camp, the woods is not a desirable location, particularly if it is a shady forest of the Sugar Maple-Beech or Hemlock-Yellow Birch type, for two reasons: first, after a rain or heavy dew, the humidity and air circulation is so poor that tents and objects inside fail to dry out readily, with the result that tents, clothing and bedding remain damp, food and leather goods become moldy, while iron and steel objects become rusty in a very short time; second, there is always danger from falling trees and branches in a high forest of

these types, especially where decay is rapid and where storms may strike. On the other hand, a Pine woods or an Oak forest is much better suited for tent camping, because it is naturally more open and better ventilated, and the trees are generally less subject to damage by windstorm. An open field or clearing is on the whole much more suitable for tent camping than a shady forest.

Where cabins are used and equipped with stoves or fireplaces, the effects of moisture and storm damage can to a large extent be overcome. Most of the cabins in the park, and certain of the more popular "trails," as cabin groups are locally called, are placed in forests of the Sugar Maple-Beech or the Hemlock type. Some thinning of sprouts and saplings and trimming of the lower branches and shrubbery have aided materially in better ventilating the dwellings. It is suggested that cabins and group camps which are not favorably located be moved to other more suitable camping areas.

The selection of picnic grounds and their improvement is another problem toward which a knowledge of vegetation and human behavior indicates a solution. Since picnics involve the concentration of people in a small area it is obviously not advisable to locate them in places where there is danger of injury to forest undergrowth. The location of a picnic grounds in a primeval forest (for example, Heart's Content and Cook Forest, in Pennsylvania) can not be too strongly condemned, since the trampling of many feet destroys undergrowth and compacts forests soils to a degree that makes afforestation next to impossible. There are a number of areas where farms have been abandoned, where old orchards are standing, and where woodlots have been pastured so extensively that there are no longer young trees or herbaceous ground

cover. In such places the trees are usually far apart, with wide-spreading crowns, with several natural openings where trees have died and where the crowns have failed to close. Although shade is desirable in picnic places, equally important is adequate ventilation of the grounds, it can not be secured where there is a dense undergrowth of small trees and shrubs. Trimming the lower branches of the trees and thinning out small, defective or suppressed specimens are desirable in such places.

It should be kept in mind that when a place is once selected for a picnic ground it is not likely to revert to a valuable forest and may tend to become less beautiful with ensuing years, unless an effort is made to maintain its good appearance. For this reason, picnic grounds should be located *near* places of scenic interest, but *not in* such places. It would appear to be good policy to locate picnic grounds at least a quarter mile from the entrance to any natural history preserve, bathing beach or lake shore, although such places might well be within view of the grounds. It is seldom that picnic grounds must be limited to spots where good spring water is available, although this is admittedly a valuable asset. Some picnic grounds have merely grown up in such places. Water and sanitary facilities of course must be considered in the selection of a site.

In these days it is essential to provide parking for automobiles, and the parking space may require as much area as the picnic grounds. An open field adjoining the woods or an old orchard should furnish a most desirable location for a parking area and picnic grounds.

There are several places where park roads have been constructed over the plateau ridges, and where striking scenery has been opened up to view by thinning or clear-

ing the forest along the roadside and by trimming the lower branches. At such places the road should be widened, so that cars may turn out while their occupants enjoy the view. Receptacles for refuse should be provided, so that these places can be kept clean and sanitary and generally attractive.

APPLICATIONS TO THE PLANNING OF ROADS AND TRAILS

Too often the building of roads and trails is determined solely by engineers on the basis of slope, geological formations, and least cost per mile, with little or no attention to the effects on vegetation and wild life, or to the possibilities of making available attractive scenic features. Certainly this could be said of the old lumber roads, which followed the valleys, although this does not strictly apply to roads which have been more recently constructed. Some, indeed, such as the so-called "sky-line" or scenic road from Salamanca to the summit of Parker hill, fulfil the requirements of good highway engineering and of a good scenic route.

The Stoddard-English road provides a short route from the Administration Building at Red House to the Quaker Run camping area, but was not originally planned for its scenic value. The clearings which have recently been made near the intersection with the old Bay State road increases greatly its charm and interest for the traveler. The road through the Hemlock forest in Big Basin (Stoddard hollow) is impressive to most visitors. This road margin is being taken by a rank growth of Fire Cherry, briars and a host of roadside plants (figures 193 and 194).

It has been suggested that vegetation along the roadside and the undergrowth in adjacent forests be cleared

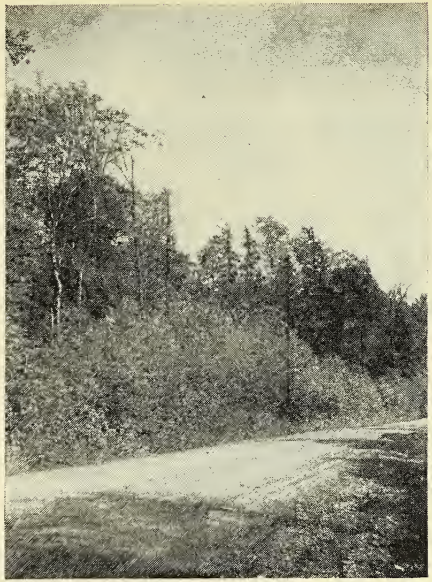

Figure 193 Roadside in Big Basin, showing small clearing where dead Hemlocks and Beeches have been removed. Nearly a pure stand of Pin Cherry has grown in this clearing.

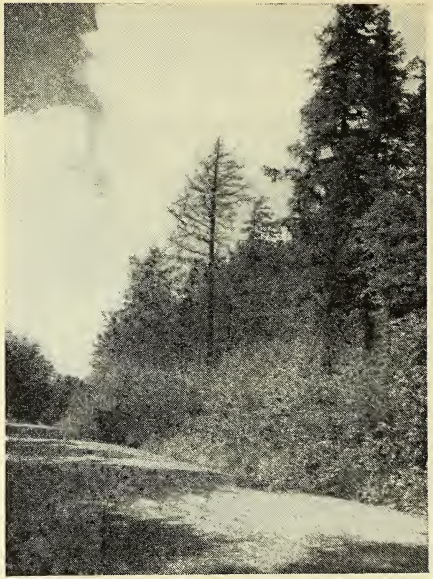

Figure 194 View along English-Stoddard road in Big Basin. Several large Hemlocks have died within the few years since the road was completed.

Figure 195 Observation tower erected on Drew hill, the watershed between Titus run and McIntosh creek, in the Allegany State Park

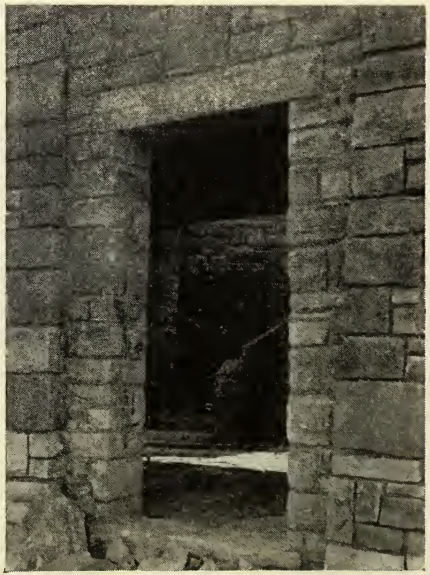

Figure 196 Architectural detail of stone tower shown in figure 195

away so that vistas can be opened up through the woods. If this project is started, it will probably have to be repeated every few years since the roadside growths will be replaced by vegetation of similar sort. The upkeep will involve considerable labor and expense. If, on the other hand, the roadside vegetation is allowed to grow undisturbed it will eventually be replaced by forest trees, Sugar Maple, Beech, Black Cherry, White Ash and Ironwood, which are more tolerant of shade than are the typical roadside plants. The shrub stage along the roadside is only a temporary one, and is naturally replaced by forest, as any one can observe along the older roads which traverse the park woodlands. Some patience is required in waiting for nature to heal the scars made by man in building roads through a region which was naturally forested.

Progress has already been made in the building of a "sky-line road" which follows the ridge east of Red House brook. This road was recommended originally by Professor Henry R. Francis, of the New York State College of Forestry. It will provide a short route through the park between the cities of Salamanca, N. Y., and Bradford, Pa. It will furnish excellent panoramas for travelers. If paved, it will take a large portion of the traffic from the valley roads through the camping areas. More people would visit the park if they could enjoy a paved highway, with frequent turnouts at places where splendid views of the park and the Allegheny River valley could be obtained.

A few more observation towers could be constructed at special points of vantage, like the one which has just been completed on the hilltop south of Titus run (figures 195–98). Another lookout is found at "Thunder Rocks," the masses of Olean Conglomerate which form

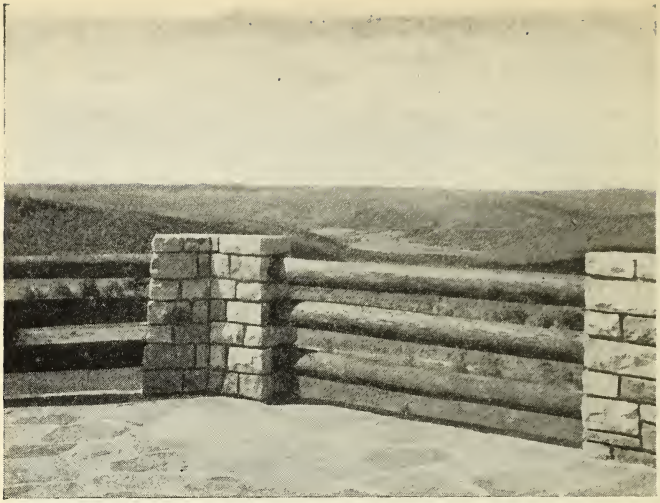

Figure 197 View southward from the observation tower on Drew hill, toward the Administration Building and artificial lake

Figure 198 View northward from the observation tower on Drew hill, showing the broad valley of the Allegheny river at West Salamanca

a small Rock City within the park and which are of unusual geologic interest (Lobeck, 1927). These rocks are close to the proposed sky-line road, and are easily reached by a short trail. The timber along the ridge top is all second-growth of the Oak and Aspen-Red Maple types. In fact, such a road would provide an excellent fire lane as well as an important route of travel.

Another method by which information from the ecological plant survey can be utilized is in trail construction. Hiking is one of the chief forms of recreation for persons who use the park in summer. Until recently the hiking trails through the forest have been blazed by the rangers, and have followed old logging roads and deer trails. Some of them are really excellent. In the past no special distinction was made between hiking trails, saddle trails and cabin trails. The trail to the "Bear Cave," for instance, is used both by persons on horseback and on foot. A more accurate use of these terms is desirable.

Allegany State Park enjoys the unique distinction of being the first park, as far as we know, to have a Natural History Trail. This trail was developed by William P. Alexander, field naturalist and director of the adult education department, Buffalo Museum of Science. In July 1921, when the park was first opened to the public, Mr Alexander conducted daily trips from the camp of the Buffalo Society of Natural Sciences to the Bear Cave. So popular were these trips that he conceived the idea of clearing a trail through the woods, one of which could be followed by campers without a guide, and on which *natural objects could be carefully labeled*, as in a museum. This is the distinctive feature of the Natural History Trail. From the first, the Natural History Trail was a great success and the idea has been widely copied in vari-

Figure 199 A fallen forest monarch. The trunk of this White Pine is about four feet in diameter and more than 160 feet long.

Figure 200 Trailside pool with aquatic plants designed and planted by Professor William P. Alexander, of the Allegany School of Natural History

ous parts of the United States (Bishop, 1928) under the name of the Nature Trail (see also Adams, 1910).

The first trail which was planned to incorporate both the desirable features of a hiking and a natural history trail was built in 1933 and 1934 on the sides of Blacksnake mountain and Mount Mohawk, encompassing the valley of Murray brook, near the Allegany School of Natural History. It was built by a squad of young men in the Civilian Conservation Corps (C.C.C.) under the direction of Mr Alexander, Lee Conway and Matt Huppuch. It is called the Allegany Hiking Trail. Plans were made at a conference of foremen from the C.C.C., park officials, and the staff of the Allegany School of Natural History in the summer of 1933. During the two following summers, Mr Alexander placed appropriate markers, at special points of interest along the trail, and added a large number of labels giving names of trees, shrubs, smaller flowering plants and fern allies (figures 200 and 202). He has in preparation an illustrated guide for the use of persons who follow the trail.

The trail begins at the school in an area of second-growth forest of the Sugar Maple-Beech type. Then it enters a forest of the Mixed Mesophytic type. Crossing the head of Murray brook, it passes through a beautiful stand of Yellow Birch and Hemlock. At the New York-Pennsylvania state line it encounters a bit of primeval forest where Sugar Maples, Beeches and Hemlocks of large proportions can be seen. Near here are a number of earthen mounds where trees have fallen in some great storm. One veteran White Pine trunk lying beside the trail is about four feet in diameter and over 160 feet in length, 75 feet to the first limb. It was truly a forest monarch (figure 199).

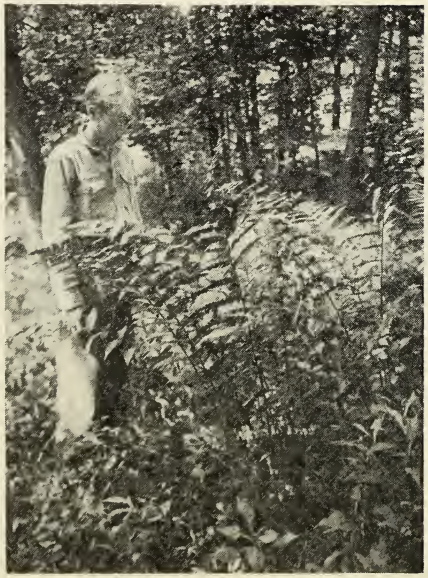

Figure 201 The native ferns are especially luxuriant on the moist carpet of the forest

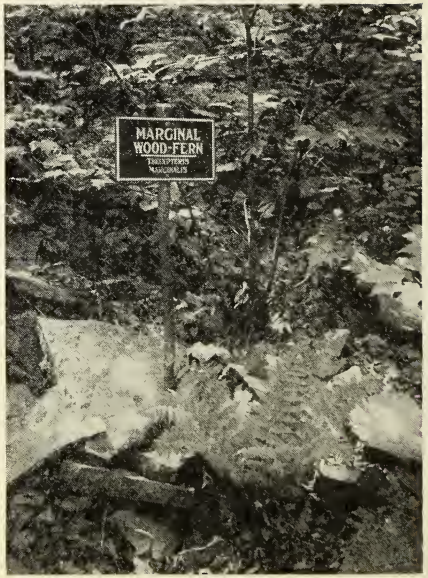

Figure 202 Trailside label used on the Allegany hiking trail

The trail descends through a second-growth hardwood forest to Murray brook where Yellow Birch and Hemlock again become prominent members of the forest community (figure 201). A short distance farther on the trail enters an old field of Goldenrod and Bracken with scattered aspens and Red Maples, which are pioneers on the site of an old "burn" (figure 203). Clearings have been made at two or three other places along the trail to enable the hiker to view the landscape. The variety of forest growth through which the trail passes was an important factor in determining its course.

There are other places in the park where such hiking trails could be constructed or improved, using the vegetation map as a guide, and including places of scenic and geologic interest. A boxed-in spring, rustic seats and trailside shelters, about a mile apart, might add to the comfort of the hiker, but restraint is needed, as conditions should remain simple and not involve much expense for maintenance (figure 204).

There is great need for walking trails to parallel the roads through the camping areas. This project has been advocated for many years by persons who spend their summers in the park. As the gravel and dirt roads are well-drained, they dry off quickly after each rain, and clouds of dust are raised by the automobiles. When traffic is heavy the dust is decidedly uncomfortable to pedestrians and at times really dangerous, because automobiles are obscured. A trail about four feet wide at a distance of several rods from the road and parallel to it, is highly desirable. It would give pedestrians a better appreciation of the beauties of the woodland, and would be far safer than the dusty roadsides. At present there is greater need of such trails than of any other kind.

Figure 203 A rustic bridge built by members of the Civilian Conservation Corps at the lower end of the hiking trail, over Quaker run

Figure 204 A boxed-in spring furnishes refreshment to the hiker on a warm day

NATIVE PLANT MATERIALS USEFUL IN LANDSCAPE IMPROVEMENT

Considerable interest is attached to problems of landscaping around cabins and other park buildings. Naturalistic effects can be realized with a great variety of plant materials, either by those native to the park, or exotics (figure 205). Naturalistic design in park improvement is an ideal worth striving for. It is not expected that we can improve much on nature in the Allegany State Park. The main problem is to heal the man-made scars. The ugly places that we see today are frequently the results of man's invention.

In a "wild park" such as Allegany, it is of considerable importance to know to just what extent, if any, nonnative trees and shrubs should be utilized for landscape planting.

As a matter of fact, the native species have shown their adaptability to climate and soil conditions of this region through the centuries. It should always be recalled, when nonnative trees and shrubs are planted in the park areas, that when these mature and produce seed they may be scattered into other adjacent areas which it is desirable to retain wholly wild and not to possess the nonnative kinds. This point needs much emphasis and has been neglected in the past. If the park nurseries grew only native trees and shrubs, that would be the simplest method of controlling a proper planting system. It will always be difficult to control the kinds planted if the material is derived from other sources. The following native plants are recommended for landscaping around park buildings and recreation centers. Many will be found suitable for roadside plantings as well, where such plantings are deemed desirable.

Figure 205 Conifers, both native and exotic, have been planted on the grounds of the new Fancher swimming pool in the Quaker Run camping area

Figure 206 *Crotalus horridus,* the Timber Rattlesnake, a species which has been nearly exterminated in western New York State. It is now confined to the extreme southwestern section of the park, in an area which has been recommended as a natural history preserve. (See map, figure 216)

Evergreen Trees

Eastern Hemlock	*Tsuga canadensis*
Pitch Pine	*Pinus rigida*
White Pine	*Pinus strobus*
Balsam Fir	*Abies balsamea*

Deciduous Trees

Red Oak	*Quercus borealis maxima*
Chestnut Oak	*Quercus montana*
Pin Oak	*Quercus palustris*
Red Maple	*Acer rubrum*
Tupelo	*Nyssa sylvatica*
Tulip-Tree	*Liriodendron tulipifera*
Cucumber Tree	*Magnolia acuminata*
Mountain Ash	*Sorbus americana*
Flowering Dogwood	*Cornus florida*
Shadbush	*Amelanchier canadensis*
Hawthorn	*Crataegus coccinea*

Evergreen Shrubs

Great Rhododendron	*Rhododendron maximum*
Mountain Laurel	*Kalmia latifolia*
American Yew	*Taxus canadensis*

Deciduous Tall Shrubs

Hercules'-Club	*Aralia spinosa*
Canada Elder	*Sambucus canadensis*
Red-berried Elder	*Sambucus racemosa*
Staghorn Sumach	*Rhus typhina*
Smooth Sumach	*Rhus glabra*
Mountain Holly	*Nemopanthus mucronata*
Winterberry	*Ilex verticillata*
Large-leaved Holly	*Ilex monticola*
Flowering Raspberry	*Rubus odoratus*
Witch-Hazel	*Hamamelis virginiana*
Withe-rod	*Viburnum cassinoides*
Nannyberry	*Viburnum lentago*
Alternate-leaved Dogwood	*Cornus alternifolia*
Panicled Dogwood	*Cornus candidissima*
Round-leaved Dogwood	*Cornus rugosa*
Shining Willow	*Salix lucida*
Prairie Willow	*Salix humilis*
Bebb's Willow	*Salix bebbiana*
Toothed Viburnum	*Viburnum dentatum*
Beaked Hazel-nut	*Corylus rostrata*
Pinxter Flower	*Azalea nudiflora*

Deciduous Small Shrubs

Dwarf Sumac	*Rhus copallina*
New Jersey Tea	*Ceanothus americanus*
Sweet Fern	*Myrica asplenifolia*
Fly Honeysuckle	*Lonicera canadensis*
Deerberry	*Vaccineum stamineum*
Dwarf Wild Rose	*Rosa carolina*

Tall Perennials

Joe-Pye Weed	*Eupatorium maculatum*
Tall Meadow Rue	*Thalictrum polygamum*
Black Cohosh	*Cimicifuga racemosa*
Culver's-Root	*Veronica virginica*
Hairy Angelica	*Angelica villosa*
Wood Lily	*Lilium philadelphicum*
Turk's-Cap Lily	*Lilium superbum*
Tall Coneflower	*Rudbeckia laciniata*

Medium-sized Perennials

Blue Flag	*Iris versicolor*
Blue Lupine	*Lupinus perennis*
Wild Blue Phlox	*Phlox divaricata*
Blue Cohosh	*Caulophyllum thalictroides*
Blue Wood Aster	*Aster cordifolius*
Yellow Wild Indigo	*Baptisia tinctoria*
Sneezeweed	*Helenium autumnale*
Cardinal Flower	*Lobelia cardinalis*
Bee Balm	*Monarda didyma*
Wild Bergamot	*Monarda fistulosa*
Turtle-head	*Chelone glabra*
Columbine	*Aquilegia canadensis*

Ferns

Ostrich Fern	*Pteretis nodulosa*
Sensitive Fern	*Onoclea sensibilis*
Marginal Shield Fern	*Thelypteris marginalis*
Common Wood Fern	*Thelypteris spinulosa* var. *intermedia*
Christmas Fern	*Polystichum acrostichoides*
Common Polypody	*Polypodium virginianum*
Interrupted Fern	*Osmunda claytoniana*
Cinnamon Fern	*Osmunda cinnamomea*

APPLICATIONS TO MANAGEMENT OF FOREST WILD LIFE

In 1921 Dr Charles C. Adams, the first director of the Roosevelt Wild Life Forest Experiment Station, prepared an article containing suggestions for the management of wild life in the Allegany State Park. In brief, Doctor Adams recommended: (1) several *Game Preserves*, in remote areas where there is the least disturbance of game by visitors and with the least risk to human life by accidental shooting; (2) a *Natural History Preserve,* where no hunting or angling should be allowed, and where plants and animals should be carefully protected in as near a natural state as possible (Adams, 1921, p. 69). "This area should be devoted mainly to the scientific, educational and recreational interests that cluster about natural history in all of its varied phases, as expressed in the popular regard for flowers, trees, birds, rocks, minerals, and fossils." It was further suggested that the Natural History Preserve should include within its boundaries a Natural History Sanctuary. "In this area should be preserved the best remaining fragments of the *virgin forest vegetation,* and these should be very carefully protected, not only from fire, but also from all other harmful influences" (Adams, 1910, p. 70). It has since been learned that there is no strictly virgin forest in the park, but there are several good examples of the old large forest trees.

Since the above suggestions were published by Doctor Adams, a central portion of the park, bounded by Red House creek and the Bay State road, has been designated as the Big Basin Game Refuge. On this refuge no hunting nor fishing is authorized. The Big Basin Game Refuge includes within its boundaries an area of more than 2000

acres of mature timber, a forest of Hemlock, Beech, Maple and Birch located in Stoddard hollow. (See second article in this handbook.)

With more intensive use of the park, the presence of three companies of members of the Civilian Conservation Corps, and growing interest in winter sports, the risk of lives by hunting accidents has become really serious. This only emphasizes the need of greatly restricting hunting in the park.

In 1929 a road was built from the Administration Building at Red House to the Quaker Run camping area that passes through the center of the Big Basin Game Refuge and divides the mature forest area almost exactly in halves. One of the results of building this road was the exposure of large forest trees, principally Hemlock, Beech and Yellow Birch, to roadside conditions. One after another these trees have succumbed; their naked branches and blistered trunks are prominently displayed along the road through Stoddard hollow (figures 193 and 194).

Recently some thinning operations have been carried on in the Big Basin forest, resulting in the removal of some big trees. Incidentally it may be mentioned that the only sawmill operated by the Park Commission is located at the lower end of Stoddard hollow, within easy access to the supply of big timber. This large and unique tract *is not at present protected specifically from destruction,* and there is always the danger that some future administration will sanction a lumbering operation in Big Basin for purposes of revenue, not realizing its immense value to the public who come to Allegany for a glimpse of the great forest which once covered western New York.

AREAS RECOMMENDED FOR NATURAL HISTORY PRESERVES

There is no other portion of the park which is so well suited for preservation as a *Natural History Preserve* as is the entire Big Basin area, including Stoddard hollow, with its large tract of big trees. This tract is by far the largest area of its kind in the park, and its vegetation is the sort that clothed the slopes of these verdant hills when Allegany State Park was the Indians' hunting ground. It provides a home for such interesting forms of life as the Varying Hare, the Pileated Woodpecker, the Winter Wren and the Wood Pewee (Saunders, 1923). It would probably take 300 years to replace a mature Hemlock forest such as the one in Stoddard hollow, in the heart of Big Basin.

It is recommended that the Allegany State Park Commission take decisive action to protect this beautiful forest for all time by designating it as the *Big Basin Preserve*, in which there shall be no fishing, no hunting, no timber cutting, nor introduction of exotic species of plants or animals. It should remain as nearly as possible in a natural state. Only in this way can permanent protection be afforded to the finest area of natural vegetation in the whole park.

A second area suitable for a Natural History Preserve is the area between the Wolf Run road and the Allegany Indian Reservation in the southwestern corner of the park. In recommending this area for a preserve, it should be emphasized that it is not suitable for a camping area. It is relatively inaccessible from the administration offices. Water resources are rather limited, and the bulk of the natural vegetation is of the Oak and Aspen types. The ridges are capped with sandstone blocks, and are covered with a

Figure 207 Entrance to temporary forest nursery at Frecks, in the Allegany State Park

Figure 208 A portion of the old forest nursery at Frecks. The peaks in the background to the north are known as the "Three Sisters".

flora which is decidedly unique, according to House and Alexander (1927). It furnishes habitat conditions, therefore, that are very different from those in the Big Basin. It is the only portion of the park which harbors the Timber Rattlesnake (*Crotalus horridus*), a species which has been nearly exterminated in western New York (figure 206). History does not mention that anyone has been bitten by rattlers in the park, and the viciousness of these serpents has perhaps been grossly exaggerated.

A third area which can be utilized most effectively as a Natural History Preserve is the relatively small area south of Quaker run, extending from the intersection of the Coon Run road to the intersection of the Bradford road. It adjoins the Alleghany National Forest and the Bradford Watershed on the south, and offers important natural advantages to many forms of wild life. It is within this area that the Allegany School of Natural History is located.

The Natural History Preserves will need no special administrative attention beyond adequate fire protection and patrol. Some labor will be needed to destroy a few plantings of conifers and other introduced forest vegetation, so that these areas will revert as rapidly as possible to "wilderness" conditions. Adams (1929) has defined the wilderness as a reservation *"set aside to allow nature to take her own course, with as little interference by man as is possible."* He discusses further the value of the wilderness under five heads: artistic, scientific, educational, recreational and economic. Adams emphasizes that the idea *"'to pass onto future generations natural conditions unimpaired'* is a very difficult undertaking... It cannot be assured until an eager, intelligent public sentiment is developed to support trained public officials. We cannot

maintain this standard in overcrowded parks, with inadequately trained staffs, with the importation of exotic plants and animals, fish and game, and with the inexpert control of predatory animals, the pollution of streams, grazing and the cutting of timber, or light burning, the excess of roads or even trails. Such measures can be stopped only when an informed public insist upon the maintenance of an ideal which has now been evolving for fifty years." The boundaries of all Natural History Preserves should be plainly marked and posted.

The remaining portions of the park, not included in the Natural History Preserves, actually make up 80 per cent or more of the total property and can be managed in such a way that the forests will continue to furnish good crops of timber, and a supply of game adequate to meet the demands of those who find hunting a pleasurable source of recreation.

AREAS RECOMMENDED FOR GAME DEVELOPMENT AND GAME SANCTUARIES

Compared with the number of persons who visit the park for camping, swimming, and attending picnics, the number who fish and hunt here is comparatively small. At the same time the park derives some income from the sale of fishing and hunting permits. This income each year is a rough measure of the value of fish and game in dollars and cents. In 1933, 600 hunting permits were issued in the fall and a bag of more than 5000 cottontails was reported. A wild life and forest survey of southwestern Cattaraugus county by Cahalane (1928) disclosed the fact that cottontail rabbits were abundant throughout the tract (p. 95). "Every suitable patch of young growth, especially along the roads, seemed to have its cottontail occupants." Since the park area is similar in many respects to the area sur-

veyed by Cahalane, it would appear that the thickets of aspen, old fields and clearings, with the included brush lands, may be considered as distinct assets to the park. It may be advisable to retain most of the open area remaining in the park to encourage game and to improve the landscape, rather than to attempt reforestation of such land, which seems to have been one of the earlier policies of the commission. Such areas should be more carefully studied with a view toward determining their usefulness in game management, before any new clearings are made.

There are two areas in the park which seem particularly suitable for game. They are already well stocked with game and should, under suitable management, be made even more productive. These areas are as follows:

1 Head of Rice brook and Irish brook *in the eastern section* of the park. Here there are open areas interspersed with brush and forest land of great diversity. Water is available from springs in this area at all time of the year.

2 Upper valleys of Bova creek, Christian run, and Leonard run *in the northern portion of the park.* It also provides a variety of habitat conditions, with water available at all seasons. It also is entirely possible that an intensive wild life management system, including the planting of special types of native food plants, will add materially to the present wild life population in the area. Certain favorable areas within those devoted to game should be made Game Sanctuaries where no hunting should be allowed. These Game Sanctuaries could be managed according to the Pennsylvania system, as Adams (1921) has already suggested. A central area, bounded by a single-wire fence (not barbed wire), waist high, marks the boundary of the sanctuary within which killing of game is not allowed, while the surrounding area is a public

hunting ground during the regular open season (John M. Phillips, 1920, quoted by Adams). The overflow of game from these sanctuaries would help to stock the hunting grounds. The wild life overflow from the Natural History Preserves would have the same influence and reinforce that from the Game Sanctuaries. *A trained wild life technician should be appointed to administer the game areas,* aided by the State Park rangers in the enforcement of necessary regulations.

There may be no particular objection to hunting in park forestry areas, but the forest supervisor should be authorized to close these areas to hunting, if in his opinion the hunters would create fire hazards or damage forest plantings. *In effect, approximately two-thirds of the park lands would remain open to hunting and fishing in season, the only exceptions being the Natural History Preserves,* which should be protected from fire and should be allowed to revert, as rapidly as their nature will permit, to wilderness conditions.

As has been said, with more intensive use of the park it is likely that hunting will, with the years, have to decline or become much restricted, and this should be borne in mind throughout this discussion.

RECOMMENDATIONS REGARDING STREAM IMPROVEMENTS

More than 500 fishing permits were issued in 1933 by the Allegany State Park Commission, and nearly 5000 Brook Trout were reported taken, averaging 8½ inches in length, besides nearly a thousand Rainbow Trout and about three hundred Brown Trout of larger size.

Several years ago a trout survey of the Allegany State Park was carried on by the Roosevelt Wild Life Experi-

ment Station, to determine as accurately as possible the trout population and stream conditions in this area. The following paragraph deserves quoting in this connection (Kendall and Dence, 1927, p. 467):

> Doubtless the maximum trout carrying capacity is considerably different from that when original conditions obtained. The question, therefore, becomes a biological problem, a more thorough understanding of present environment and outside influences than we have at present.

Cool mountain streams with alternating shady pools and riffles, where the water is well-aerated, furnish favorable conditions for trout. When the water becomes muddy, and when it is warmed by flowing slowly over a shallow stream bed in the open, its oxygen content is reduced, and other conditions prevail which are altogether quite unsatisfactory for Brook Trout. In the lower portion of Stoddard hollow, for instance, Kendall and Dence reported that there had been some clear-cutting of trees for chemical extraction purposes. At the time of their survey (August 17, 1922) they stated that "the water of the creek from this point to the mouth is too warm for brook trout" (*loc. cit.,* fig. 70, p. 423).

Much remains to be known concerning the food of Brook Trout, especially the small fry and fingerlings which are usually planted in the streams. It is generally assumed that they feed on microscopic plants, insects and other small animals (Muttkowski, 1925). During the year 1933 the streams of the park were planted with 19,500 native trout. Of this number it may be expected that a few hundred may grow to maturity, and the vast majority are not likely to reach legal size, since they are preyed upon by larger trout and parasites. Just how many of the small fry will survive or furnish food for larger game fishes will

depend on the supply of small water animals and insect larvae in the streams. Since the food of animals, no matter how small they are, must come eventually from plants, some attention should be given to the maintenance of aquatic plants and protection of streamside vegetation. Not only does this provide shade and shelter and prevent the washing of mud and sand into the streams after rains, but it also furnishes a supply of organic nutriments through death and decay of its foliage and other parts. The organic matter furnished by the decay of vegetation in streams is an important source of food for bacteria, diatoms, tiny animals and insect larvae, which in turn furnish food for the smaller fish.

These fundamental facts must be taken into account whenever a program of stream improvement is proposed.

Figure 209 Tree nursery recently established at Red House, in the lower Red House valley

In Michigan and a few other states trout streams are improved by placing of barriers of rock or logs and brush across the streams; these obstruct the flow and result in the gouging out of pools below the obstructions (Hubbs, Greeley and Tarzwell, 1932). The results, however, of these proposals should be considered as yet in the experimental stage, and have not yet reached the stage for broad policies of improvement. The authors wisely state (p. 51): "Really efficient stream improvement work depends to a large degree on having a trained crew of strong, willing and interested workers, well equipped, and superintended by a foreman who is thoroughly familiar with the improvement methods." There are some streams in the park that would benefit especially by the encouragement of streamside vegetation. At present great caution is needed in all matters of stream improvement, and it should be undertaken only under expert supervision.

SUGGESTIONS FOR THE PRACTICE OF PARK FORESTRY

Approxiately 625,000 trees, including seedlings and transplants, have been ordered from the State Conservation Commission for purposes of reforestation in the park. Hundreds of acres of open land were planted principally with Scotch Pine, White Pine, Red Pine and Norway Spruce during the period from 1923 to 1928. Two forest nurseries were also started, one at Frecks, in the valley of Quaker run, the other at Red House (figures 207–9). The object, as stated in the Sixth Annual Report of the Commissioners of Allegany State Park, was "the desirability of bringing the park back, so far as possible, to its primitive state, so that future generations may see forests as they were before the lumberman came"

Figure 210 Red Pines, Scotch Pines and Norway Spruces in planting near the Barton Trailer Camp, in the Quaker Run area, Allegany State Park

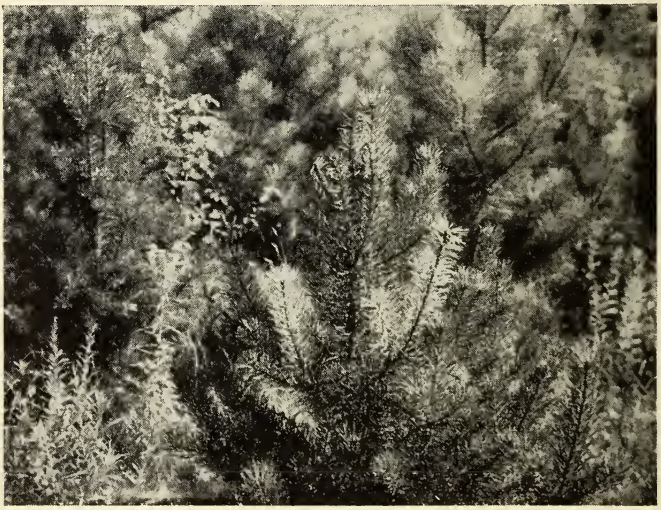

Figure 211 Upper portion of a Scotch Pine, showing weevil damage. The dead shoots turn brown and curl back.

(Fancher, 1927). Certainly this was a very worthy desire, and one in keeping with the original purposes in the establishment of the park. Let us see to what degree this objective was realized.

Of all the species which have been extensively planted in the park, only one, namely White Pine, was originally native to this region. Red Pine (or Norway Pine) did not occur in primeval forests, although the park is within its natural range in eastern North America. Scotch Pine and Norway Spruce were of course exotics (figure 210). Here is a very obvious case where a knowledge of the natural vegetation would have proved valuable to the commission in carrying into action a management policy.

CONIFER PLANTINGS ON OPEN LANDS

Let us see what has been the fate of the principal tree species planted in the park within the past ten years. All of the conifers have been planted in straight rows in open fields, a very common practice in reforestation work. The White Pine plantings have been severely injured by the White Pine Weevil (*Pissodes strobi* Peck.) to an extent which has made them almost worthless as a future source of timber (figure 213). Scotch Pine plantings also show severe injury from the weevils, especially where they were planted close to White Pines (figure 211). Norway Spruce appears also to be a favored host of the insects. Red Pine is much more resistant, and is only occasionally injured by weevils, according to authorities. The writer has found no weevil damage to Red Pines in Allegany State Park.

According to Graham (1926), "it has already been noted that the weevil is particularly abundant on young trees

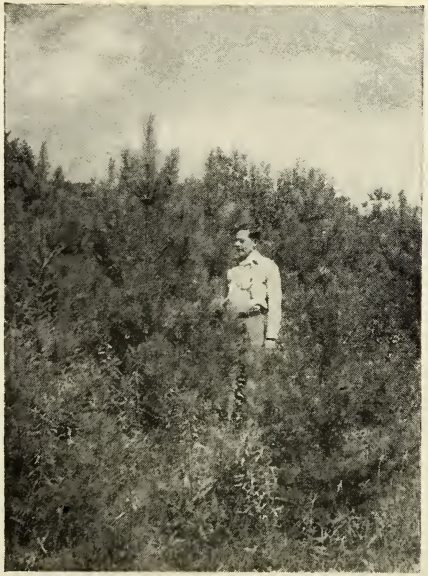

Figure 212 The author standing beside a nine-year-old Red Pine, at his right; an eight-year-old Scotch Pine in the foreground at his left, is scarcely half as large as the Red Pine

Figure 213 Shoot of White Pine, showing damage by the White Pine Weevil. Terminal buds are usually destroyed, and the leader is killed.

from five to twenty years old, and trees that are growing unusually rapidly." All students of the White Pine Weevil have noticed the insects' preference for trees exposed to sunlight, and that "weevil injury is invariably greatest in open pure stands of White Pine growing in full sunlight. In mixed stands, where hardwoods shade the pines, the injury is much less, and it decreases with increasing shade until it reaches the zero point under a shade such as that cast by an average stand of oak or maple."

"In view of these facts, which have been proved beyond a doubt, it would seem that some system of silviculture should be used which would provide shade during the susceptible period; that is, until the trees are about fifteen to twenty-five years of age or somewhere between twenty and thirty feet in height" (Graham 1926, p. 21–22).

It therefore appears that the planting of White Pine in pure stands in open fields has provided the best possible conditions for the White Pine Weevil. If mature White Pines are desired to be of commercial value, they should be grown under the "shelterwood system" of forestry. That is, they should be planted in the shade of hardwoods, preferably in stands of Aspen-Red Maple type which have reached an age of 20 or 30 years. It is interesting to note that in seminatural Oak forests of the park, natural reproduction of White Pine can be found showing comparatively slight damage from weevils. Finally, most of the White Pines have been planted in areas that should remain open, or on lands not intended for timber production.

RED PINE VERSUS SCOTCH PINE FOR PLANTING PURPOSES

General observations of conifer plantings in Allegany State Park point to the conclusion that the Red Pine

grows better than Scotch Pine. It seems to be making more rapid growth than Scotch Pine on all sites where it has been observed (figure 213). Also it has not proved susceptible to weevil injury, as has been previously noted. It can be grown practically in pure stands in the open, offers immediate protection against erosion of topsoil, and promises a fair return in merchantable timber. In the Adirondacks, in native stands, Red Pine reaches an average height of 58 feet and an average diameter of 8.3 inches 4½ feet above the ground at the age of 55 (Recknagel 1923, p. 84). It ought to give better yields in plantings than in native stands, where it no doubt suffers from competition with other species. Red Pine is, however, not approved for planting in the park on the grounds that it is not native to this region.

It may be desirable to designate certain portions of the park as Park Forests, where complete fire protection can be assured, and where there are open areas which can be planted. It is further recommended that all plantings of Scotch Pine and Norway Spruce in this park and the weeviled plantings of White Pine should be marketed as Christmas trees, if they can be so utilized. Otherwise, they could be readily destroyed by cutting and burning. It is questionable whether the Red Pine plantings, in a park devoted to recreation, should be permitted, since they occupy areas of distinct recreational value. Two areas are recommended for Park Forests, as follows:

1 Area south of Limestone creek, between the Red House to Bradford road and the Tunungwant. About 5400 acres (figure 214).

2 Area between Quaker run and Wolf run, between the Coon Run road and the Indian Reservation. About 4200 acres.

Both of these areas are located where there is a diverse forest growth and contain open areas where plantings can be made, as well as areas of Aspen-Red Maple which can be clear-cut for aspen reproduction or underplanted with more valuable timber species, such as White Pine or shade-tolerant hardwoods.

The Park Forest areas should be administered by the forest supervisor, who should also have complete charge of the forest nurseries, the planting of tree seedlings in the Park Forest areas, the establishment of fire lanes, supervision of fire wardens, and timber cutting in other portions of the park not in preserves.

NATIVE TREE SPECIES FOR USE IN SILVICULTURE

Only tree species native to Allegany State Park should be grown in the nursery at Red House, until they are large enough for transplanting in the areas designated for Park Forests. The planting, of course, should be done where environmental conditions are most favorable for the growth of each species. During the course of the ecological botanical survey, it has been observed that Hemlock reproduction is best where there is considerable shade, where there is seepage on the hillside, where swampy conditions prevail in the bottomlands, and where decayed wood is present in the forest litter. It is a mistake to grow Hemlock in open areas, or under Oak forest stands, or under Aspen stands unless they are located on moist sites. Yellow Birch and *Oxalis acetosella* are perhaps the most reliable indicator plants for good Hemlock establishment. The following suggestions for planting native tree species are given on the basis of observations made in the Park Forests:

1 For planting on dry sites covered with the Aspen-Red Maple type of forest, aged 20–30 years, under the shelterwood system of silviculture:

White Pine.....	*Pinus strobus*
Red Oak.....	*Quercus borealis*
White Oak.....	*Quercus alba*
Chestnut Oak.....	*Quercus montana*
Cucumber Tree.....	*Magnolia acuminata*
Yellow Poplar.....	*Liriodendron tulipifera*
Pignut Hickory.....	*Hicoria glabra*

2 For planting on moist sites covered with the Aspen-Red Maple type of forest, aged 20–30 years, under the shelterwood system of silviculture:

Black Ash.....	*Fraxinus nigra*
White Ash.....	*Fraxinus americana*
Cucumber Tree.....	*Magnolia acuminata*
White Pine.....	*Pinus strobus*
Hemlock	*Tsuga canadensis*
Balsam Fir.....	*Abies balsamea*

3 For planting on dry sites, covered with the Oak type of forest, under the shelterwood system of silviculture:

White Pine.....	*Pinus strobus*
Yellow Poplar.....	*Liriodendron tulipifera*
Cucumber Tree.....	*Magnolia acuminata*
Pignut Hickory.....	*Hicoria glabra*

From the foregoing recommendations it can be seen that the ideal to be realized here is a mixed stand. Toumey (1928, p. 338–39) states that "although the mixed stand is ideal, the practice both in the United States and abroad often has been to replace the original mixed stand with a single species. This has been particularly true of white

pine, red pine, western yellow pine, Engelmann Spruce and Douglas fir in the United States and Scotch Pine and Norway Spruce in Europe. The ease with which pure stands can be artificially established, their uniform and rapid juvenile growth and their early promise of yielding large financial return on the investment are important reasons for their formation." The objections to pure stands are typified by the disappointing results obtained with White Pine, Norway Spruce and Scotch Pine in Allegany State Park.

PRACTICE OF SELECTIVE CUTTING AND THINNING

In a region such as Allegany State Park, where a variety of forest industries have taken their toll of the big timber, where large tracts have been clear-cut and destroyed by fire, the park forester is confronted with a

Figure 214 View southward into the head of Limestone hollow, in the Allegany State Park. This is one of the two areas suggested for development of a park forest. Photograph by F. T. Thwaites.

difficult problem to change pure stands into mixed stands. There are two important kinds of pure stands which occupy extensive areas in the park, namely: (1) Aspen stands in the Aspen-Red Maple type; and (2) Sugar Maple stands in the Sugar Maple-Beech type. Each of these types of forest has developed in response to different treatment. Aspen stands now grow mostly where the original forests were clear-cut and burned, so that the humus has been destroyed. The Aspens and associated species, Red Maple and Pin Cherry, are not tolerant of heavy shade. Aspen and Pin Cherry are both short-lived and rapidly succumb to fungus diseases and to insect attacks. On the other hand, pure stands of Sugar Maple are usually the result of clear-cutting of Beech-Sugar Maple forests, with subsequent coppice growth and slight damage to the humus layer.

Obviously the same recommendations for selective cutting and thinning do not apply to both types of pure stands. Selective cutting in pure stands of Aspen is scarcely profitable until the stand is at least 20 years of age. Thinning operations should eliminate about 50 per cent of the Aspen, which can be utilized for pulpwood, boxwood and excelsior. Some Red Maple and Pin Cherry can also be utilized then for pulpwood and firewood, but it may prove more economical to leave them until the forest is about 30 years old, when some of the Pin Cherry will have died and decayed. Age 30 is perhaps the best time to thin the Aspen stands until the crown density reaches 50 to 60 per cent. Underplanting with more valuable timber species can be practised at any time between the 20 and 30-year stage of maturity. Red Maples and Aspens act as "nurse trees" until the planted species have grown well above the shrub layer in the forest. This practice

illustrates the shelterwood system of silviculture. It need scarcely be said that all commercially valuable species, if they are represented by thrifty trees of good form, should be encouraged in any thinning operation.

In some portions of the park set aside for commercial or economic forestry or for game management, it may be desirable to maintain the Aspen stands indefinitely by favoring sprout growth. Aspen reproduces mainly by sprouts from the roots of older trees and the best method of harvesting mature aspens is to cut the timber clear. "The production of sprouts is heavy, regardless of the season of cutting, and . . . in general the maximum number of sprouts is in evidence within a season following the removal of timber" (Sampson 1919, p. 23). It is generally bad practice to burn slash in an Aspen forest. Slash may be piled about the stumps of lopped trees. Old trunks, stumps and logs should be left to decay. For the most part they will furnish valuable humus, which is practically deficient in Aspen stands. Where aspens are found with an undergrowth of Sugar Maple and Beech, it is usually an indication of better humus conditions than in a pure stand of Aspen. There is every likelihood that, as the Aspen matures it will be replaced by Sugar Maple, in pure stand or in a mixture.

Pure stands of Sugar Maple present a more difficult problem in attempting to obtain a better mixture in the forest. This is due primarily to the heavy shade conditions on sites where Sugar Maple thrives. Few native tree species can survive in the shade of a dense stand of Sugar Maples, and their growth is very slow indeed under such conditions. Those which do survive are the most shade-tolerant species, namely Hemlock, Beech, Sugar Maple, Hop Hornbeam, and Blue Beech. Only Hemlock should

be planted under Sugar Maple stands, if Yellow Birch is also present. Thinning may be carried out to the extent of reducing the crown density to 50 per cent every ten or fifteen years (Dana 1930, p. 46–49).

Sugar Maple stands from 20 to 40 years of age can be depended upon to supply all the firewood needs of the park for years to come, if properly managed under the selection system (figure 215). In fact, enough cordwood may be obtained from thinnings to justify marketing some of it for the wood distillation industry, if such a market can be found. The principal species which should be utilized for fuel-wood are Sugar Maple, Beech, Yellow Birch, Hop Hornbeam and Blue Beech, obtained from thinnings. More valuable species, such as Black Cherry, White Ash,

Figure 215 Fuel wood is obtained from thinnings in a forest containing a large proportion of hardwoods. Big Basin Game Refuge.

Basswood and Cucumber Tree, should be left untouched, unless they happen to be of such poor form that they are not likely to produce a high grade of timber.

Live trees, damaged by boring insects or decayed fungus growth, should be selected by preference in improvement cuttings, but most dead trees should be allowed to stand. As a rule the insects and fungi which infest dead timber are not those which attack living trees. Dead trees provide nesting sites for Squirrels and such valuable birds as the Woodpeckers, Chickadees, Nuthatches and Wrens (Saunders 1923, 1929). These birds are important natural safeguards against outbreaks of destructive insects. Furthermore, as dead trees decay rapidly in forests of the Sugar Maple-Beech type, they soon add to the supply of humus on the forest floor, and insure regeneration of Hemlock. Any practice which favors the regeneration of the Hemlock forest in Allegany State Park should be given most careful consideration, since this is one way in which the park can be restored to its primitive state.

> "These historic and abandoned forests, once so important and productive, shall again and for all time serve the uses and betterment of mankind."

SUMMARY OF RECOMMENDATIONS

The preceding discussion indicates a number of possible uses which may be made of information obtained about Allegany State Park since 1921, when the park was established. In this connection it is well to recall a number of unique qualities which this region possesses.

1 It is the third largest state park in New York and the largest in western New York; perhaps it is the only wild

area that is likely to be developed in this part of the State.

2 It lies within easy driving distance of the second and third largest metropolitan districts of the State, namely, Buffalo and Rochester.

3 Its summer climate approaches most nearly to that of the Adirondacks, making it particularly suitable for summer camping.

4 The Allegany State Park region is the only large area of state-owned land in western New York with extensive forests containing "big trees," in which deer, bear, porcupine, beaver and similar wild life can be preserved and made available for the public to see under natural conditions.

5 It is the only state park in the United States concerning which there is such an abundant literature dealing with its natural resources, geology, vegetation and animal life. It can be compared only with Yellowstone and Yosemite National Parks in this respect.

The importance of the park as an area for camping, picnicking, hiking, fishing, sight-seeing and recreational education, can not be overstressed. It should be the major responsibility of the Park Commission and the citizens of the vicinity to guard jealously these unique features. There is no necessity for catering to city park developments, since these are municipal and private responsibilities rather than those of the State.

A zoning policy is therefore recommended as the first essential in administering this large state park (figure 216). The vegetational survey has shown that there is here a variety of natural and seminatural conditions which should be taken into consideration in zoning the park; some areas are much more suitable than others for certain kinds of plants and animals. A uniform treatment or

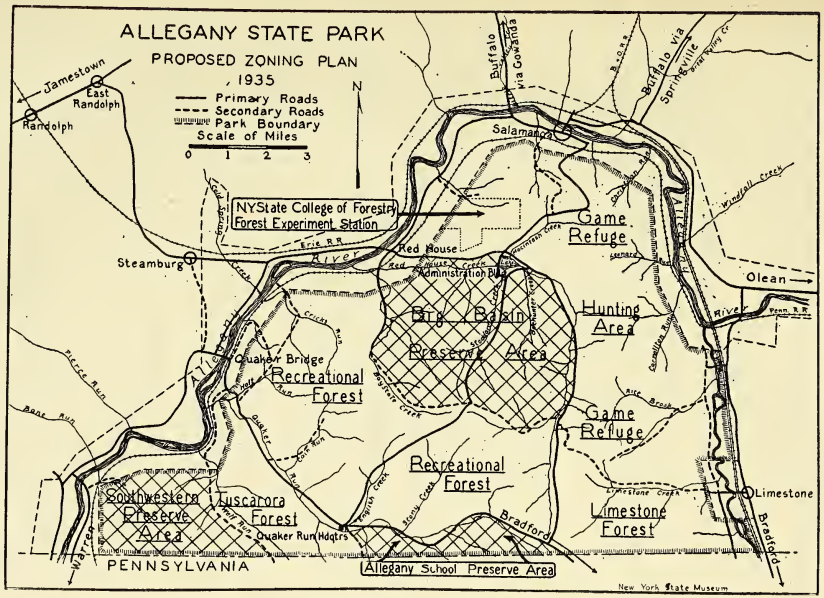

Figure 216 Map of Allegany State Park, N. Y., showing areas provisionally proposed as natural history preserves, forests and game preserves

policy for the whole park is sure to run counter to certain of these natural conditions within its boundaries. For ease of administration the zones should include:

1 *Administrative areas.* Lands used for highways and the administration centers, such as those at Red House and at Frecks, on Quaker run.

2 *Recreation areas.* Picnic grounds, swimming and bathing sites, and of special importance the camping areas.

3 *Natural History Preserves.* Certain areas will be of greatest value to the park if they are left in a wilderness state, where no hunting or fishing is allowed, and no cutting of timber or planting shall be permitted. These tracts should include the following:

a Big Basin Preserve area. The present Big Basin Game Sanctuary should be included in this preserve, bounded by Red House road and Bay State road. A limited amount of camping should be allowed only at the margins of this area, not far from the main roads which bound it, and at carefully selected sites.

b The Southwestern Preserve area. This tract is bounded by the Wolf Run road, the Pennsylvania state line and the Allegany Indian Reservation.

c The Allegany School Preserve area. This tract lies south of Quaker run, from the intersection of the Coon Run road to the intersection of the Bradford road, and is bounded on the south by the Pennsylvania state line.

4 *Game Sanctuaries and hunting areas.* These areas, devoted primarily to game management, should include large areas set aside as Game Sanctuaries, bounded by a wire, in which no hunting should be allowed. The overflow of game and other wild life from the Game Sanctuaries, is intended to help stock the remainder of the park, where hunting and fishing should be permitted,

under proper restrictions. The Natural History Preserves are also expected to fulfil this function. At least two areas are recommended for Game Sanctuaries subject, of course, to such restrictions on hunting as may seem wise, or perhaps its elimination:

a The Christian Hollow Game Sanctuary. The Game Sanctuary on this tract should include the headwaters of Christian run and Bova creek.

b The Rice Brook Game Sanctuary. The Game Sanctuary on this tract should be located between Irish and Rice brooks, including their headwaters.

5 *Park Forestry areas.* The need for firewood and timber requires that certain portions of the park be devoted to intensive forestry management subject to recreational uses. The practices of selective cutting and thinning on such lands should result in actual improvement of the forest stand, in meeting immediate needs of the park for firewood and timber, and possibly providing a limited revenue. Areas especially recommended for the practice of park forestry are:

a The Limestone Forest, south of the Limestone road, between the intersection of the Bradford road and Tunungwant creek.

b The Tuscarora Forest, between Quaker run and Wolf run, east of the Coon Run road to the Allegany Indian Reservation.

The remainder of the park, with the exception of the preserves, should be managed as a recreational forest, following the recommendations of De Forest A. Matteson in a special report to the commission on A Forest Policy for the Allegany State Park (February 1935).

The above outlined system of zoning and segregation should serve as a basis for appropriate policies which are

essential in park management. Each area should be clearly posted so that there can be no confusion about their boundaries. Small maps of the park and concise statements of the policies for each area should be printed and posted at the boundaries so that park officials, employes and the public may be fully informed.

Other general recommendations are these:

1 Every effort should be made to protect these forests from fires which in recent years have been a menace mainly near the park boundaries.

2 For the present, only native trees and shrubs, grown in park nurseries, should be planted here. It appears that there has been too much conifer planting in the past, and that much of it has been of the wrong sort.

3 Only native wild life should be encouraged in the park. An exception must be made in the case of Brown Trout which have already been introduced in the streams.

4 Selective cutting rather than clear cutting should be made the policy in areas devoted to park forestry. Every effort should be made to transform the pure stands of Sugar Maple to mixed stands.

5 Streamside vegetation should be protected, in order to keep the water clear and at the temperatures favorable to Brook Trout. No other stream improvements should be undertaken except under expert supervision.

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SUGGESTIONS CONCERNING POLICIES FOR THE ALLEGANY STATE PARK

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In the following pages I have expressed my opinions on the matter of certain permanent policies that I believe should be established to direct the management of the Allegany State Park in the future. I have spent ten summers in the park since its creation, one of them being the first summer, 1921.

During those summers I have paid particular attention to the natural history of the park, and have become very familiar with those areas of the park that have been opened to campers and summer recreationists. I have met and talked with many persons who use the park in summer. I have given talks on birds and other phases of nature in many of the summer camps.

Although now I am a naturalist and a teacher, I was originally trained as a forester and practised forestry, so that I understand forestry problems and the forester's viewpoint as well as that of the naturalist.

The conservation of any area of wild land is for one or more of four reasons. These are: (1) commercial and economic, (2) recreational, (3) educational, and (4) scientific. The Allegany State Park was not set aside for commercial purposes. On the other hand, the management requires consideration of the economic side. But the economic is subordinate to the other purposes of the park. If certain areas in the park are to be set aside for cutting of timber on forestry principles, I believe that they should be termed economic and not commercial areas.

Foresters are trained along economic and commercial lines. While they differ from the old-time lumberman in considering the future production of the forest, still they are inclined to look upon a forest area as an area for growing commercial timber. Since Allegany Park is not a commercial area, and its economic aspects are secondary to other features, the foresters who are or may be connected with the administration of the Allegany Park should be ones who will see and keep in mind the recreational, educational and scientific uses of the park as greater than the economic.

The recreational features of the park probably appeal to more persons than any other feature. We are familiar with the problem that has arisen in recent years; that of teaching the workingman how to use his increased leisure time to best advantage; how to find those kinds of recreation that do not pall and become stale after a time. The recreations of a wild area such as Allegany Park are such kinds. Yet many persons who come to the park do not understand the forms of recreation to be found there, and try to bring the recreations of city civilization. It is from these persons that come demands for dance halls, moving picture theaters and various similar things. It should not be a policy of the park to cater to such demands. People who do not understand the outdoor recreations that go with a wild region should be taught them. Those who can not learn to appreciate these kinds of recreation will cease to come. They should not be encouraged by giving them the recreations they desire, because these recreations can be found elsewhere and frequently interfere with those of others who are seeking recreation that can not be found except in a wild region.

For example, I one day undertook to introduce some lovers of nature to the song of the Hermit Thrush. We had to go a considerable distance away from the grounds of the Allegany School of Natural History, not because there were not Hermit Thrushes nearby, but because a party of people on the picnic grounds across the lake had brought a portable phonograph and were playing jazz records as loudly as possible.

The dance hall in Quaker run at the present time brings a crowd of people who, at any time between 11.30 p.m. and 1 a.m., drive along the Quaker Run road, and by loud laughter and shouting, parking at the lake and night swimming, disturb the rest of the daytime users of the park. Thus recreations that are to be had in cities conflict with recreations that are more in keeping with the park surroundings.

Recreation of the proper sort in the park may be divided into two classes: the summer recreations, such as camping, hiking, swimming and observation of nature; and the spring and fall recreations, such as hunting and fishing.

These two classes of recreation can both be promoted without one interfering with the other. So far as I know summer campers who abide by the park rules do not in any way interfere with the interests of hunters and fishermen. Those, however, who choose to ignore the rule that forbids dogs in the park, do interfere, not only with the hunter but the nature lover as well. The rule forbidding dogs has not been enforced up to the present time, nor effectively brought to the attention of campers and visitors.

The game and fish interests apparently have interfered with the rights and desires of summer nature lovers. I am informed that, in the past, park rangers have been encouraged to kill hawks, owls, grebes, herons and kingfishers, because they are ignorantly supposed to be detri-

mental to game and fish. Scientific studies of the food of these birds have shown that the amount of game or game fish destroyed in the park or elsewhere by them is negligible. The case against them is based entirely upon ignorance and prejudice.

Even if these birds were detrimental to fish and game, there would still be the question whether the desires of hunters and fishermen are of greater importance than the desires of naturalists and nature lovers. I doubt if the number of men who hunt and fish in the park is now greater than the number who study nature in one form or another. The idea that the conservation of any one form of wild life requires the killing of some other form is a mistaken one. Those who hunt in Allegany Park should be forbidden to kill predators. Even if a predator should occur in such numbers as to be harmful and in need of control, hunters could not be relied upon to aid in the control, for the average hunter can not distinguish useful predators from harmful ones.

The number of hawks in Allegany Park has greatly decreased in the past few years. This is particularly true of the most beneficial species of hawks, the ones that keep rodents in check. Last summer (1934) I was able to show my class in bird study only one pair of Red-tailed Hawks, and not a single hawk of any other species. This may not be due to killing in the park so much as to nationwide persecution. But that makes it all the more important that park authorities should not add to this persecution.

Between those forms of recreation for which the park was created and the educational features it is impossible to draw the line. One leads to the other. That form of education is best and most lasting which comes unconsciously through recreation. In fact, education, rightly

considered, is a recreation, and that man who has discovered this, and makes his recreation educational, has found a source of true happiness. To give to more and more persons this source of happiness is a far greater achievement than to give them mere recreation alone. The study of nature in all its forms, for which Allegany Park is well equipped, is one of the very best of such educational recreations.

There are still some persons who think that the study of nature is merely a fad, but the number of persons in this country who are interested in nature is steadily increasing, and has been increasing for the past 35 or 40 years. Fads do not grow and last in such a healthy manner.

I believe that park policies should plan to develop this educational feature beyond those that are mere recreations. That is, more time and money could be put into the development of labeled natural history trails, the hiring of park naturalists, nature guides or campfire speakers on nature subjects. The Allegany School of Natural History has laid a foundation for such things. Numbers of persons who have taken courses there have become competent to fill such positions. Since many of them are teachers, they are likely to be available during the summer months. The possibilities for developing the educational features are great. That they are educational need not be stressed. It would perhaps be better to call them a form of recreation. But they are far better to develop than those forms of recreation that are such and nothing more.

Just as the recreational and educational features merge into each other, so the educational merges into the scientific. In fact, were it not for the scientific we could not have the educational. This is true in Allegany Park where scientific research into the natural features of the region

has already accumulated a considerable knowledge, on which the education of the nature-loving public, that uses the region, is based.

But the scientific study of the natural features of the region has only begun. A fairly complete knowledge of the geology and natural history of the region can not be had for many years. Even in a single narrow field new things are to be learned each year. In the study of the interrelations of the forms of life that inhabit the forested areas of the park only the surface has been touched and a great deal remains to be discovered.

It is of far greater importance than the layman realizes that areas of forested land should remain as nearly as possible in natural wild conditions that we may obtain scientific knowledge not merely of the species that occur, but of their interrelations with each other. The Allegany Park is a wild forested region, and was, from the beginning, intended to be kept such. While the creation of camp sites, picnic grounds and various similar developments have necessitated a certain amount of changing of conditions, all such changes, unless really necessary, should be avoided. The clearing out of underbrush, the removal of old logs and dead trees, the planting of nonnative trees and the introduction of nonnative animals are generally to be avoided.

Destruction of natural conditions has the greatest effect upon the wild life of a region, either through a decrease in numbers or a change of the species that occurs. In the Quaker Run valley the bird life is greatly decreased and changed on those areas that have been turned to camp sites and picnic grounds. This is due largely to removal of undergrowth, old logs and dead trees, and of course partly to the erection of buildings. The development of the park

for public use required such changes, but it does not require them over large areas. There are persons who do not understand this; who seem to think a park must be open groves of trees, green lawns etc. Such parks have their place but they can not furnish the best conditions for wild life. Because there are plenty of such parks in other places is a strong reason why Allegany Park should not be such. The chief idea of a landscape architect seems to be cutting and trimming and removing undergrowth. Natural landscapes are beautiful in themselves and require no landscape architect.

One of the features of Allegany Park is that its wild life is of a different sort from that of places that are nearer large cities and civilization. Animals, birds and plants that are less familiar may be encountered there. But whenever areas are cleared for camping places it is these wilder, lesser known species that decrease. In bird life, for example, Robins and House Wrens, birds that are familiar about civilization, increase on camping areas; whereas Juncos and Hermit Thrushes, birds that are unknown in summer in more civilized areas, decrease or entirely disappear. To retain the desirable wild life of Allegany Park we must retain relatively natural conditions.

The Big Basin, an area that it is proposed to keep inviolate, is not merely unique in the possession of large trees. It is more than just an example of mature climax forest. Certain species of wild life are found there that are missing in other parts of the park, except in a few small areas of similar character. Such are the Pileated Woodpecker, Winter Wren, Hooded Warbler and Brown Creeper. It is true that Deer and Ruffed Grouse are missing or scarce there for they do not commonly inhabit such areas, preferring second-growth forest or the partly open

Aspen-Cherry thickets. For that reason the original idea that the Big Basin should remain inviolate should not have been twisted around to the idea that it was purely and simply a game refuge. It is unnecessary to make cuttings in such an area to provide a place for deer and grouse, since there are plenty of other areas of the right character that may be made game refuges.

The unique species of birds that I have named as occurring in the Big Basin area are dependent on dead trees, old logs, roots of fallen trees and undergrowth. Removal of these would cause the disappearance of these species. I do not agree therefore with the proposal to remove dead trees along the roads in this area, nor that to remove and utilize wind-thrown hemlocks. I realize that such practice is good commercial forestry, but Allegany Park is not commercial nor primarily economic.

The Hooded Warbler is dependent on undergrowth. To remove undergrowth within 50 feet of the road on both sides, as was proposed and partly practised this year by those in charge of Civilian Conservation Corps (C.C.C.) workers, while it would still leave areas for the breeding of this bird, would remove it from the roadside, and make it more difficult for bird students to find this unique species, and for that matter, such removal would have the same effect on a great many other kinds of birds, making all roadside bird study difficult.

When the park was first opened there were numerous open areas that had once been cleared, and were slowly reforesting, naturally, to Aspen-Cherry. These areas contained different kinds of plants and wild life than did the forests. While the main area of the park was forested, the occurrence of these areas created greater variety and

added to the recreational, educational and scientific values of the park.

Many of these areas, however, were planted to straight rows of Scotch, Red and White pines. From a standpoint of commercial forestry this is often considered good practice, but from a standpoint of recreational and educational park management it is not. We need a few open areas. Why destroy those that we have by planting foreign trees and then seek to create other open areas by cutting mature forest?

I can see no need for forest planting on any large scale in the park, and consequently no urgent need of a nursery. Decorative planting of strictly native trees and shrubs might be done in certain spots, but this is not forest planting. The forests of Allegany Park reproduce well. There is almost no fire problem. Watchfulness for signs of fire in dry seasons will always be necessary, but since in two unusually dry summers, 1930 and 1934, no serious fires within the park area occurred, although many campers were about, there is reason for not expecting great damage by fire, or reason for reforestation on that account.

Roads in the park first followed the stream valleys and camp sites developed chiefly in such valleys. Certain forms of wild life occur mainly or entirely in the stream valleys and the development of camp sites in such places has caused them to become scarce or entirely gone. Certain unusual plants also occur in such regions and are likely to be exterminated when such areas are opened up to camping. For example, in 1921 a pair of Northern Water Thrushes was evidently breeding along Quaker run. But the spot, almost directly back of the present Fancher camp, was the center of the first development of camp sites. The birds

disappeared and Water Thrushes have not been found breeding anywhere in the park since then.

There are numerous stream valleys still in a wild state that follow the smaller streams and the stream sources, but there are only a few larger streams with forested borders. I can think of but two such areas in the portions of the park that have been developed, one on Quaker run and one on Red House creek. The Quaker Run area is that just below Frecks and above the present site of the C.C.C. camp. There the road takes to the hills and camp sites have not been located along the stream. The Red House area occurs below the beaver dam where the stream is on the east side of the road. These two areas are particularly beautiful and interesting because still in a comparatively wild state. I should like to suggest that it be a policy to keep them so and not develop camp sites in those particular areas. There would be no objection to allowing fishing along these streams nor to developing foot trails through them, but to build roads and develop camp sites in them would destroy the last bits of larger forested streams in the more accessible parts of the park. At present both areas are apparently rarely visited by campers in the park.

Apparently certain rules and regulations concerning Allegany Park that affect campers are made by those who can not see the results, and executed by those who do not care what the results are. I hear a camper exclaiming "Why did they cut all the flowers along the road? Yesterday those fireweeds were so pretty! And now look at them wilted and flat on the ground." To explain to the camper that there is somewhere a ruling that such things must be done and that the men who carry out the orders have no choice but to cut everything within a certain distance

of the road does not help. The explanation for such a ruling is still not clear. In some places, of course, weeds along the roadside might interfere with the vision of motorists, but this is not the case in most instances.

Certain zoology students are using patches of thistle or milkweed as a place to collect butterflies when suddenly the cutters come through and the milkweeds and thistles are gone. In certain other cases birds' nests are destroyed or so exposed by cutting the growth that concealed them that the nests fall prey to natural enemies. The extent to which such cutting is done varies in different years. Sometimes it is extremely thorough and the men go through camping grounds and mow everything. To one who knows the flowering plants of late summer and anticipates their blooming, only to find them cut down before their time, there are many disappointments. A patch of Pale Jewelweeds near my cabin was mowed down a week or two before blooming time, and the same has been true of many patches of Coneflower, Goldenrods, Asters, Joe-Pye Weed and other species in the wild natural flower gardens that should beautify the roadsides of Allegany Park all summer. In years when appropriations are low and few men can be spared to cut the "weeds" campers who know the beauty of these flowers rejoice that the cutting is only partly and haphazardly done. Except at special points where the growth of vegetation may interfere with the view of the road, I know no reason why such cutting must be done, and I believe it would be an excellent policy to do away with this ruling, or to make it so flexible that it need not be carried out except where necessary. In another New York State Park wild flowers (not cultivated gardens) are planted by the roadsides, and signs request the public not to pick them.

Those who ride in automobiles everywhere they go, perhaps do not realize the extent to which summer campers walk along the Allegany Park roads. Walking on these roads, in dry weather, is unpleasant because of the dust, and the frequent passing of motor cars. The latter also create some danger. It has been suggested a number of times that footpaths be established for pedestrians, parallel to the roads. Such footpaths would be a great benefit to campers. Probably hitch-hikers would not want to use them, but many would walk in preference to hitch-hiking if the walking were pleasant.

Since writing the above, another condition has arisen that threatens the extermination of certain species of birds. Numerous Barn and Cliff swallows and Chimney Swifts nest about farm buildings in the lower valleys of the park. In the past two or three years the park has purchased many of these farms and immediately torn down the buildings where these birds nest. A number of colonies of these birds in Quaker run, Wolf run and Red House valley have disappeared in the past two summers (1935 and 1936). While the Barn Swallow and Chimney Swift are common birds in many places, the Cliff Swallow is getting scarce in eastern United States, and the few places where they still breed commonly should be saved. Several spots where Cliff Swallows bred a year or two ago, and where I was in the habit of showing my bird classes the birds and their unique nests, are now destroyed, and the destruction has often been accomplished in the summer while the birds were nesting. If the farm buildings must be destroyed it would seem possible to erect some substitutes for them that the swallows could utilize. Certainly a state park devoted to wild life should not adopt policies that exterminate a disappearing and unique species of bird.

The Cliff Swallow is one of the special wild-life assets of Allegany Park, and particular efforts to keep it there are justified.

In conclusion, I believe it is practicable and highly desirable to coordinate the economic, recreational, educational and scientific purposes of the park in such a way that they do not interfere with each other. The proposed division of the park into definite areas or zones, some for economic practice of forestry, some for camping and recreational areas, some for game refuges and some for inviolate sanctuaries seems to me the best way to develop such permanent policies and assure those who are deeply interested in the future of the park that no matter how much the management of the park may change, these policies will be carried out.

I have examined carefully the map of these proposed areas, and while I am not so familiar as some others with some of the areas in the northern and eastern sections of the park, I approve of the proposals as shown on these maps. I have already stated reasons why I believe the Big Basin area should be an inviolate sanctuary. The area in the southwestern section of the park, covering the valleys of Wolf run and Peter's run, has large areas of Oak-Hickory forest, a distinctly different type from the Maple-Beech of the Big Basin. It is highly desirable that an area of this type should remain inviolate, and there is probably no better area for this purpose than the one proposed. The area between Quaker run and the state line, bounded by the Bradford road on the east and the Coon Hollow road on the west, is the scene of many studies by research workers at the Allegany School of Natural History. These studies carry on from year to year, and would be seriously interfered with if artificial changes were allowed to go on there.

It has been recommended that certain areas be set aside as commercial forest areas. I would prefer to hear these areas spoken of as economic forest areas, as more in keeping with the purposes of the park. I am not sure that cutting the trees for economic purposes in the park will really be economic; that is, the cost of cutting and all the other lumbering operations that must take place, when done on a small scale, will make the timber produced cost more than to buy it in the market.

If cuttings are to be made, they should be selection cuttings, at least in the Maple-Beech areas. The clear-cuttings once made in the park for chemical wood were, of course, made without any idea of forestry in mind. Clear-cuttings in an all-aged forest could not be considered proper forestry.

Selection cuttings will not be detrimental to wild life in general. They probably would be detrimental to certain particular species, but for other species the cuttings would create greater variety of conditions than would be found if cuttings were not made. In fact, if the entire area of Allegany Park were mature climax forest, like the Big Basin, there would be less variety in the species of wild life found, and certain desirable species would be very rare or absent. For that reason future plans for continual cutting of timber in the park, so long as the particular areas to remain inviolate are untouched, would be helpful in creating a greater variety of species and interests for the nature lovers and the naturalist.

SUMMARY

1 The purposes of the park are recreational, educational, scientific and economic. The park is not commercial. The economic is secondary to the other purposes. Practice of

economic forestry should be carefully planned so as not to interfere with primary purposes for the park.

2 *Recreation.* Those recreations that belong to city regions should not be encouraged in the park, and if allowed at all should not interfere with other recreations.

Summer camping and summer recreations, and hunting and fishing should each be developed without interfering with the other. Laws forbidding dogs should be enforced and existence of that law brought to attention of all summer campers and visitors.

The right to have all natural forms of wild life present in normal numbers for the nature lover should not be taken away by hunters and fishermen. Wild life should not be dealt with from the standpoint of prejudice and ignorance. Conservation of one form of wild life does not require killing of another form.

3 *Education.* Recreation of the best sort is educational. Educational recreations develop into more opportunities to use leisure time to greater advantage, and give them a more lasting basis for true happiness. The study of nature is such an educational recreation.

Future policies should put greater stress on education in natural history through labeled nature trails, the employment of park naturalists, nature guides, campfire speakers etc. Those who have taken courses at the Allegany School of Natural History are familiar with the natural history of the park region and equipped to fill such summer positions. Many, being teachers, would be free to do such work in summer.

4 *Scientific.* The educational program depends upon the scientific knowledge of all the natural features of Allegany Park. A complete knowledge of such facts requires keeping most of the park in a wild condition, and making certain areas inviolate sanctuaries.

To keep the area wild, cutting of underbrush, removing old logs, dead trees etc. must be kept at a minimum and done only when necessary for the development of camp sites, picnic grounds, trails, roads etc. The removal of underbrush etc. for landscaping purposes should not be allowed. The removal of dead trees and logs for economic purposes should be forbidden, except on areas set aside for the practice of economic forestry.

Open or partly open areas should remain such, or be reforested only by the slow process of nature. Planting of trees, especially trees foreign to the region and set in straight rows, should be prohibited.

The ruling that provides for cutting weeds and wild flowers along the roadsides should be modified and practised only where actually necessary to give motorists a clear view of the road.

5 Two areas along larger streams that are still in wild condition and not opened to camp sites should remain so. These areas are: (1) along Quaker run between Frecks and the site of the C.C.C. camp, and (2) along Red House creek on the east side of the road below the beaver dam.

6 The division of the park into areas or zones, some for camping, some for hunting and fishing, some for game refuges, some for economic forestry, and some for inviolate sanctuaries should be carried out. Inviolate sanctuaries should include an area of Maple-Beech forest (the Big Basin), an area of Oak-Hickory (Wolf and Peter's Run areas), and the area back of the Allegany School of Natural History (bounded by state line on the south, Bradford road on the east, Quaker run on the north, and Coon Hollow road on the west).

ERRATA

Map showing Vegetational Areas of the Allegany State Park, N. Y. and Adjacent Territory

1934

1 Site of Allegany School of Natural History is at the small lake, on Quaker run between Mount Oneida and Blacksnake mountain.

2 Site of the Administration Building (Park Headquarters) is in open land southwest of the large lake, in valley of Red House brook.

3 Site of Rental Office in Quaker Run section is at "Frecks." All the old dwelling houses, stores, and mill sites at Halls, Frecks, and Wolf Run (Elko P. O.) have been removed by park authorities.

4 New roadway around the large lake in Red House Brook valley is shown in figure 188.

5 Approximate course of primary roads in Allegany State Park, not shown on vegetational map, are shown in figure 216. The most important of these are the English-Stoddard road from "Frecks" on Quaker run to mouth of Stoddard hollow at large artificial lake in Red House Brook valley. Another important road is completed to the head of Quaker Run valley connecting with Pennsylvania State Route 46 to Bradford and with another park road through the entire length of Red House Brook valley. Junctions are shown in figure 127.

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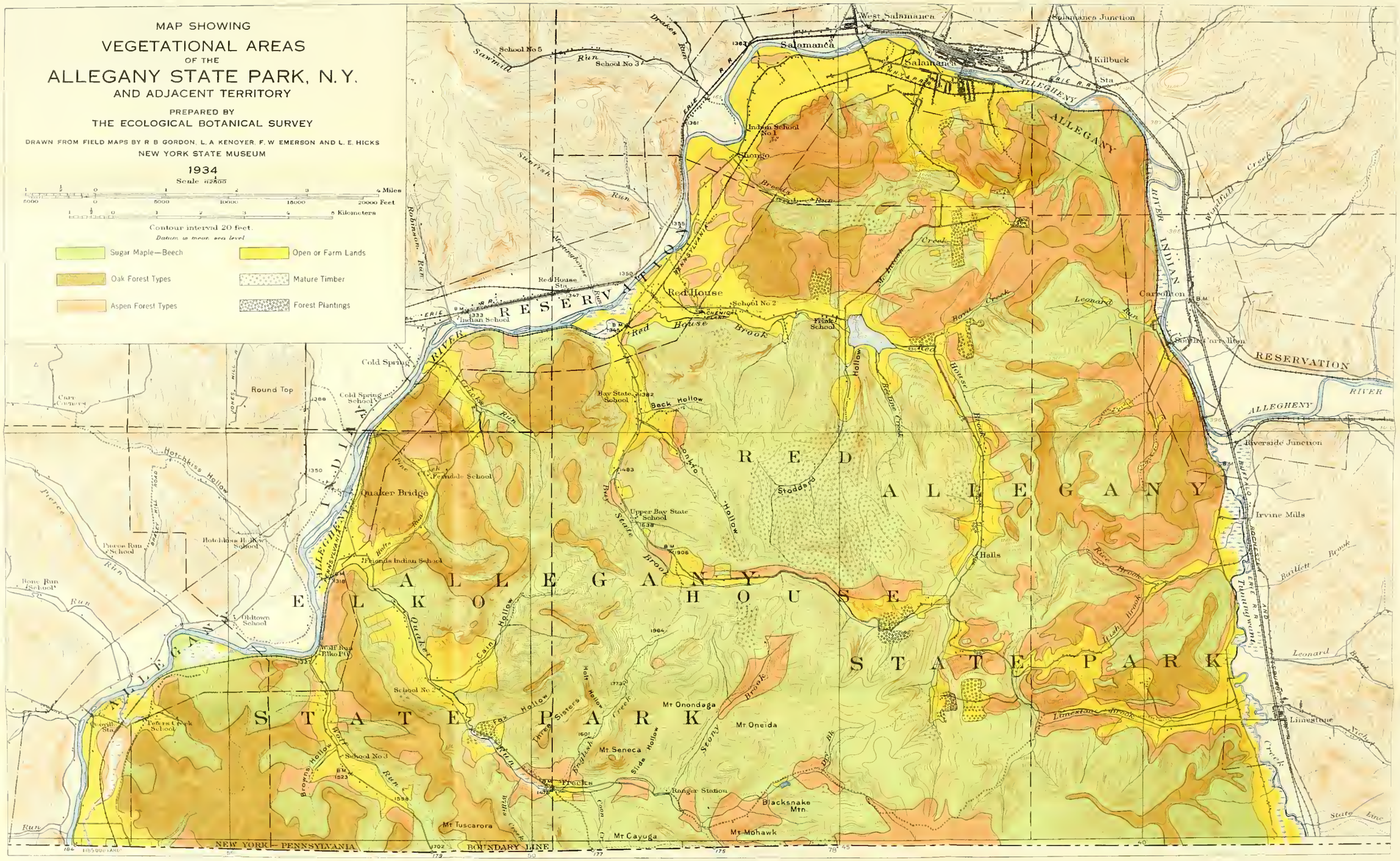
Date Due

Map Showing
Vegetational Areas
of the
Allegany State Park, N. Y.,
and Adjacent Territory

Date Due



Topography by U. S. Geological Survey in cooperation with the State of New York.

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