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ROYAL EASTMAN SHANKS

AN ECOLOGICAL SURVEY OF THE VEGETATION OF MONROE COUNTY, NEW YORK

by

ROYAL E. SHANKS

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ROYAL EASTMAN SHANKS

1912–1962

Biographical Note

On page 298 in the literature cited by Richard H. Goodwin in his *Flora of Mendon Ponds Park* (Proceedings of the Rochester Academy of Science volume 8, numbers 5–6, April 27, 1943) appears the following: "Shanks, R. E. 1943. An Ecological survey of the vegetation of Monroe County, New York. N. Y. State Museum Bulletin. (In press.)" In the same issue and offering further encouragement to amateur and professional botanists in the county, who were to eagerly await publication of the paper, was the following statement explaining sources of data in: *Notes on the flora of Monroe County, New York,* by Royal E. Shanks and Richard H. Goodwin: "Unpublished data on plant distribution compiled during the course of an ecological survey of the vegetation of Monroe County jointly sponsored by the New

York State Museum and the Monroe County Division of Regional Planning, 1938–1942. Copies of these data are filed at Albany and Rochester, and the report of this survey will be published as a bulletin of the New York State Museum."

Vainly indeed, have those interested in this study searched for it in local libraries, and even in the State Museum at Albany. Because of numerous vicissitudes, the promised paper could not be published until now. Several years after its writing, the manuscript came to the notice of local botanists. Correspondence with Doctor Shanks showed that he would welcome its publication and the State Museum kindly relinuished the manuscript to the Rochester Academy of Science. The Council of the Academy voted to publish the study.

Again, unavoidable circumstances delayed manuscript consultations and editorial work, and the preparation and printing of the many superb and necessary illustrations. At long last, the Academy feels great satisfaction in bringing out the present issue devoted to this penetrating study. Despite the facts that the field work was done in 1938–40 and that the bulldozer has introduced many geologic changes since then, the data are still timely. They can serve as an indispensable basis and guide for future work. The forest types described by Doctor Shanks are still present to serve as links to the past; many are preserved in our parks. Those who love the woodlands will be fascinated by the variety in Monroe county and will learn to recognize and enjoy various types from this detailed and clear presentation.

How did the research for and subsequent writing of the paper originally come about? Royal Eastman Shanks was born in Harding County, Ohio, on November 11, 1912. He took his A.B. degree at Ohio Northern University in 1933 and taught and administered in public schools for several years thereafter. Eventually he became a full-time student in ecology at Ohio State University, from which he received the M.S. and Ph. D. degrees in 1937 and 1938, respectively. Among his first post-doctoral positions was that of Temporary Plant Ecologist with the New York State Museum. In this capacity he worked in Rochester, and began and completed the ecological survey of its surrounding vegetation areas.

Then, from 1940 until his death, Doctor Shanks was a member of the Faculty of the University of Tennessee. During World War II he was an instructor, first in the Army, and in the Navy. His wide interests and versatility in solving problems of many kinds are revealed by examining his published works following the war. They include a study of the flora of Tennessee and a classic paper entitled "Climates of the Great Smoky Mountains". The latter was based on the analy-

sis of data recorded by the joint Tennessee Valley Authority-National Park Service for a U. S. Weather Bureau Smoky Mountain snowfall study. He also tested methods of plotless sampling in the Smokies. This is valuable in regions where the boundaries of the plots are difficult to find or the terrain is too rough for full penetration. He worked on the accumulation of radioactive wastes in certain areas and investigated the plants which grew in such places. Formation, development and morphology of soils challenged him and his students. For a number of years he studied the ecology of Arctic environments, with the Biological Field Station of the Arctic Institute of North America at Point Barrow, Alaska, as his headquarters. Problems relating to the rate and depth of thaw in the Arctic were pursued.

Lamentably, in the summer of 1962, Dr Shanks lost his life while examining marine organisms on a coral reef near Port Limon, Costa Rica. We can only partially honor his career with this issue and thereby salute him as a man, teacher, a scientist and an internationally renowned plant ecologist.

We cannot express our respect better than in the words from a Resolution prepared by Doctors H. R. Deselm and Edward D. Clebsch, with the help of colleagues, which was published in the Bulletin of the Ecological Society of America; he is described thus: "Shanks' sharply analytical mind was able to dispense with the trivial and unnecessary thoughts and restrictions that clutter the minds of most. He collected experiences rather than possessions. Seeking information only applicable to matters at hand, he was able to cut through the fog of controversy and characterize a problem in its most rudimentary form. In his death the field of ecology, his associates, friends and colleagues have lost a source of inspiration and an example of intellect and manhood seldom seen."

Mrs. Betty Morris Shanks graciously and generously consented to the posthumous publication here of: "An Ecological survey of the vegetation of Monroe County, New York." She found the manuscript and negatives and sent them to the members of the Rochester Academy of Science with whom Doctor Shanks had been working. We are most grateful to her for making the publication of this monumental work possible.

B. B. C.—H. L. G.

AN ECOLOGICAL SURVEY OF THE VEGETATION OF MONROE COUNTY, NEW YORK

by

Royal E. Shanks

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AN ECOLOGICAL SURVEY OF THE VEGETATION OF MONROE COUNTY, NEW YORK

INTRODUCTION

While the New York State Museum has been making scientific studies of the natural resources of the state for over one hundred years (Kilfoyle 1940), a general realization of their importance in relation to man's life in the region has developed rather slowly. General awareness of the importance and exhaustibility of the natural resources has only developed in the last quarter century. This awareness has been reflected in more comprehensive programs of conservation, and has given rise in many quarters to organized planning directed toward most efficient use of mineral, water, soil, animal, and vegetation resources, as well as human resources.

The present study is a logical outgrowth of this growing interest in the natural resources in relation to regional planning (Adams 1937). The field research has been sponsored and financed by the New York State Museum in cooperation with the Division of Regional Planning of Monroe county, New York, and has been accomplished through the cooperation of the Work Projects Administrtaion Land Planning and Planning Inventory Projects. It is basically a study of the vegetation of Monroe County, New York, in relation to man. This implies a study of the ecology or environmental relations of the vegetation, since both the vegetation and the factors affecting it influence man's program in the region. To put it otherwise, we might say that this is a study of plant ecology in relation to human ecology.

Since this survey is ecological in its approach, it must include not only an inventory of the present plant cover of the county but also an analysis of the organization of that plant cover into definite plant communities, or vegetation types, which recur with remarkable uniformity throughout the region. It must deal with the intimate interrelations between species within vegetation types and with the broader relationships between vegetation types. It must analyze the vegetation pattern, or areal distribution of vegetation types, and insofar as possible point out the local differences in environment which are responsible for the differences in the vegetation. This means that considerable attention must be devoted to physical factors which influence the vegetation, such as climate, geology, physiographic history and resultant topography, and soils and their water relations.

Conclusions with regard to natural environmental relations and the broad vegetation pattern have a much simpler and sounder basis

when we eliminate man's disturbing and modifying influence. In order to do this we must build up an accurate picture of the primeval vegetation of the region. When white man first entered the region he found a relatively stable plant cover. It had attained a relative equilibrium with the environment through a period of time in centuries. This is the basis for the generally accepted principle that the natural vegetation occupying a region constitutes our best measure of the total effect of the environmental factors operative in that region. A climax association is shown in Figure 1.

Sometimes climatic factors are limiting, sometimes topography, sometimes soil conditions, but the natural vegetation indicates their total effect. This, the indicator value of vegetation, is the basic principle upon which any application of a vegetation survey to human ecology must rest.

In constructing an adequate picture of the primeval vegetation of this area and analyzing the relationships of the primary plant communities it will be necessary to employ not only all the information available from present remnants of the original vegetation, but also all available sources of information relative to the vegetational history of the area and the general region of which it is a part, both before and after the advent of white man as an ecological factor about a century and a half ago. This information will be summarized and the methods in which it is used will be discussed in detail in the following pages.

It is hoped that this report may serve not only as a historical record of the vegetation of Monroe county and as a contribution toward a more complete understanding of the plant ecology of western New York, but also that the results of this study, as well as the approach and methods employed, may prove of further value as they are applied to the problem of regional planning.

It must be emphasized that this report presents results of a cooperative project. Accomplishment of such a detailed survey has only been possible through the cooperation of the New York State Museum, the Division of Regional Planning of Monroe county, New York and the Work Projects Administration. Dr. Charles C. Adams, Director of the New York State Museum was among the first to call attention to the significance of and need for such work and has directed the project. The writer appreciates Dr. Adams's suggestions and the close contact with the detailed work of the project which he has maintained. He also wishes to thank Mr. J. Franklin Bonner, Director of Regional Planning of Monroe county, and his staff for their excellent cooperation.

THE REGIONAL BACKGROUND

Monroe county, formed from parts of Ontario and Genesee Counties in 1821, includes a land area of 633 square miles lying on both sides of the Genesee river and on the central south shore of Lake Ontario, and surrounds Rochester, third largest city in the state of New York.

When the white man entered this part of western New York he encountered a wilderness region, most of it heavily forested, with a wide variety of topography. It graded upward from a gently sloping lake plain to a dissected plateau. A well marked ancient beach ridge traversed this plain east and west, and formed a convenient highway seriously interrupted only by such features as Irondequoit Bay and the Genesee river. Parts of this plain were almost featureless while other parts were characterized by irregular hills and ridges of unconsolidated materials or by ovoid hills (drumlins) lying in a uniform northeast and southwest directon, with frequent boggy swamps between.

South of the first mentioned ridge lay two less continuous, but in places more prominent, limestone "ridges" (escarpments), where the bedrock lay at or near the surface.

However the one feature which dominated the picture more than any other was the great river which drained most of the region, crossing it in a general northerly direction and flowing into Lake Ontario, whose waters gave the region a natural boundary on the north. It is from this river with its broad flats, its great falls and potentialities for water-power development that this region, early recognized as a geographic unit, came to be called "the Genesee Country".

The Seneca Indians, guardians of the west door for the Iroquois Confederation, had claimed and occupied this territory for a long time, but Indian hands had rested lightly upon it. The largest recorded Indian clearing in what is now Monroe county was about 30 acres in extent. It was occupied by the homes and fields of the village of Totiakton, on the "plains of Abraham" (east of the Plains road), Mendon. Indian fields also occupied about nine acres on the east bank of the Genesee at the present site of the campus of the College of Arts and Science of the University of Rochester. Adjacent areas were doubtless subject to occasional fire, whether intentional or accidental. A few well-marked trails followed natural routes. But the Indian population was never large and with the exception of these very local areas, there was little evidence of human occupation. The Indian fitted into the natural environment; he did not dominate and modify it greatly as did his white successor.

From the time of La Salle's exploration in 1679 and Denonville's military expedition in 1687 a century elapsed before white man took up permanent residence in the area now included in Monroe county. The Indian title to these lands was not extinguished till 1788 and Indian hostility presented an effective barrier to settlement. But during the years 1788 to 1790 the first surveys and land sales were made and the first half dozen settlers came in, the vanguard of a migration that was to alter the face of the area profoundly, to destroy nine tenths of its forests, exploit its other resources and build a city of over 300,000 in a century and a half.

Physiography

Monroe county lies in the eastern lake plains division of the central lowland physiographic province (Fenneman 1917), its northern part in the Ontario plain and its southern part in the Erie plain (Fairchild 1928). Its altitude ranges from 246 feet at the shore of Lake Ontario to over 1,040 feet in the southeastern corner of Mendon. The gentle regional slope from south to north accounts for most of this 800 feet and local relief rarely exceeds 150 feet.

Few of the present topographic features of Monroe county date from Tertiary time. The two limestone escarpments and their intervening depression are still evident, and the regional slope and stream flow toward the north remain unchanged, but most of the minor details are due to glaciation or have developed since the Pleistocene.

The major points in the story of Pleistocene glaciation have been carefully worked out for this and related regions (see Fairchild 1928 for general account and references). The region was probably covered by glacial ice at least twice, but for our purpose in this discussion the number of stages has little significance, since the last Mankato (Wisconsin) ice masked or destroyed the effects of any previous glacial advance and destroyed the vegetation which had occupied this region in interglacial time.

The ice advanced from the Quebec, or Labrador, center. Its direction of movement as indicated by the drumlins (see Figure 2) in Monroe county was between south and southwest. This direction is also reflected in the course of the Genesee river and other streams, and therefore in the orientation of political boundaries, roads and property lines. This directional pattern may be observed in Figure 3.

Pre-glacial drainage was northward, so the advance of the ice sheet resulted in the damming of the streams and formation of temporary lakes in their valleys. The ice-front lakes thus formed soon filled to the level of the lowest points of the divide to the south,

and outlets were cut by the escaping lake waters. This region, which had once drained northward, now drained to the south. But still further drainage changes were to take place in the Genesee valley, for when the rate of melting of glacial ice exceeded the rate of oncoming supply ice and the ice margin receded down the regional slope to the north, successively lower outlets to the ponded valleys were uncovered. The record of these recessional lake stages is clearly recorded in ancient beaches, deltas, lacustrine plains and abandoned outlet channels.

Fields strewn with limestone boulders just back of the escarpments give evidence that some glacial erosion took place here, but the work of the glacier in this region seems to have been largely depositional. It had crossed a lowland area of weak rock, the basin now occupied by Lake Ontario, and was heavily loaded with rock debris when it reached this area. Conditions here were favorable for deposition of part of that load, and most of the bedrock of Monroe county is well mantled with glacial drift. Where this material was deposited directly by the ice it is unassorted, but where deposited in water at or near the ice margin it shows sorting and stratification, and it exhibits the typical forms known as kames, eskers, and deltas.

The surface features of Monroe county due to glaciation are summarized in Figure 3. The moraines shown on this map were laid down in glacial lake waters at the ice margin and therefore consist principally of kames, which frequently have kettle holes among them. Kettle lakes, such as some of the Mendon Ponds, sometimes occupy these depressions. Drumlins, also shown on the map, are quite characteristic of the topography of this region. They are made up of unsorted drift and their characteristic ovoid shape is shown on the map and in Figure 2.

The history of the glacial lake stages is too complicated for review here, but interpretation of many of the surface features of the county depends upon an understanding of this story. There is evidence of the following stages:

1. Lake Avon, with a well-marked outlet channel through Rush and Mendon occupied in part by present Honeoye Creek, and channels and deltas in southwestern Monroe county formed by streams flowing into it [see Fairchild, 1932];

2. Lake Warren, which stood at a higher level, and left wave-smoothed terraces on the tops of the kames in the southern part of Perinton;

3. Lake Dana, in which the kames of the Pinnacle moraine in the southern part of Rochester were formed;

4. Lake Scottsville, the temporary lake held back by the Pinnacle Moraine, in which the extensive silt plains along the Genesee in the southern part of the county were deposited;

5. Lake Dawson, into which Lake Scottsville drained and which drained through the Fairport outlet channel shown in Figure 3;

6. Lake Iroquois, whose prominent beach ridge is now occupied by the Ridge Road and whose sand plains form the most important commercial orchard and garden region in the county;

7. Gilbert Gulf, which stood at sea level, in which the extensive sandy delta deposits around the mouth of the Genesee were laid down.

After the weight of glacial ice was removed, a differential uplift occurred, raising the level of the basin and tilting it toward the southwest, and Lake Ontario came into existence. The streams which flow into Lake Ontario have also developed in post-glacial time. As successive lake stages were drained and successive lake plains were exposed, the Genesee cut through its own delta deposits; the surface configuration that had resulted from glacial deposits prevented it from occupying the course followed by the corresponding stream in pre-glacial time. The location of the buried valley of the "Irondogenesee" can be seen in Figure 3; this valley seems to have been almost completely filled with sand and gravel lake deposits. The fact that the Genesee is now cutting a new course in the bedrock accounts for its scenic gorge and falls. Parts of sands deposited in the ancient valley have been excavated by Irondequoit Creek.

In summarizing the direct and indirect influences of glaciation on the vegetation of this area we might list the following points:

1. destruction of plant cover, so that the history of the present vegetation starts only with the withdrawal of the ice and water that covered the region;

2. destruction of previously developed soils, leaving in their place only raw and mixed soil materials from which true soils might develop in time;

3. a wide variety of materials from which soils with varying moisture relations might develop—gravels, sands, silts, unsorted glacial drift, and exposed bedrock;

4. a wide variety of topographic forms providing diverse habitats—till plains, drumlins and moraines, kames, eskers and kettles, ancient beaches, and deltas and lacustrine plains;

5. constructional topography with slight development of drainage, providing poorly drained as well as well-drained habitats;

6. some refrigerating effect on the climate of regions immediately adjacent, limiting the species available for immediate migration into the land area upon exposure.

A comparatively short time has elapsed since glaciation; little physiographic development has occurred away from the major streams, except for some erosion in the town of Irondequoit. The topography is still largely the product of glacial deposition, rather than stream erosion, and many of the interesting features in the topography, soils and vegetation of the region are due directly or indirectly to the Mankato ice.

Local Geology and Soils

The bedrock is well masked by glacial drift over most of Monroe county. Principal exposures are in the gorge of the Genesee and other major streams and near the Onondaga escarpment in the extreme southern part of the county. There has been continuous interest in the geology of the region since the classic pioneer work of James Hall a century ago made the Genesee gorge the type locality for the Silurian beds in America; few areas in this country have received more careful attention. Fairchild has devoted a lifetime to the geologic interpretation of this and related regions, and his Geologic Story of the Genesee Valley (1928), is an excellent semi-popular account.

This entire area is underlain with relatively horizontal beds of sedimentary rocks laid down in Paleozoic time. As a result of a slight southward dip and a general northward regional slope, these strata would form a banded outcrop pattern if the mantle of drift were removed, and the youngest rocks would lie to the south. The Queenston shale outcropping to the north is generally regarded as upper Ordovician in the region. The Onondaga limestone to the south is, with the exception of the lenticular Oriskany sandstone which may occur locally, the oldest representative of the Devonian here. Everything between these mentioned strata is Silurian. It will be observed that limestones, sandstones and shales all occur in the area. This alternation of beds of different degrees of resistance has been an important factor in shaping some of the topographic features of the region. The Lockport dolomite supports the Niagara escarpment; the Onondaga limestone supports the Onondaga escarpment; and the Salina depression has been eroded in the less resistant shales lying between.

Since the rocks underlying this region are for the most part well covered, their influence on the vegetation is largely indirect, through their influence on topography, drainage and soils. Even where the

limestone is exposed it does not bear a very distinct or characteristic flora, but influences the vegetation indirectly through the effect of subterranean drainage and shallow soil on the water relations of the plants. Where they affect the topography underlying rocks provide conditions under which certain types of habitats are likely to develop. For instance, a high proportion of the bog area of Monroe county lies in the Salina depression. Such rocks are the source of most of the parent material from which the overlaying soils of the region have been derived, and local soil differences are due to variation in both parent material and topography.

The raw rock materials deposited by the ice and lake waters probably became covered with vegetation soon after they were exposed. But these gravels, sands, silts and clays were not yet true soils, merely parent materials from which soils might develop. Only under the long-time influence of climate and vegetation would they develop the stable profiles, clay and organic matter content, and stable underground life, both plant and animal, which characterize true soils.

The soils of this region have been mapped and described and rated as to productivity by the Soil Survey Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture (Sweet et al 1938). In this survey 32 soil series, including 65 soil types and 37 additional phases of types, were recognized, in addition to 12 miscellaneous land types. The following outline includes the most important series, grouped according to appearance and origin. Since the climate is relatively uniform throughout the county, differences in soils are due largely to differences in the character of the parent material and differences in relief and drainage.

Monroe County Soil Groups

Brown and dull reddish brown soils with unsorted, very gravelly, subsoils (glacial till including drumlin till):

Ontario, Honeoye, Hilton, etc.

Light brown, brown and reddish brown soils with stratified subsoils (old lake and stream deposits):

Heavy texture—*Dunkirk, Collamer, Schoharie,* etc.;
Light texture—*Berrien, Ottawa, Petoskey,* etc.

Brown and grayish brown soils containing water-worn gravel and underlain by beds of sand and gravel (kames, eskers, fossil beaches and deltas):

Alton, Groton, Palmyra.

Dark brown, brown, and dull red soils, shallow over rock:

Farmington, Lockport, etc.

Dark gray, brown, dark brown, and reddish brown soils developed from recent alluvium:

Genesee, Tonawanda, etc.

Dark gray and nearly black soils, occupying small valleys, basins, and flat poorly drained areas:

Colwood, Poygen, Wayland, etc.

Miscellaneous land types (muck, marsh, and so forth):

Scattered locations.

"The normal mature soil developed from the till of this region consists of brown or slightly reddish brown gravelly soil. Below a depth of 8 inches the color is lighter brown, free or nearly free of brown stains or gray mottling. At a normal depth of about 16 inches the texture becomes heavier, the structure more compact, and the subsoil more gravelly. Maximum heaviness and compaction are reached at a depth ranging from 20 to 30 inches, below which the very gravelly till is more friable. The surface soil has a pH value ranging from 6 to 7, at a depth of 15 inches the material is slightly alkaline, and the material below an average depth of about 24 inches is highly calcareous." (Sweet et al 1938).

The soils of the county tend to be rather light in texture, consisting principally of loams and fine sandy loams, but the alluvial, lacustrine, and depressional soils include fairly extensive areas of silt loam, and the Lockport and depressional soils include limited areas of silty clay loam.

The early settlers did not attempt so detailed a classification of the soils of the region, but they did develop the ability to evaluate their potential productivity, and therefore to classify them in relation to most profitable land use. The surveyors and early settlers must have taken soil color, rockiness and drainage into account, but they seem to have leaned heavily on the natural vegetation as an indicator of the potentiality of the land for crop production. In this connection O'Reilly (1838) makes the following generalizations, which may be open to question but are nevertheless interesting:

"The geologic formation of western New York is marked by a regularity truly surprising; and the native forests of the whole country, as well as those of the Genesee valley, will serve as almost unfailing indications of the soil beneath. Over the whole extent of this territory it may be said that oak timber marks a soil of which the base is calcareous, or in which more or less lime is present. The presence of elm, beech and maple distinguish those in which aluminous earth preponderates; and where pine, hemlock and birch prevail, the soil varies from loam to sandy, or is siliceous in its character."

As pointed out in an account written in 1804 (Munro), "it frequently happens that the soil varies materially in different places where the same sort of timber grows." The correlation between mapped soil types and mapped vegetation types is likely to be far from perfect, since different degrees of generalization are likely to be used in preparation of the maps. But soil boundaries frequently coincide with vegetation boundaries, and this is especially true where the basis for the soil separation is a difference in texture or drainage. Since major differences of this sort do exist between the soil groups listed above, and the degree of generalization is more nearly the same, these soil groups show much closer correlation with the vegetation types recognized in Monroe county than do the soil series, types, and phases.

Climate

Early observations on the climate of this region indicate that it compared favorably with the more familiar regions to the south and east and that it would be quite suitable for occupation by an agricultural population. Indian crops were cited as evidence and the early settlers found that in most years the weather was mild enough that they could winter their cattle on the river flats. Timothy Dwight (1821), noted scholar and President of Yale University, made the following comments on the climate of western New York in the account of his travels in New England and New York, published in 1821: "There is a difference of climate between this country in several respects from that of New England, from that of New York along the Hudson, and parts of the region itself differ from others. There is, so far as observation extends, a circuit of seasons embraced in periods of ten to perhaps fifteen years. From 1791, terminating with 1804, a regular succession of warm seasons has existed. All summers were warm. The winters of 1780, 1792, 1798, and 1799 were cold, the first named being remarkable for its severity. The opinion is given that the climate of this tract is milder than those in the same latitude eastward, and the proximity to water is adduced as an explanation. . . ." McIntosh (1877) makes further comment: "The winter of 1779–1780 is memorable as one of unprecedented severity. Snow to the depth of full five feet lay like a blanket upon the surface of all western New York. Game, a chief reliance of the Indians, perished by thousands, and the dissolving snow in spring showed the forests filled with the carcasses of the deer." Dr. Coventry, in a discussion of the "medical topography" of western New York published in 1827 says: "In 1795, no rain fell in June or July; the water in the lakes was lowered; every little inlet became a seat of putrefaction; the heavens seemed

on fire, the earth scorched, and the air saturated with pestilence; hogs were found dead in the woods, flies turned white, and fell upon the floors." Dr. Ludlow, in a similar discussion (McIntosh 1877): "The summer of 1804 was moderately warm, while the winter was intensely cold. Much snow fell, and lay longer than ever before known." A further note from McIntosh is of interest: "It was in 1816 that the wheat did not ripen till September. The corn crop was almost wholly lost, and there was a nightly frost from June 6 to 12."

Meteorologic data have been collected in Rochester since 1830. Prior to 1872 the observations were made at the Rochester Collegiate Institute under the direction of the Regents of the University of the State of New York. Since 1872 the observations have been made at the Rochester Weather Bureau Station. These data give a pretty adequate picture of climatic conditions in central Monroe county, but data from other parts of the county, fragmentary by comparison, indicate the possibility of significant differences within even such a limited area and the desirability of further investigation. Records at Brockport date from 1889 and readings of temperature and monthly precipitation were kept at Charlotte during the nine years 1860–67 and 1871.

Comparison of these data and those from Le Roy, Avon, Hemlock and Macedon, nearest points of record, indicate that the average annual rainfall in the latitude of Brockport and Rochester, exceeds that at the mouth of the Genesee (Charlotte) and also that up the valley at Avon and Hemlock; yet Le Roy, just southwest of Monroe county, has a tenth greater annual precipitation than Rochester, most of the difference being due to greater snowfall. However Rochester has more days with some precipitation than any of these stations with which it has been compared. Effect of proximity to Lake Ontario is indicated by frost dates and data on length of growing season. Data are not available for Charlotte, but Rochester has a growing season which averages at least two weeks longer than the other stations mentioned.

A broader regional comparison is made by Mordoff (1925) for the entire state. It is of interest that Rochester has the highest percentage of possible sunshine and lowest relative humidity during the growing season of the nine official weather bureau stations distributed throughout the state.

Mean annual precipitation along Lake Ontario and in the lower Genesee valley is decidedly below the mean for the state but is usually well distributed throughout the year. At Rochester the win-

ter months have the least and June and July have the greatest mean precipitation. Comparison of the corresponding years' records with those kept at Charlotte reveal that only in late fall is the monthly precipitation at Charlotte likely to exceed that at Rochester and the monthly means are all lower at Charlotte.

The century of continuous weather records at Rochester indicates severe drought periods in the decades following 1830, 1880 and 1930 and occasional intervening periods of deficient precipitation. Such extremes as these may be far more important in their effect on both native and introduced vegetation, and therefore upon man, than the more uniform precipitation of the years between, or the long-time mean precipitation.

Temperature extremes may have similar significance. The severe winter of 1933–1934, which reached a record low of –22° F. at Rochester and –25° F. at Brockport, following two drought years, destroyed almost half the commercial acreage of apple orchards in Monroe county, offsetting the effects in orchard growth of the preceding forty normal years (Monroe County Division of Regional Planning, 1938). During this same winter the native shrubs spicebush (*Benzoin aestivale*) and buttonbush (*Cephalanthus occidentalis*) were also killed in parts of Monroe county.

The following climatic summary compares the records of the Rochester station, at an elevation of 500 feet, and the Brockport station, at an elevation of 537 feet. Each of the reported mean values is based on at least 38 years of record. Data are derived from Mordoff (1925) and Geren (1941).

Climatic Summary

Rochester *Brockport*	*Rochester*	*Brockport*
Mean temperature	47.3° F.	47.2° F.
Mean growing season temperature	64.7° F.	64.6° F.
Highest temperature	102° F.	104° F.
Lowest temperature	–22° F.	–25° F.
Mean growing season	178 days	162 days
Average date of latest killing frost	April 26	May 4
Average date of earliest killing frost	Oct. 21	Oct. 13
Percentage of growing seasons less than 150 days	5%	21%
Mean annual precipitation	31.29 in.	31.92 in.
Mean growing season precipitation	14.24 in.	14.75 in.
Mean annual snowfall	78.8 in.	78.3 in.
Mean number of days with precipitation	167 days	138 days

ROCHESTER ACADEMY OF SCIENCE

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AN ECOLOGICAL SURVEY OF THE VEGETATION OF MONROE COUNTY NEW YORK

by

ROYAL E. SHANKS, Ph. D.

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FIGURES 1 to 45

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FIGURE 1—The climax beech-sugar maple association was the most extensive forest type of Monroe County, occupying the better upland soils. Photographed northwest of Pittsford.

FIGURE 2—Secondary stand of sugar maple atop a drumlin, southeast corner of the Town of Riga. When this area was surveyed in 1791 the timber was principally oak.

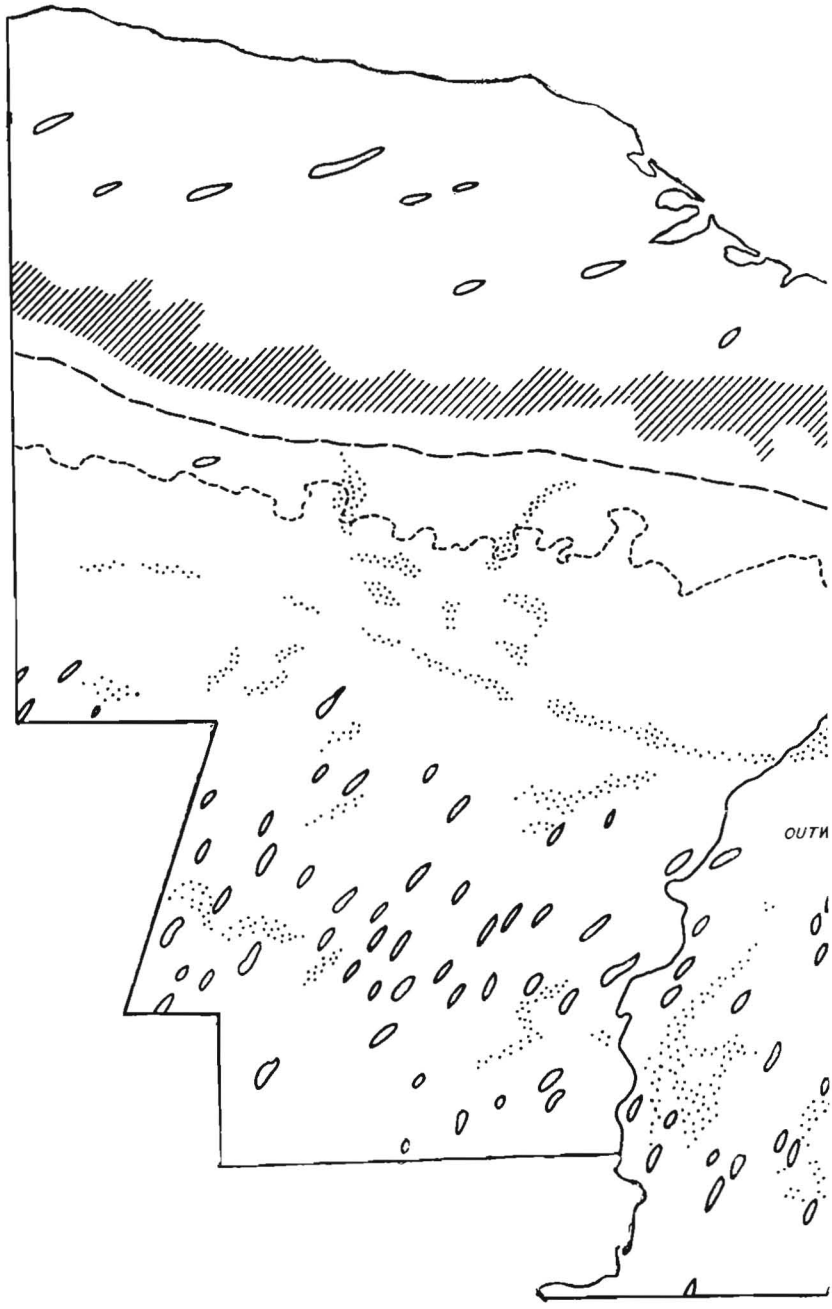
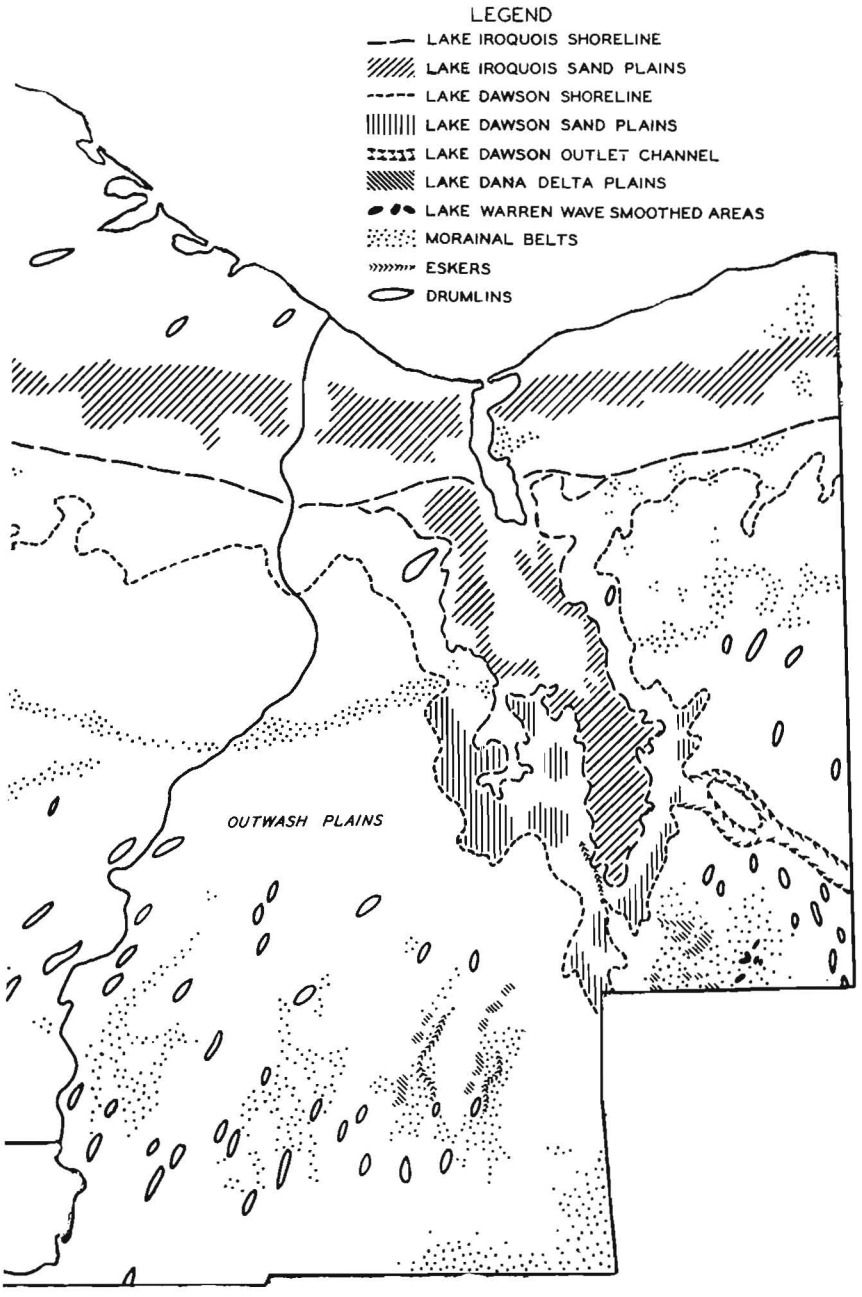


FIGURE 3—Map showing physiography of Monroe County.


LEGEND
LAKE IROQUOIS SHORELINE
LAKE IROQUOIS SAND PLAINS
LAKE DAWSON SHORELINE
LAKE DAWSON SAND PLAINS
LAKE DAWSON OUTLET CHANNEL
LAKE DANA DELTA PLAINS
LAKE WARREN WAVE SMOOTHED AREAS
MORAINAL BELTS
ESKERS
DRUMLINS
OUTWASH PLAINS

MONROE COUNTY ECOLOGICAL SURVEY - WOODLOT ANALYSIS

TREE SPECIES	%	R
Arbor vitae		
Ash, Black		
Red		
White		
Aspen, Trem.		
L-T		
Basswood		
Beech		
Birch, Black		
Yellow		
White		
Butternut		
Cherry		
Chestnut		
Cottonwood		
Cucumber		
Elm, Amer.		
Slippery		
Hemlock		
Hickory,		
Bitternut		
Pignut		
Shagbark		
Small Pig.		
Ironwood		
Locust		
Maple, Black		
Red		
Sugar		
Oak, Black		
Chestn.		
Mossy C.		
Red		
Sw. Wh.		
White		
Yellow		
Pine, Pitch		
White		
Poplar, Bals.		
Sassafras		
Sycamore		
Tamarack		
Tulip		
Tupelo		
Willow, Black		

Date_____ Town_____ Area No._____

Surveyed by_____

FOREST TYPES

SOIL TYPES

HISTORY
- __Original forest
- __Selective cutting
- __Complete lumbering
- __Cultivation

PASTURING
- __Excessive
- __Moderate
- __Slight
- __None

STAND
- Mature Timber_____%
- Av. canopy ht._____ft.
- Av. diam. of dominants _____in.

REPRODUCTION
- __Good
- __Fair
- __Occasional
- __None

UNDERGROWTH	Small Trees	Shrubs	Vines
Abundant			
Frequent			
Patches			
None			

Blue beech	Currant	Spicebush
Choke cherry	Deerberry	Viburnum
Dogwood, Fl	Dogwood, Gray	Maple-leaf
Dogwood, Alt.	Dogwood, Red Osier	Toothed
Hawthorn	Elder, Common	Wahoo
Pawpaw	Elder, Red	Waxberry
Shadbush	Hazel, Beaked	Winterberry
Striped maple	Hazel, Amer.	Yew
Sumac	Hi-bush cranb.	
Willow	Honeysuckle	
Witch hazel	Leatherwood	Bittersweet
	Prickly ash	Blackberry, CR
Alder	Raspberry, Bl.	Carrion vine
Azalea	Raspberry, Red	Grape
Blackberry	Rose	Moonseed
Blueberry, High	Sheepberry	Poison ivy
Blueberry, Low	Shrubby Cinquef.	Solanum
Buttonbush	" St. Johnsw.	Woodbine

GROUND COVER (dominants listed on back of sheet)

	Herbs	Ferns	Sedges	Grasses	Mosses
Abundant					
Frequent					
Occasional					
Rare					
None					

FIGURE 4 Woodlot analysis form used in the survey of existing natural vegetation.

FIGURE 5 —The oak openings of Monroe County were characterized by prairie species. The taller grass is Indian grass (*Sorghastrum nutans*), the shorter is little bluestem (*Andropogon scoparius*). On deep sand near Pittsford.

FIGURE 6 –A dry prairie association, similar to that in FIGURE 5, on the shallow overdrained soils of the Onondaga escarpment. Five Points Road, Town of Rush.

FIGURE 7—The dominant grasses of the prairie, little bluestem (*Andropogon scoparius*) and tall bluestem (*Andropogon furcatus*), growing as bunch grasses on the stabilized dunes near East Rochester.

FIGURE 8—Other prairie species were also common in our area. This prairie sunflower (*Helianthus grosse-serratus*) occurred as a roadside species in the Town of Chili.

FIGURE 9—The deep sands near Irondequoit Bay were an isolated station for pitch pine (*Pinus rigida*), here shown near Westfall Road, Penfield.

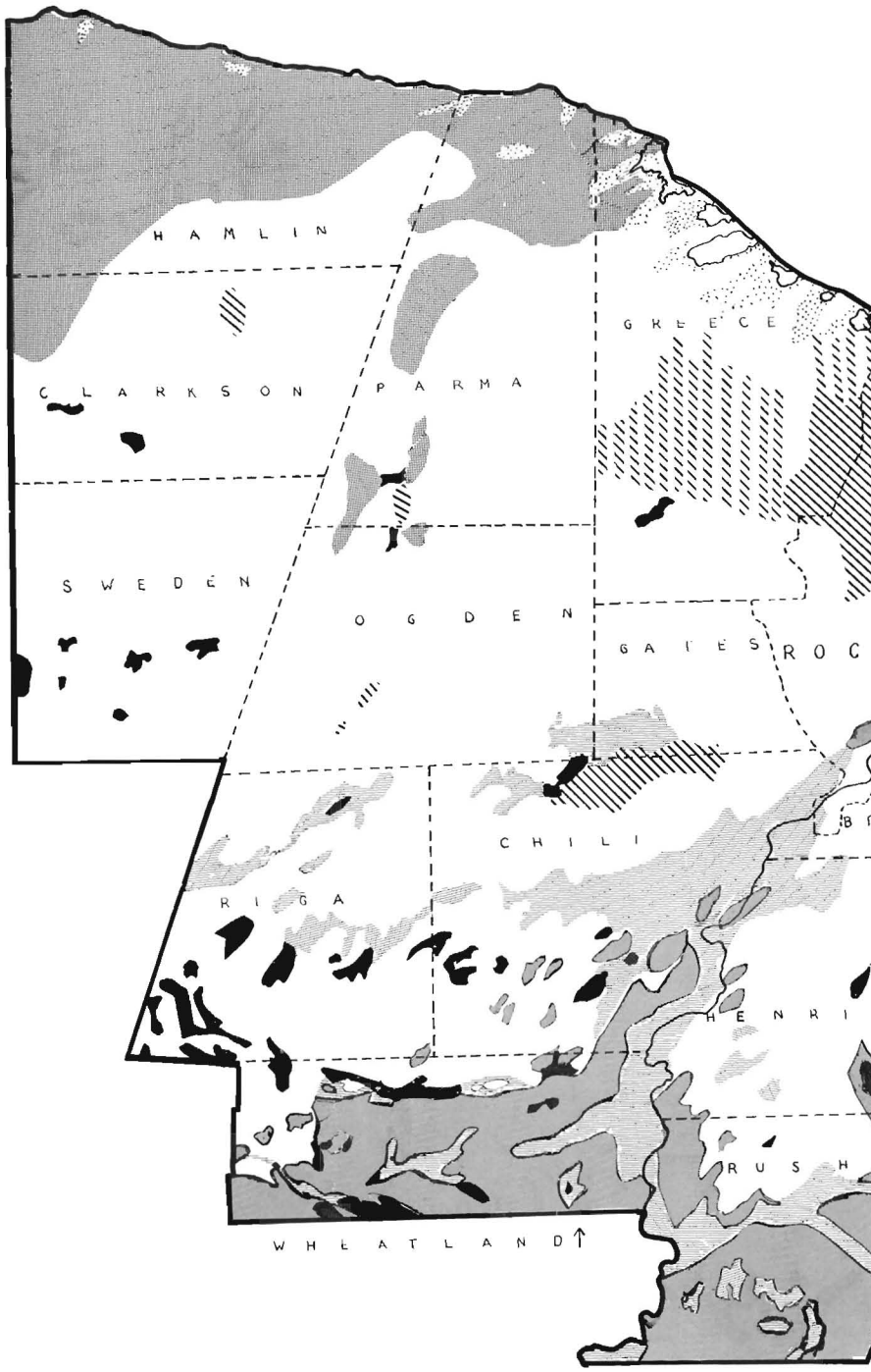
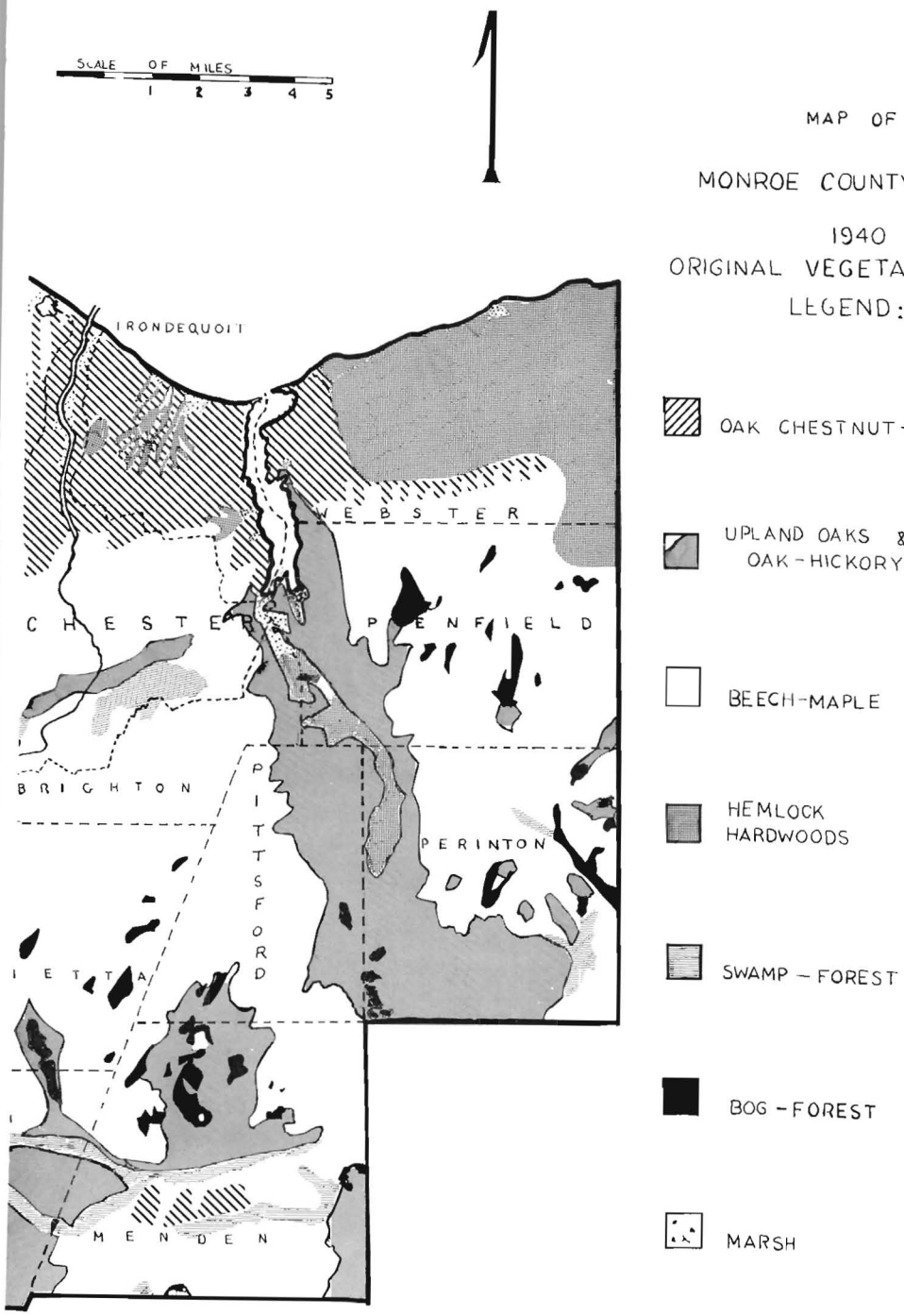


FIGURE 10—Map of Monroe County showing general distribution of original forest types.


SCALE OF MILES
1 2 3 4 5
MAP OF
MONROE COUNTY, N. Y.
1940
ORIGINAL VEGETATION.
LEGEND:
OAK CHESTNUT-PINE
UPLAND OAKS & OAK-HICKORY
BEECH-MAPLE
HEMLOCK HARDWOODS
SWAMP - FOREST
BOG - FOREST
MARSH
IRONDEQUOIT
WEBSTER
CHESTER
PENFIELD
BRIGHTON
PITTSFORD
PERINTON
MENDEN

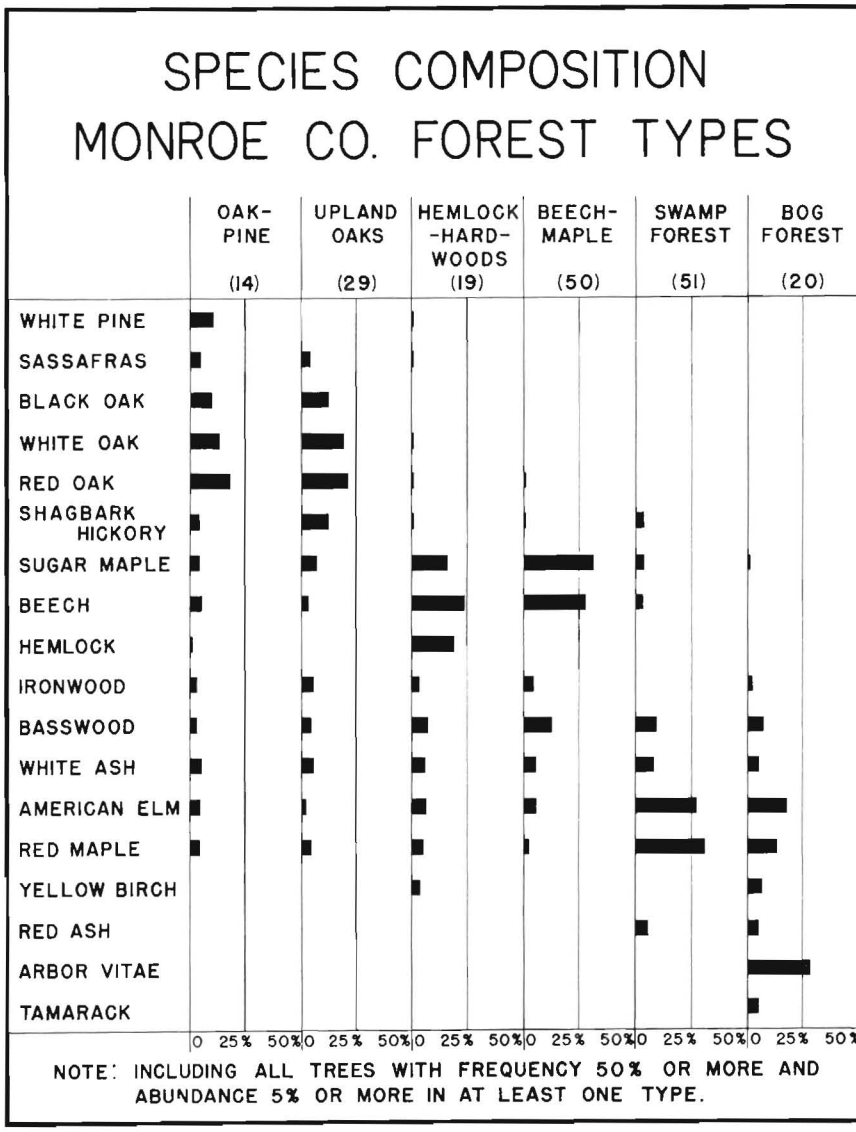

SPECIES COMPOSITION
MONROE CO. FOREST TYPES
OAK-PINE (14)
UPLAND OAKS (29)
HEMLOCK-HARDWOODS (19)
BEECH-MAPLE (50)
SWAMP FOREST (51)
BOG FOREST (20)
WHITE PINE
SASSAFRAS
BLACK OAK
WHITE OAK
RED OAK
SHAGBARK HICKORY
SUGAR MAPLE
BEECH
HEMLOCK
IRONWOOD
BASSWOOD
WHITE ASH
AMERICAN ELM
RED MAPLE
YELLOW BIRCH
RED ASH
ARBOR VITAE
TAMARACK
0 25% 50%
NOTE: INCLUDING ALL TREES WITH FREQUENCY 50% OR MORE AND ABUNDANCE 5% OR MORE IN AT LEAST ONE TYPE.

FIGURE 11

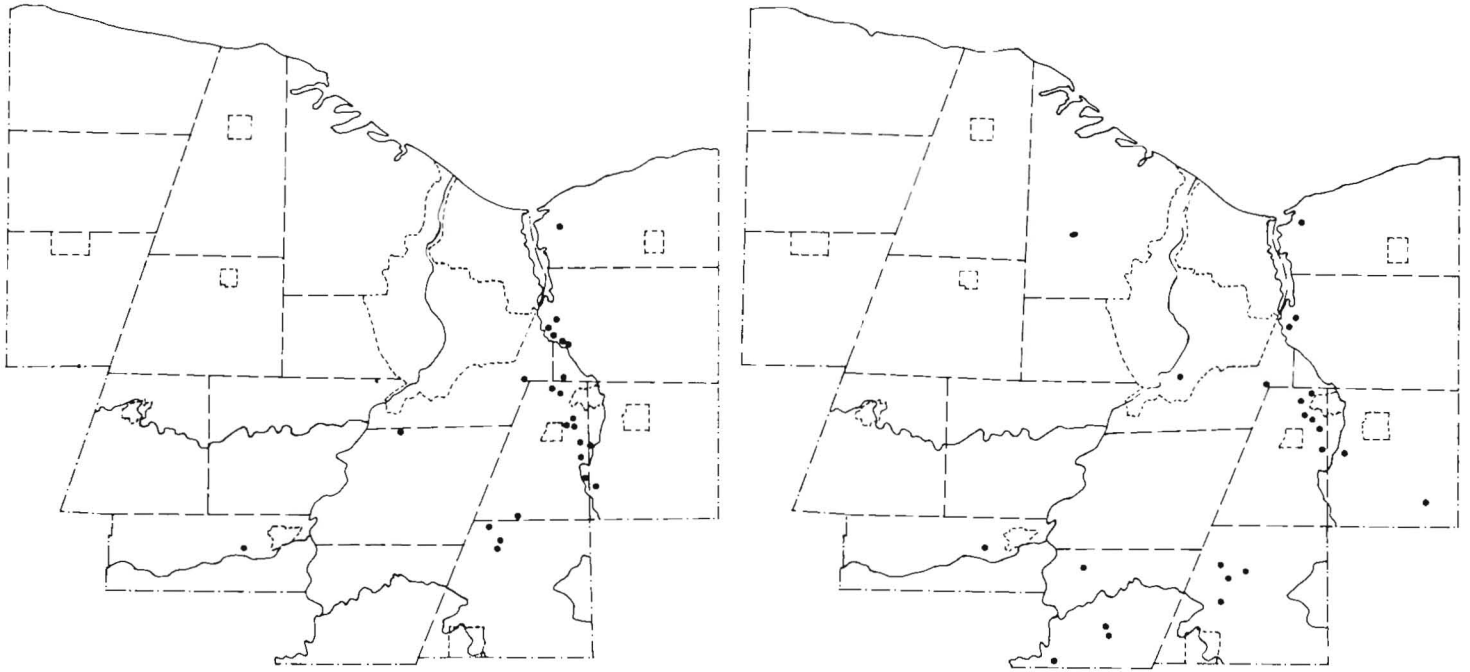


FIGURE 12—Maps showing present distribution of tall bluestem grass, *left*, and Indian grass, *right*, in Monroe County.

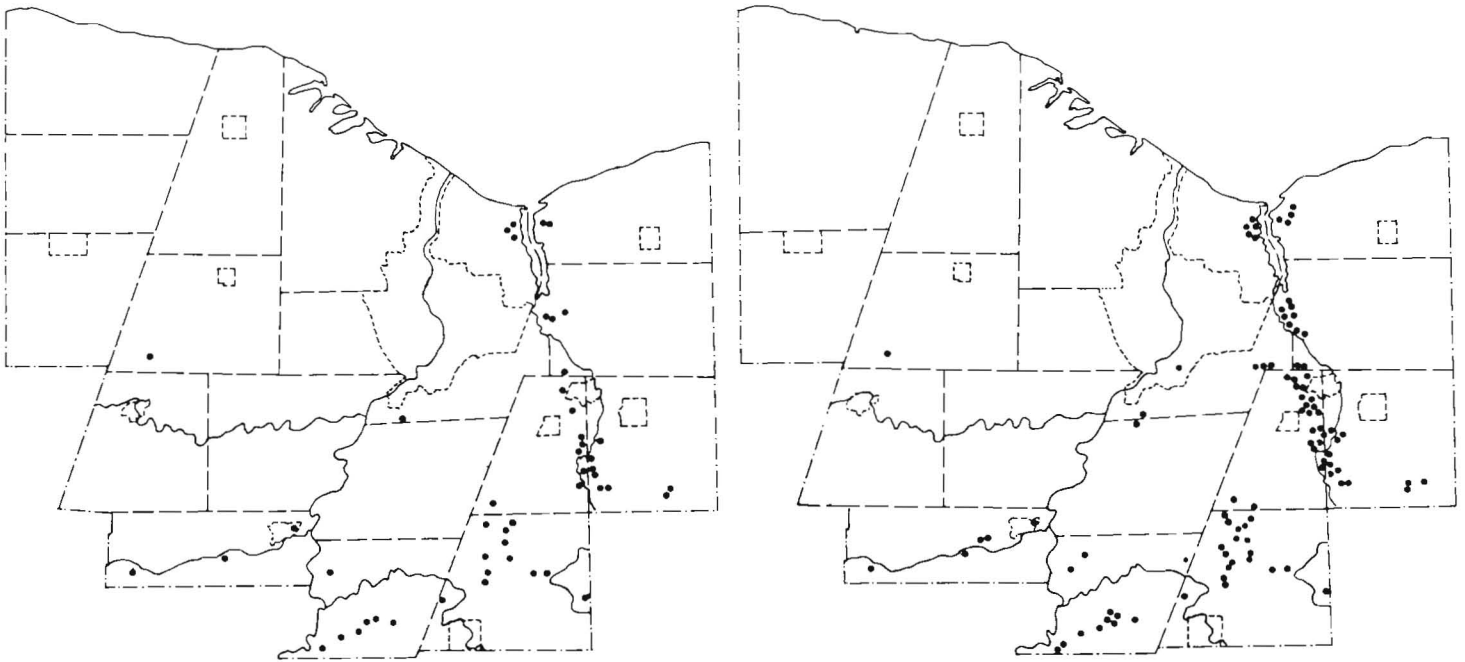


FIGURE 13—Maps showing present distribution of little bluestem grass, *left*, and combined distribution of all three prairie grasses, *right*, in Monroe County.

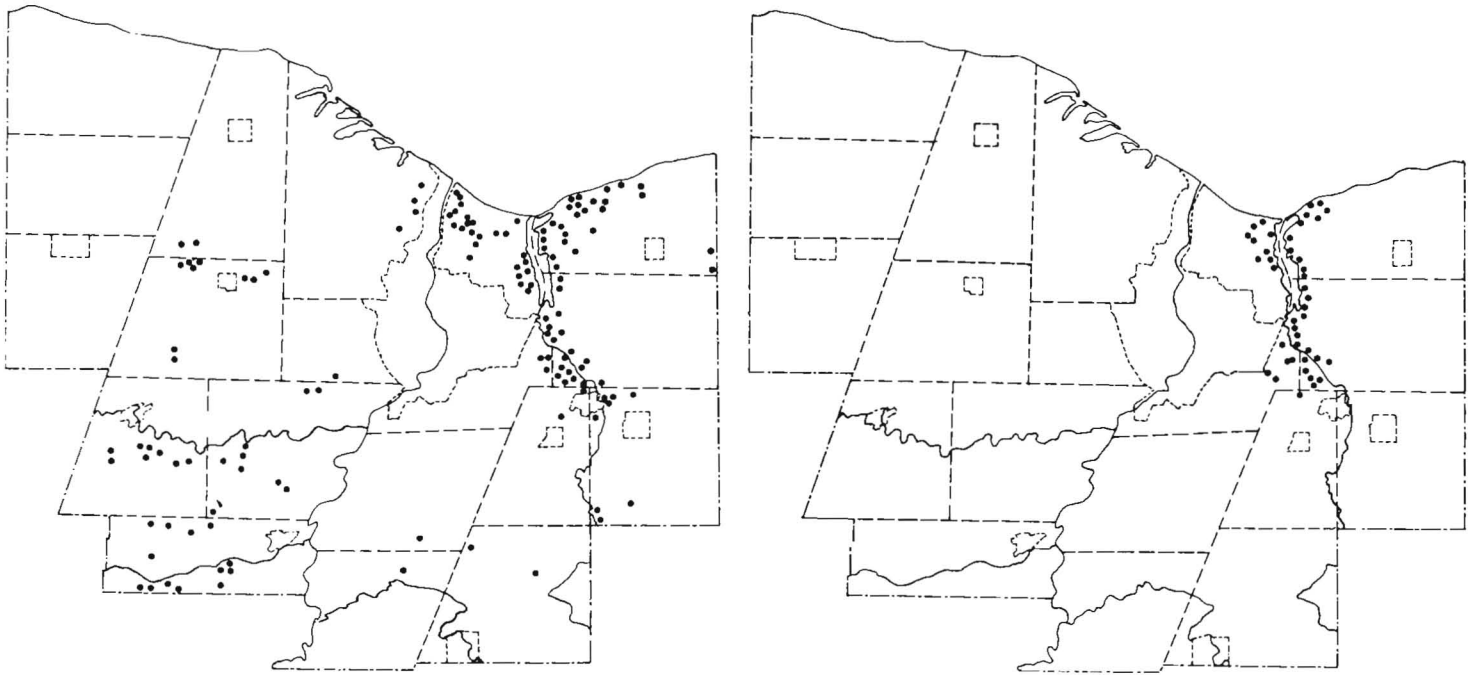
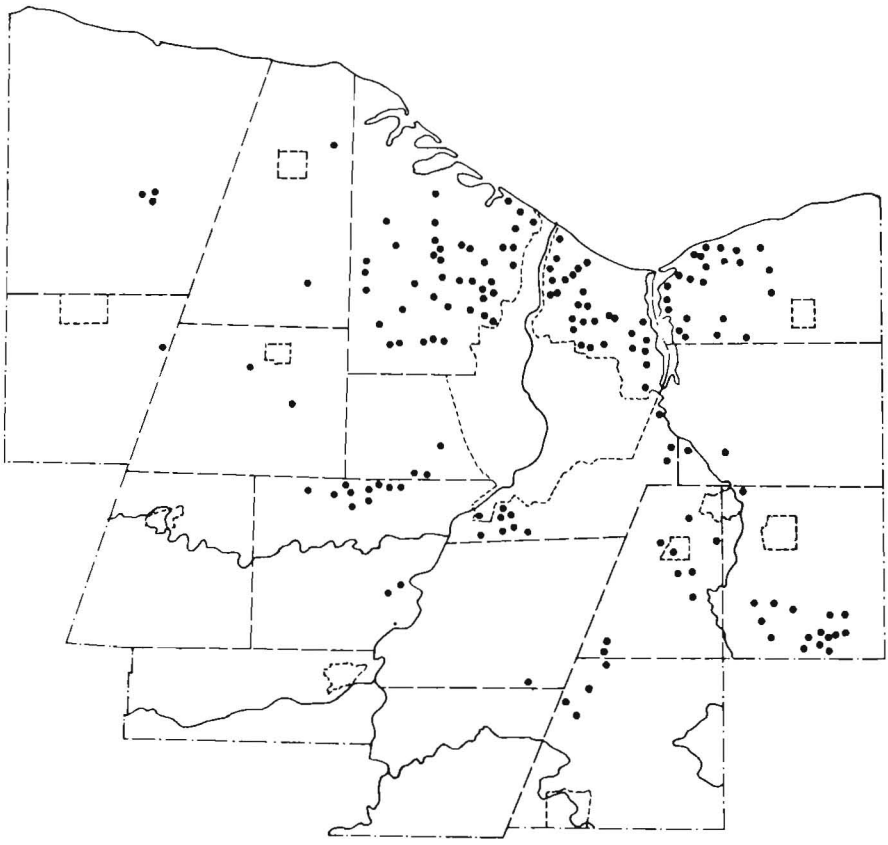


FIGURE 14

FIGURE 15—White pine occurred very locally on this gravelly upland site, Widger Road, Ogden.



CHESTNUT

FIGURE 16

FIGURE 17—Chestnut was an important associate of the oaks and pines on the drier sites. These blight-killed chestnuts are being succeeded by aspen. Chestnut Ridge, Chili.

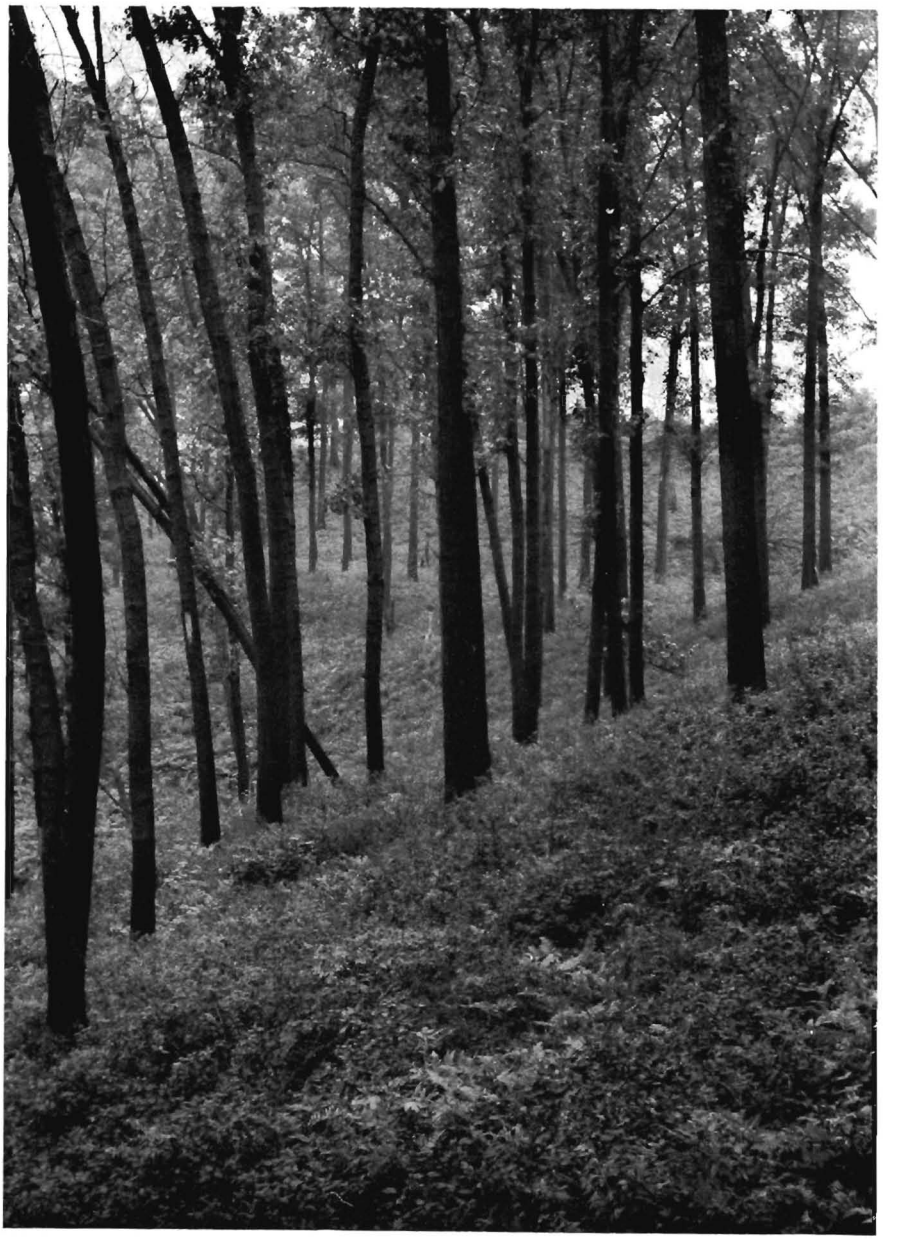
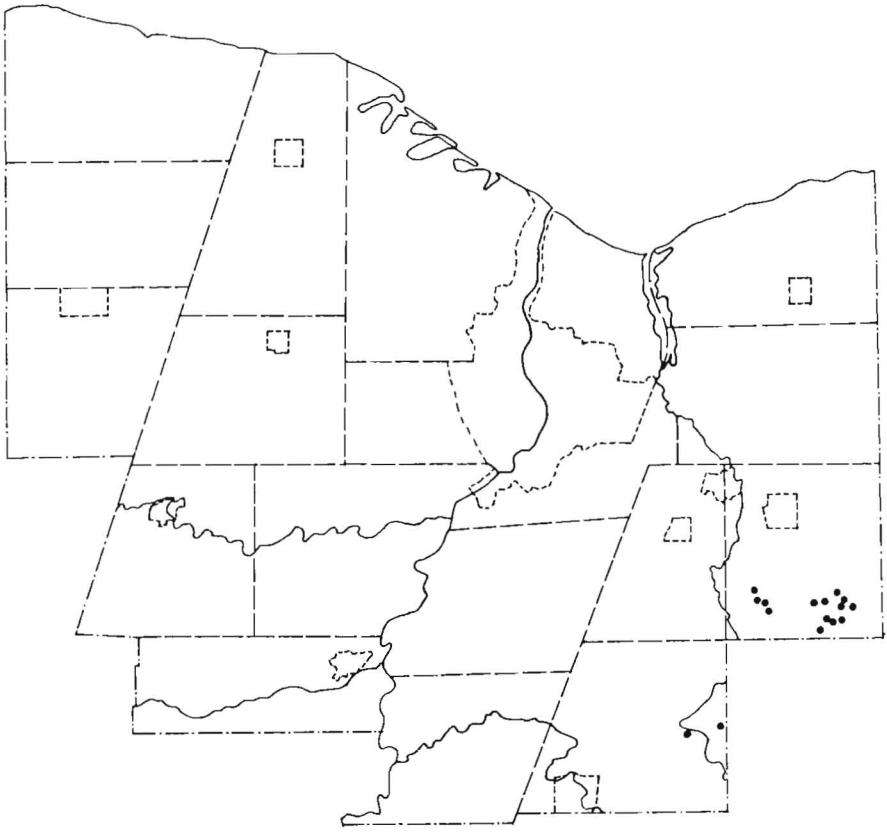


FIGURE 18.—Secondary black oak-white oak stand on the steep sand slopes east of Irondequoit Bay, originally occupied by pine, and now frequently burned over. The ground cover is bracken fern and New Jersey tea.



CHESTNUT OAK

FIGURE 19

FIGURE 20—Old stand of white, black, and red oak, invaded by sugar maple and beech. Near Irondequoit Creek, west of Fairport.

FIGURE 21—One of several old white oaks in a much younger stand of beech and sugar maple on the bank of the Genesee River, Henrietta (40 inches DBH).

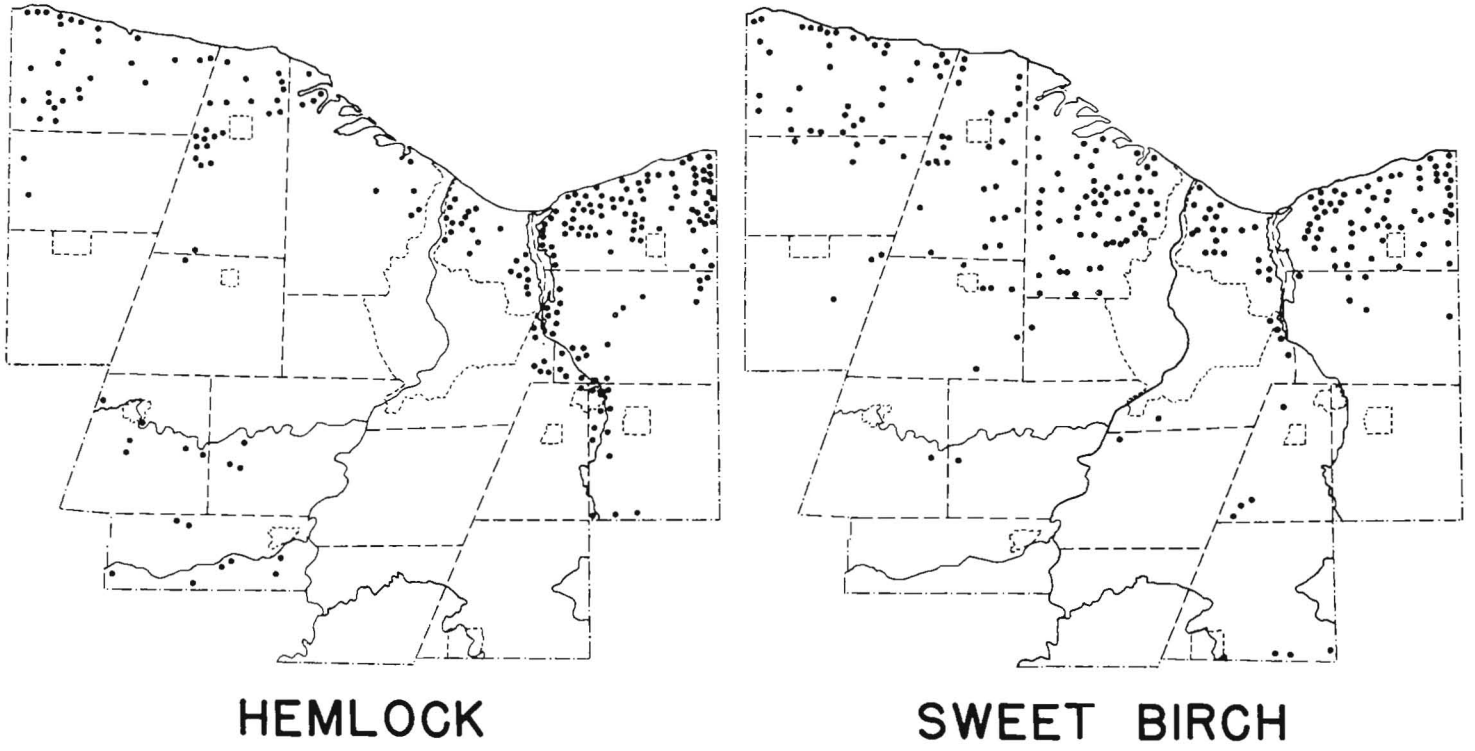
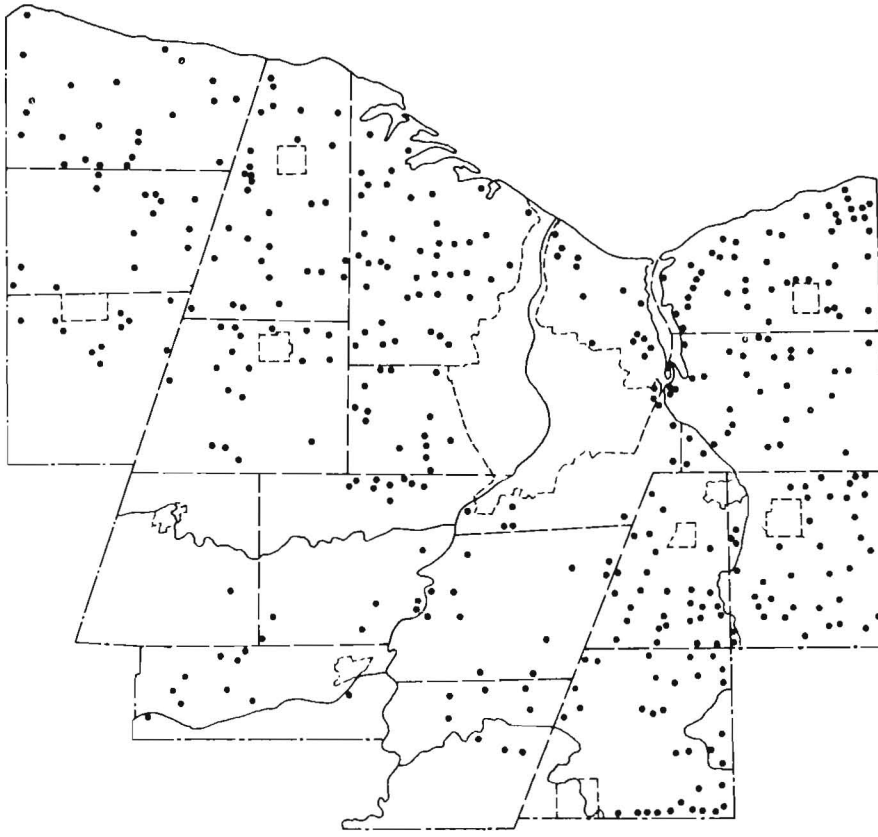


FIGURE 22



TULIP TREE

FIGURE 23

FIGURE 24—An unpastured beech-sugar maple stand with various age-classes present, including the characteristically abundant sugar maple reproduction. Town of Pittsford.

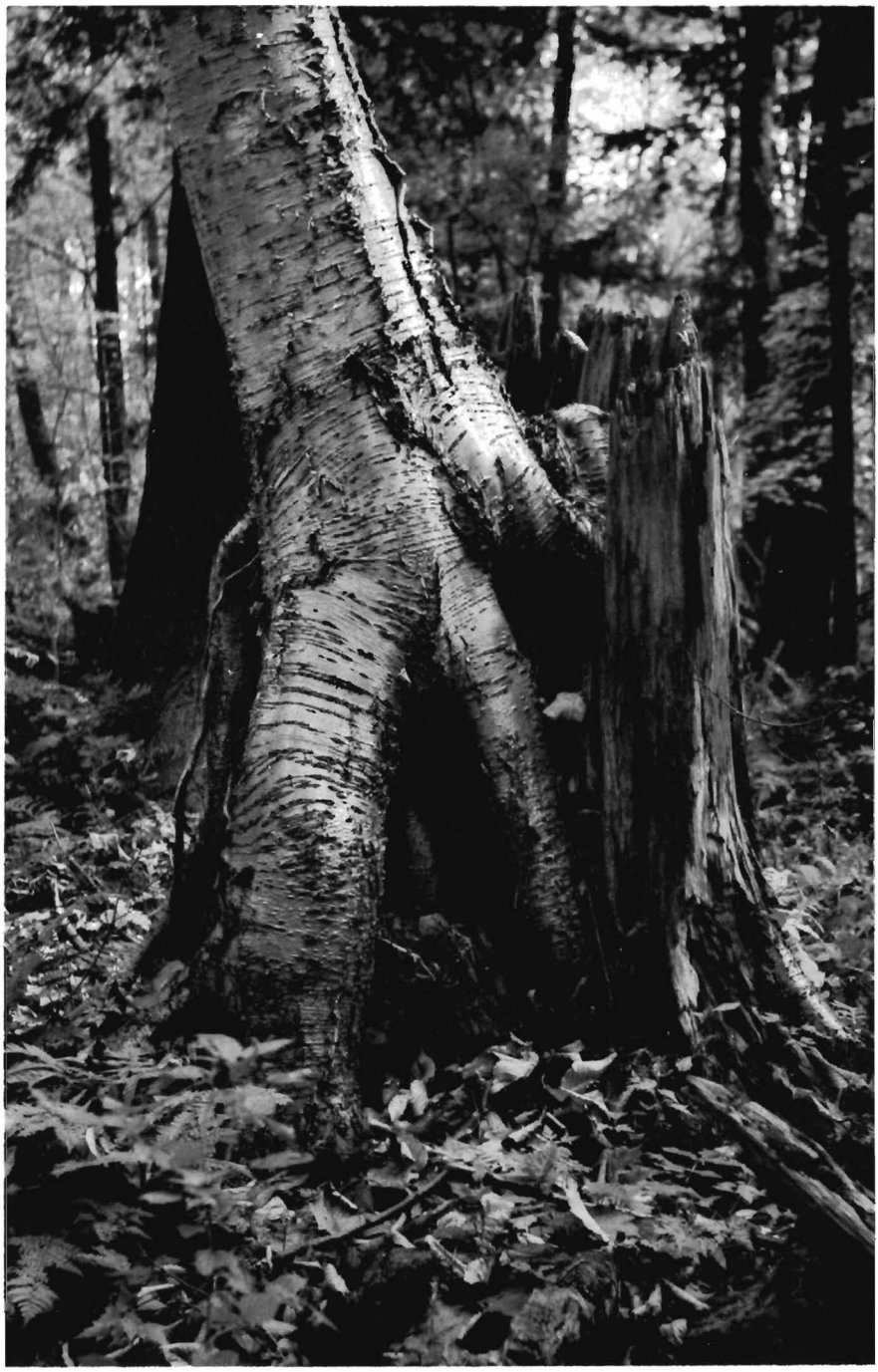


FIGURE 25—Yellow birch (8 inches DBH) perched on an arbor vitae stump, near Union Street, Town of Chili.

FIGURE 26—Natural drainage development has lowered the water table and resulted in the death of these large trees of arbor vitae near Union Street, Town of Chili.

FIGURE 27—A view in the woodlot, recorded in FIGURE 26, showing white pine, yellow birch, and hemlock, the species which have succeeded arbor vitae.

FIGURE 28—A general view of the hemlock-hardwood forest shown in the two preceding pictures. A rich herbaceous vegetation including a wide variety of ferns covers the very uneven forest floor.

FIGURE 29—Hobble bush (*Viburnum alnifolium*), a characteristic associate of hemlock, in the mixed forest of the northeastern corner of the county. South of Woodhull Road, Town of Webster.

FIGURE 30—Beech, birch, hemlock, and sugar maple are all important in this fine example of the hemlock-hardwood forest. Hale Woods, Town of Webster.

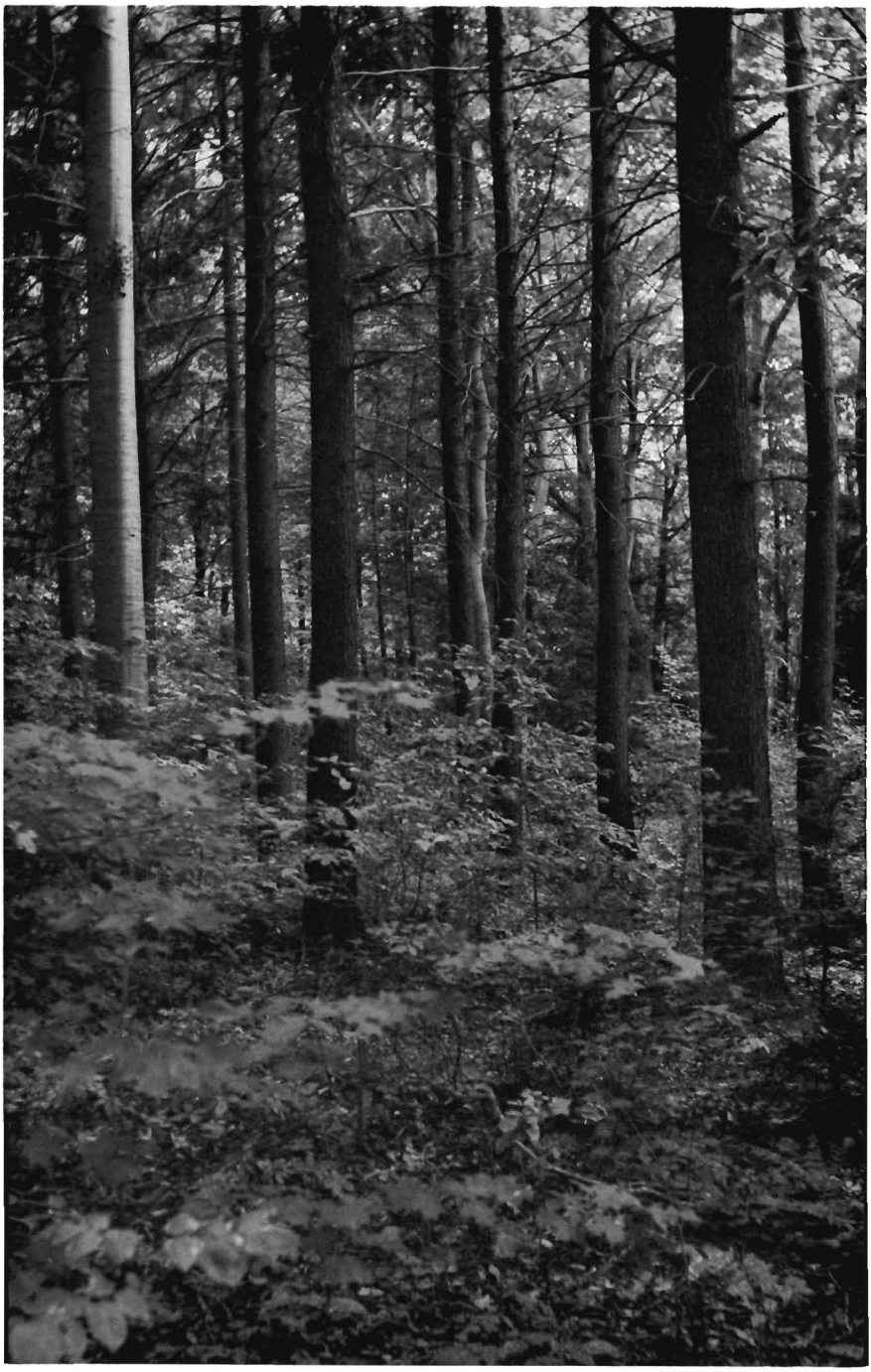


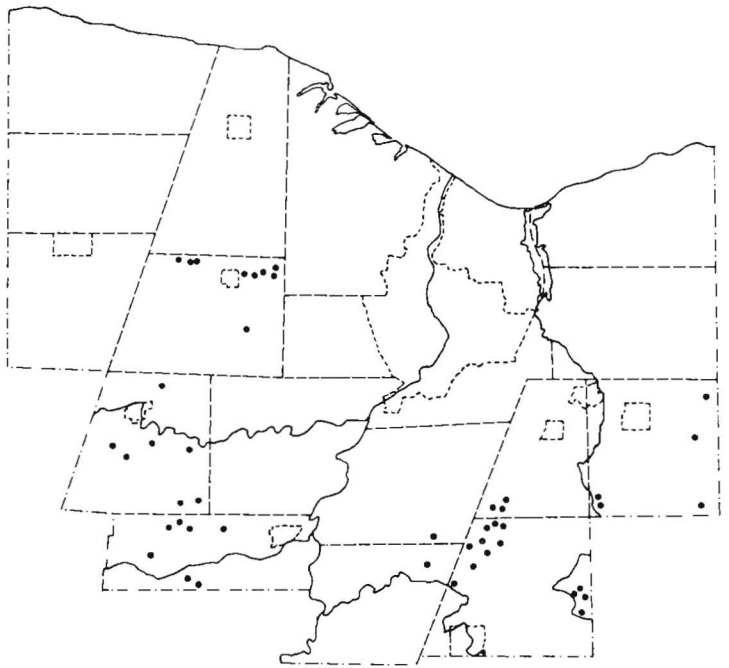
FIGURE 31—A remnant of the hemlock-hardwood forest which occupied extensive areas north of the Lake Iroquois beach ridge. Hemlock and beech are the dominants in this upland area northeast of Hilton, in the Town of Parma.

FIGURE 32—The extensive silt plains of extinct Lake Scottsville, west of the Genesee River, Town of Chili, with a remnant of their continuous swamp forest in the distance.

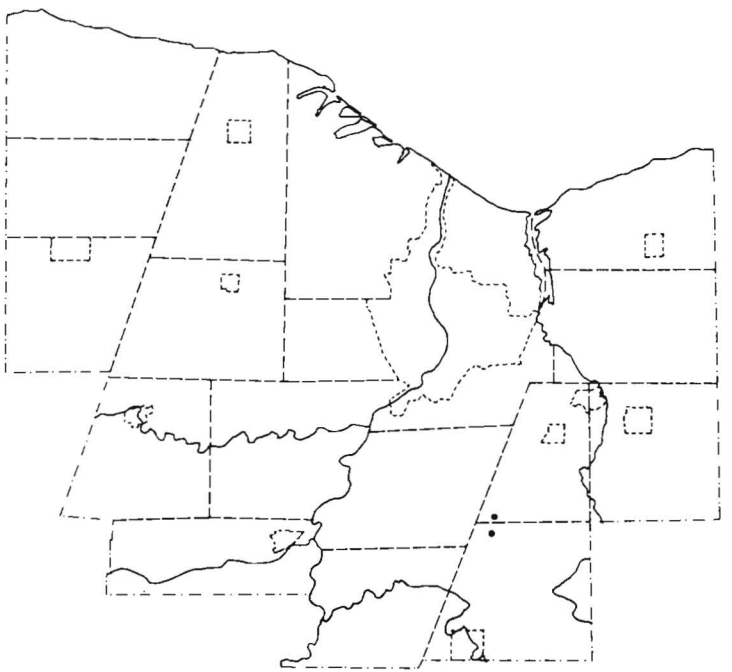
FIGURE 33—Interior view of the swamp forest shown in FIGURE 32. Elm and soft maple are most abundant in this particular portion and the forest floor bears a luxuriant herbaceous vegetation.

FIGURE 34—The pawpaw (*Asimina triloba*), here approaching the northern limit of its range, occurred in a few places in western Monroe County. This typical grove occurs east of Brockport.

FIGURE 35—A clump of black spruce, with tamarack and high bush blueberry at the edges. Black spruce is restricted in Monroe County to the Mendon Ponds area.



TAMARACK



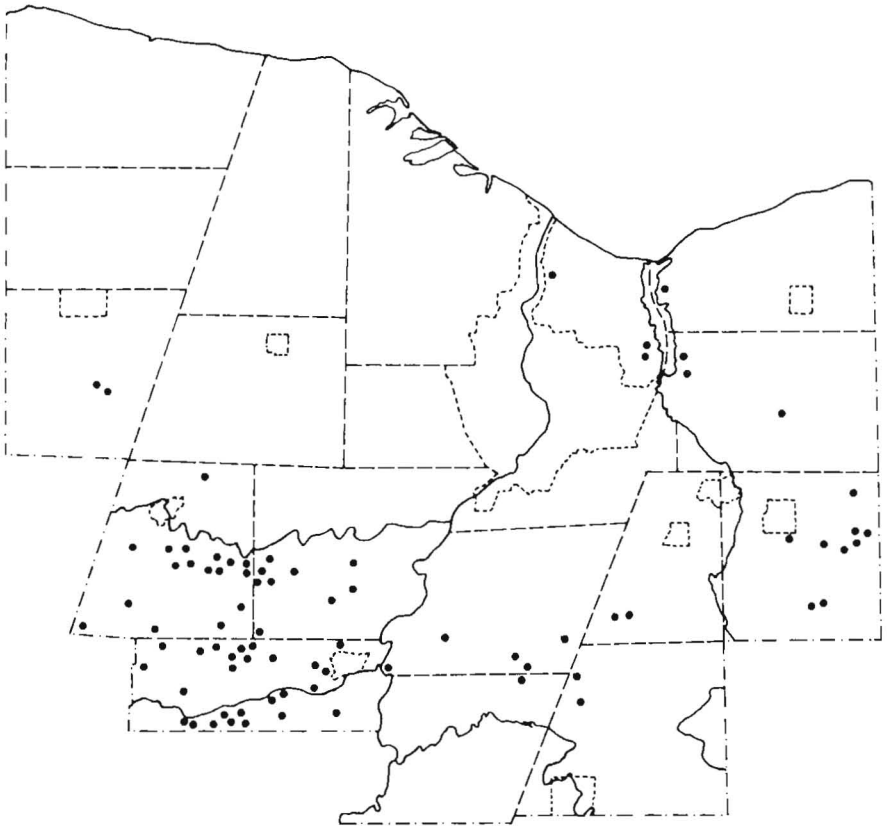
BLACK SPRUCE

FIGURE 36

FIGURE 37—Closed bog forest of tamarack with cinnamon fern in the foreground. Powder Mill Park, Town of Perinton.

FIGURE 38—Kennedy bog, Mendon Ponds Park. Patches of tall shrubs and occasional trees of tamarack have invaded the low heath. *Above:* Chain fern and cotton sedge may be seen in the foreground. *Below:* Small areas of the bog have not yet been invaded by the heaths, and are characterized by sphagnum moss and cranberry, with scattered pitcher plants and bog orchids.

FIGURE 39—A typical remnant of the arbor vitae bogs which characterized the Salina depression across the county. Such bogs are underlain with marl. Near West Chili.



ARBOR VITAE

FIGURE 40

FIGURE 41—White pine characteristically overtopped the associated arbor vitae, black ash, and red maple of the bog forests in the southwestern part of the county. Riga-Buckbee Corners Road.

FIGURE 42—Yew (*Taxus canadensis*) forms a dense ground cover in parts of the Attridge Road arbor vitae bog. Town of Riga.

FIGURE 43—Emergent vegetation, principally water lilies, pickerel weed, bulrushes, and cattails, invading the open water of Buck Pond, Greece.

FIGURE 44—Extensive cattail marshes occupying the head of Irondequoit Bay, south of Atlantic Avenue, Penfield.

FIGURE 45—Marsh dominated by *Calamagrostis* and *Carex*. Mud Pond. Mendon lies just behind the fringe of trees and tall shrubs in the background.

METHODS EMPLOYED IN THE STUDY OF THE VEGETATION

Survey of Present Vegetation

The basic approach to the plant ecology of Monroe county in this study has been a survey of the present natural plant cover of the county. The entire county has been covered systematically and every woodlot or other natural or semi-natural area has been visited by a field man or field party. Sufficient time was spent in each area to accomplish the following objectives:

1. to record the species present—trees, shrubs and vines, and the most abundant and characteristic plants making up the ground cover;
2. to estimate in percentage the abundance of the tree species making up the forest canopy;
3. to obtain data on apparent history, present use, condition of the stand and reproduction;
4. to map the distribution of present plant cover types.

In order to accomplish the first three objects a mimeographed woodlot analysis form was devised and used throughout the survey (Figure 4). It will be observed that this form includes alphabetically arranged check lists of the trees, small trees, shrubs and vines most likely to be encountered, and tables and blanks for the recording of other data. It has the advantage of putting all data on a comparable basis and makes the data more readily available than random notes. Being made up largely as a check list, it saves considerable time and serves as a reminder of points that might sometimes be neglected.

The fourth field objective—the mapping of cover types—was accomplished at the same time. Outlines of woodlots were pantographed from aerial photographs to field maps at a scale of 1000 feet to the inch and assigned consecutive reference numbers for each town. The generalized cover types were determined by preliminary reconnaissance and a color legend established. The types were then mapped with colored pencils on the field maps. This mapping was done after the woodlot analysis sheet had been filled out and before the field party left the area. If the area covered by a single woodlot analysis sheet included more than one cover type it was so indicated in the space provided, with an estimate of the portion of the area covered by each type (for example, Beech-Sugar Maple 10%, Elm-Red Maple 90%). However in cases where a single type did not predominate in an area, a separate sheet was made out for each type, since abundance estimates cutting across two or more distinct types were felt to have little value.

The following criteria were employed in establishing the generalized cover types to be recognized in field mapping:

1. that each type should occupy significant total area and occur in large enough units to be shown on a map of the scale to be used;
2. that each type should be sufficiently generalized to include a series of related stands, although these stands might vary somewhat in composition;
3. that the total number of generalized types should not be too great for practical use in the field;
4. that the type names used should be descriptive and should correspond insofar as possible with names in general use;
5. that the types should be so defined as to be readily recognized in the field;
6. the classification set up should include the entire range of vegetation in the county, so that any stand of significant size would be included in a generalized type.

The following list briefly defines the cover types recognized in field mapping:

Present Natural Cover Types of Monroe County

Oak-Pine Type—
usually dominated by upland oaks but with white or pitch pine present.

Upland Oak Types—
including black oak-white oak, mixed oaks and oak-hickory.

Beech-Sugar Maple Types—
including sugar maple predominant, typical beech-sigar maple and sugar maple-basswood.

Hemlock-Northern Hardwood (Mixed Forest) Types—
composed principally of beech, birch, hemlock and sugar maple.

Swamp Forest Types—
including elm-ash-soft maple, basswood-elm, elm-swamp oaks, and willow-cottonwood.

Bog Forest Types—
including arbor vitae, tamarack, white pine and black ash with more or less red maple, elm and yellow birch.

Dry Pioneer Types—
including sumac, sassafras, locust, blueberry, huckleberry, blackberry and raspberry.

Hawthorn Type—
including areas predominantly hawthorn (usually pastured).

Aspen Types—
including areas predominantly aspen (followig fire or complete lumbering on certain sites).

Wet Pioneer Types—
including buttonbush, alders, shrubby willows, and red osier.

Sedge-Meadow Types—
including sedges, rushes, bulrushes, and burreed with more or less willow-herb.

The writer organized this program during the summer of 1938, spent a part of that summer training and working with the field men and was able to supervise and check the field work closely. During the summers of 1938, 1939, and 1940 he visited all parts of the area, some of them repeatedly, in order to check on seasonal change and make comparative observations as well as to check the records submitted by the other field men.

Most of the field survey work was done by field men working in pairs. As soon as a town was completed the field maps were transferred to a town map and checked for completeness. These town maps are filed with the Monroe County Division of Regional Planning. The original woodlot analysis sheets and field maps for the entire county are filed with the New York State Museum in Albany and duplicates of the woodlot analysis sheets for the entire county are filed with the Monroe County Division of Regional Planning in Rochester.

Investigation of Historical Records

Historical records were used as an additional source of information in constructing a picture of the original vegetation of the region. Remnants of the natural vegetation constitute the principal basis for this picture when present, and historical records may then be employed merely as a confirmatory source, but we must lean more heavily on such records in areas where remnants are not available. Such records also indicate the degree of modification of the primeval vegetation by white man and the history of that modification.

If they deal with long enough periods of time, historical records may provide a basis for interpreting vegetation pattern and species distribution. One line of historical investigation that has yielded interesting results from this long-time point of view is the study of the vertical distribution of fossil pollen of various species in bog peat deposits. There is need for such information from this immediate region. However work done in the middle west (Sears 1935, 1942a, 1942b), in central New York (McCulloch 1939), in southeastern Canada (Auer 1930), and in New England (Deevey 1939), suggests the major phases of vegetational history since the last glaciation. This approach to interpretation of the vegetation pattern and associated distribution problems will be discussed in a later section of this report.

In mapping primeval vegetation more recent historical sources are employed—the records and reports of people who saw the region before

it had been greatly modified by the axe. The region has been settled and has supported a fairly large population too long for the reports of people now living to have much value in this connection, except as these people are the repositories of family tradition. The journals and accounts of early settlers, land agents and travelers are more valuable sources.

The Mohawk and Ontario lowland has been a natural highway to the interior of the continent since Indian times. The location of Niagara Falls, a natural wonder of great attraction even in pioneer times, has also routed a great deal of traffic through this section of western New York. People interested in a natural feature such as Niagara Falls might also be expected to be interested in the natural features of the country through which they traveled. Their journals and accounts, with their liberal sprinkling of local anecdote, make interesting reading and frequently yield rather definite information. The best of these is the booklet by Robert Munro, published at Fredericktown, Maryland in 1804, probably written with a view to attracting settlers to the Genesee country. This booklet is entitled *A View of the Present Situation of the Western Parts of the State of New York, Called the Genesee Country,* and in its preface several people then living in the region were cited as references as to its accuracy. It should be kept in mind while reading the following quoted material that the region thus defined includes not only present Monroe county but also a number of neighboring counties in western New York.

"The quality of the soil is various, but in the better or lower part of the country beforementioned a rich loamy soil is the most common, and it is covered on the top with a loose black mould from six to ten inches thick. This part of the country is timbered mostly with the sugar maple, beech, lyn, here called basswood, oak, and elm; and the hilly parts are generally timbered with oak. Where the sugar maple and basswood are most common the land is generally esteemed best for grass, and probably for grain, and is experienced to be durable; and lands which produce mostly beech timber are considered as generally clayey, wet and cold. A considerable proportion of the better part of the country is timbered with oak, and lands on which it is of a large growth are by many esteemed the most durable, although at first not productive of as good crops as maple lands, and harder in tillage. Grain is frequently put into the ground without ploughing, the ground being only broke with a heavy harrow, and frequently yields with this cultivation upwards of twenty bushels on an acre.

"But although the growth of timber usually denotes the sort of soil on which it grows, yet it frequently happens that the soil varies materially in different places where the same sort of timber grows, and it is observed in some parts that the growth of the young timber is of a different

sort from the old. Lands on which the growth of timber almost entirely consists of maple, basswood, and beech, appear to be attended with a scarcity of timber most suitable for fences; although a quantity of oak, elm and ash is usually found on land of this description, it is said sufficient for the purposes of fences and building; and basswood rails when the bark is taken off are tolerably durable. A considerable part of the country has a rock of limestone sunk some feet under the surface of the earth.

"The most useful sorts of timber are, the sugar maple, oak, pine which grows in some parts, yellow poplar, here called whitewood, wild cherry, white and black walnut, hickory, wild plum and dogwood. Of shrubs and plants the most noted are sassafras, wild hops, fox grapes in some parts, ginseng, sarsaparilla, snakeroot, spikenard, mandrakes in taste and flavour much resembling a pine apple, strawberries, whortleberries, cranberries which are used for preserves, and wild gooseberries."

It is of interest that in the quoted account the author recognizes (1) the grouping of certain species of trees into a definite community—"sugar maple-basswood-beech"; (2) plant succession—"it is observed in some parts that the growth of the young timber is of a different sort from the old"; (3) correlation of types of vegetation with topography and soils; and (4) indicator value of vegetation for land use.

Certain other accounts are less specific but help to round out the general picture. Space does not permit further quotation from them here but an extended and well annotated bibliography may be found in the flora of Monroe county published by the Rochester Academy of Science (Beckwith and Macauley 1896). These accounts vary in their degree of generalization, but they show a remarkable degree of conformity and are in agreement with the evidence still observable in the region.

Probably the most specific and therefore most useful sources of information in this connection are the records of the men who made the original land surveys in this region. The tracts were divided into towns and the towns into lots. The earliest of these surveys in the present area of Monroe county were made in 1789 and most of the subdivision into lots was completed by 1811. Scattered records, principally further subdivision of "great lots" into sections, extending as late as 1858, contain some additional information on the vegetation.

Unfortunately these records are not all collected in a single place, and the writer was unable to obtain land survey records for the entire area. Some records were found at Rochester, some at Bath, some at Canandaigua, in the offices of the county clerks, and others are in either public or private libraries or historical collections. Although the records for the county are incomplete, it was observed that all major vegetation areas in the county are represented.

These early land surveyors had the job of describing the land as well as measuring it into parcels and the descriptions in their field books include notes on topography, soil, rockiness, streams, and timber. Not only did they locate lot corners by citing distance and direction to the nearest "witness trees", which they described as to species and diameter, but in most cases they recorded the principal kinds of timber they encountered in running the lot lines, and in some cases gave a summary statement for each lot. The notes were included as an indication of the quality of the property, since much of this land was purchased from the land agents by people who had not visited the region.

Sears (1921, 1925) called attention to the value of land survey witness trees in reconstructing a picture of primeval vegetation and the method has since been employed in a number of surveys of Ohio counties. Lutz (1930) investigated early land survey notes as an indicator of original forest composition in northwestern Pennsylvania, and Gordon (1940) employed the method in his survey for the New York State Museum of Cattaraugus county, New York, and has discussed some of the problems involved.

The most obvious problem is the matter of identification of species. The surveyors were woodsmen and were unquestionably familiar with the kinds of trees. Each was consistent in the names he applied, but different surveyors might employ different names in referring to the same species, even as we do today. Sometimes "basswood" was used for *Tilia,* sometimes merely "bass", sometimes "lyn". In two towns the name "yellow oak" was used instead of "black oak" for *Quercus velutina* and "walnut" instead of "hickory" for species of *Carya.* Gilbert in notes on the survey of Town 12, Range 4 (Perinton), 1789, states "the walnut mentioned is chiefly shagbark. . . ." and cites "shagbark walnut" (*Carya ovata*) several times in the body of the survey. Not only are the common names of the characteristic and abundant timber trees mentioned, but species unimportant or unusual in this region are also cited. Several of these are identified in the following list:

Boxwood	*Acer negundo*
Tamarack, or Hackmatack	*Larix laricina*
Black gum	*Nyssa sylvatica*
Alder	*Alnus incana*
Cucumber	*Magnolia acuminata*
Yellow pine	*Pinus rigida*
Popple, or Pople	*Populus tremuloides*
Buttonwood	*Platanus occidentalis*
Ironwood	*Ostrya virginiana*
Whitewood	*Liriodendron tulipifera*

There is little cause to question the ability of the surveyors to recognize species, but it is obvious that interpretation of the names they used depends on some familiarity with the vegetation of the region.

The second problem is the possibility that the surveyors may have selected certain species as witness trees because of low economic value, because they were conspicuous or because they were easily marked. However this supposition is not borne out by reords that include both witness trees and remarks on the timber on each "great lot", such as those for the towns of Perinton and Irondequoit, or those that include both witness trees and descriptions of each change in type encountered in running the lot lines, such as those for the other towns of Monroe county for which records are available.

The third question sometimes raised is that of adequacy of sampling. Did the surveyors see a large enough portion of the vegetation to make their data valid as a description of the vegetation as a whole? It is probable that they did, for most of the lots are approximately one mile by one-half mile in size and they were surveyed one at a time. This meant going over each lot line two or three times. The result is a series of detailed transects at half mile intervals in one direction and at mile intervals in the other direction. However, no attempt has been made to treat them statistically so that the adequacy of the sample need not be challenged. It is felt that these records have more value when subject to topographic interpretation and when used merely as a contributory source of information.

Reference to a map of the town of Perinton (Town 12, Range 4) in the southeastern corner of Monroe county will give some idea of the degree of detail these records contain. Boundaries of the great lots have been drawn, the surveyor's remarks have been transcribed on each lot, and the species of witness trees have been indicated at the corners. In four cases a corner post without a witness tree was used, indicating that no trees were near the corner. This town was surveyed by Gilbert for Major William Walker and Joseph Goodwin in 1789. The remarks include not only notes on the timber but also the earliest attempt at land classification in this area. Gilbert appends the following information at the conclusion of the survey notes:

"The timber mentioned in the remarks may be considered the principal timber; the walnut mentioned is chiefly shagbark and as the lands are generally levelish and destitute of steep rising hills or troublesome rocks and stones, therefore there is no mention made except in cases that are uneven or stoney . . .".

The present vegetation of Perinton fits very well into the pattern revealed by these records and therefore attests their value in connection

with the mapping of original forest types in parts of the area not now timbered.

Mapping of Primeval Vegetation

The general facts of areal distribution of the vegetation of a region—extent of types and distribution pattern—may best be shown on a map. Such an attempt at graphic portrayal requires familiarity with the vegetation both as it exists today and as revealed by historical records. Local site or habitat factors must be evaluated and correlations of species and types with topography, drainage, exposure, and soils must be established. This requires detailed study of the least disturbed tracts of vegetation available—those which most nearly approximate virgin conditions.

On the basis of these habitat correlations and with constant reference to the available records, it is possible to fill in the gaps in the picture of the primeval vegetation. The underlying assumption in such interpolation is that similar sites were characterized by similar vegetation, the assumption which also underlies the use of natural vegetation as an "indicator" of the quality of land for agriculture or forestry. The validity of this assumption is unquestioned, and the interpolation becomes increasingly reliable when we deal with a relatively small geographic area, in which there is reasonable uniformity of climate. This means that attention can be chiefly devoted to edaphic factors, which are more effective in local differentiation and concerning which we have more detailed information. In most cases interpolation consists merely of projection of known vegetation to a continuation of the site on which the remnant occurs.

With this mental picture of the primeval vegetation the job is only half done, for it must still be translated into graphic form. Not only must the vegetation of the area be classified into vegetation types, but these types must also be generalized for mapping. Certain minor types and variants occupy insignificant or poorly defined areas and cannot be adequately or accurately shown on a small scale map. Such types and phases and transitions between well defined major types are valuable as an indication of relationship between the major types, but their recognition on a county map would tend to obscure the regional pattern and, since such detailed information is not uniformly available for the entire county, would result in a map with varying degrees of detail. The following objectives should be kept in mind in the preparation of vegetation maps:

1. recognition of major types only;
2. that degree of detail which would yield the most accurate and most useful map;
3. uniformity in degree of generalization throughout the map.

Vegetation mapping is similar to soil mapping in that it includes:

1. analysis of variation,
2. classification,
3. categorical and cartographic generalization,
4. establishment of boundaries.

In the interpretation of both soil maps and vegetation maps, it is well to remember that we frequently deal with merging phenomena, and boundaries between types, which are of necessity somewhat generalized, are frequently more or less arbitrary. Seldom do we encounter in nature a disconformity or abrupt break between adjacent types unless there is an abrupt break in topography, as from upland to flood plain. Usually the types grade into one another with transitional zones anywhere from a few feet to several rods in width and a large area of one type is likely to include local spots of another type too small to be indicated in mapping. It is usually not practical to attempt to show areas of less than ten acres on a map at a scale of 4000 feet to an inch.

In the establishment of vegetation boundaries, observed boundaries in existing stands are projected to the areas lying between them. This is least difficult where boundaries follow abrupt topographic breaks, but such is not usually the case. It is more commonly necessary to consider the interactions of the factors of the environmental complex—topography, drainage, soils, and exposure. Detailed soil maps on a topographic base are especially useful as a supplement to field observations, since they yield information on all these points. Frequently the vegetation boundaries sought coincide with boundaries between mapped soil types or soil groups, but these correlations vary locally and must be verified at frequent intervals.

POST-GLACIAL VEGETATIONAL HISTORY

After the Pleistocene ice had melted away from this region and by its melting farther to the north and east had opened outlets which drained the ice-front lakes, this newly exposed area soon came to be covered by vegetation. With the exception of local areas denuded by fire and used for Indian agriculture, it had a continuous vegetational cover from that time until white man started his systematic clearing about 150 years ago.

Vegetation is dynamic. Each of the plants composing it must eventually die, but the vegetational cover continues. The dead plants are replaced by others which may or may not be of the same kind, depending partly on chance and partly on whether there has been any significant change in the habitat during that generation. Drainage improvement or change in climate may, for example, make conditions more favorable

for certain species and less favorable for others; gradual change in forest composition may take place over a period of years if the replacements differ from their predecessors. Thus the vegetation of an area, while relatively stable, is subject to constant change, and reflects not only current environmental conditions, but past conditions as well,—the conditions leading up to its establishment. In fact the natural vegetation of an area such as Monroe county reflects the major phases of the entire vegetational history of the area since glacial times.

Several elements in the primeval vegetation pattern of Monroe county cannot be satisfactorily explained on the basis of the present day environment and apparently depend on historical conditions. Among these are the localized communities related to widespread plant formations of other climatic regions, such as the "oak openings" with their prairie grasses and associated western plants, and the local stands of pitch pine with associated species characteristic of the Atlantic coastal plain. As a solution to distribution problems such as these, Gleason (1922) postulated a late post-glacial "xero-thermic" or "xeric" period, and Transeau (1935) presented additional evidence in support of this hypothesis in his discussion of the "prairie peninsula".

This explanation assumes that at least once during late post-glacial time a severe and prolonged period of deficient precipitation, perhaps accompanied by unusually high temperature, occurred in eastern North America. This period of extreme drought was unfavorable to the more mesic species which had characterized the region and favorable to the eastern spread of the more xeric species of the grasslands. It is supposed that the extension of the "prairie peninsula" as far east as Ohio and western Pennsylvania occurred at this time. Although the prairie climate was after a time succeeded by forest climate, large areas of prairie persisted in those parts of the region least favorable for forest growth. Such relict areas of prairie occurred as "oak openings" in Monroe county in historic times. Present day remnants are pictured in Figures 5 through 8.

Pitch pine, shown in Figure 9, is likewise a xeric species and probably entered the area during a dry period, whether contemporaneously with the prairie plants is not known. But it is likely that it entered this region from the east, since its present distribution indicates migration along the Ontario lowland, and Monroe county is its western-most station in this lowland. As is the case with the prairie species, it occurs principally on areas of deep sand where its low moisture requirement enables it to compete successfully.

Holdovers from xeric periods are not the only relict types present in the area. The bog vegetation has persisted since early post-glacial time

and the microclimates of the deep ravines of the Irondequoit area have preserved the hemlock types which occupy them. Every local stand of this kind is a problem for historical explanation and at the same time a clue to the region's history.

Studies of vegetation adjacent to living glaciers and to existing glacial lakes, such as those by Cooper (1931) in Alaska, provide an additional basis for inferring post-glacial vegetational history. His studies indicate that succession from tundra to forest may occur in areas where receding glaciers are still present.

Reference has already been made to bog pollen studies, which constitute the paleontologic approach to the problem of vegetational history. No published studies are available for western New York, but the summaries by Sears (1935, 1938, 1942a, 1942b) and work by Deevey in Connecticut (1939) and McCulloch in central New York (1939) tend to support the "xeric period" hypothesis. Sears (1942a) has inferred the following post-glacial sequence:

I. A moist cool period—maximum of fir and spruce;

II. A dry, probably warmer period—maximum of pine, often with oak;

III. A more humid, also warm, period—maximum of beech, and, in places, of hemlock;

IV. A warm dry period—maximum of oaks and hickories, minimum of beech;

V. The present—probably cooler and with more available moisture than in IV.

The various lines of evidence suggest the following general sequence in this region. Tundra vegetation similar to that which now occupies the treeless regions of the far north, and regions above timber line in our own latitude, was probably contemporaneous with the glacier. There must have been patches of tundra on the shallow soil deposits on top of the ice, and the mosses and lichens, the grasses, sedges and heaths of the tundra must have been the first pioneers to occupy the newly exposed shores of the glacial lakes. But there is no evidence to indicate that this stage was widespread and of long duration; in fact it is even likely that it was succeeded by forest on top of the ice, the situation reported by Cooper in Alaska. It is now generally believed, as pointed out by Antevs (1938), that Pleistocene climate was not especially severe, a few degrees change in temperature or a slight change in winter precipitation being enough to induce or end a glacial period. Under such conditions the northern coniferous forest probably advanced rapidly to the shores of the glacial lakes. The bog records indicate that this northern forest

of spruce and fir and associated species remained in the region a long time (period I of Sears), but during the subsequent periods of less favorable climate these species were almost entirely eliminated from the area. Relict communities related to the tundra and spruce-fir forest persist only in restricted bog areas, where substratum conditions were unfavorable for the species which succeeded them elsewhere.

During the drier and warmer climate which followed (period II of Sears) pine seems to have reached its maximum abundance and to have been accompanied by deciduous species, particularly the oaks. Subsequent increase in effective moisture (period III of Sears) favored the establishment of more mesophytic species, such as beech, sugar maple, hemlock and the birches. The hemlock-northern hardwood forest apparently reached its maximum extent during this period. Fairly extensive remnants of this mixed forest remain in Monroe county today, especially in the portion nearest Lake Ontario.

It is probable that by the time the hemlock-northern hardwood forest had become well established many other species of deciduous trees had migrated into the area, among them the elms, ashes, and maples of the swamps. At first the deciduous species must have entered into the mixed forest, but with progressive change in climate, deciduous forest types similar to those we find in the region today must have been segregated out and must have come to occupy the greater part of the region.

Probably the establishment of deciduous forest dominance preceded the xeric period (period IV of Sears), during which the prairie species and the pitch pine presumably entered the area. This marked change in climate no doubt brought about important changes in the dominance of species and types already present. Areas occupied by the oaks, hickories, and chestnut increased at the expense of the more mesophytic beech and maple and their associates; it is quite likely that the swamp oaks increased in importance in the swamp forests, for they are better able to survive the severe drought periods which must have affected even the swamps. Relicts from preceding plant formations were drastically reduced in area and many of them were entirely eliminated. This seems to have been the fate of many bogs. The relict bog vegetation, once eliminated by prolonged desiccation, did not reinvade many of these areas, but was succeeded by the swamp and marsh vegetation now more characteristic of poorly drained spots in this region.

The increase in effective moisture which has followed the late xeric period may have been due to an increase in precipitation or to a more uniform distribution of precipitation, with fewer and less prolonged drought periods. It is likely that lower temperatures have also contributed to the change. Regardless of cause, it has brought about a

re-expansion of the area occupied by the mesophytes, such as beech, sugar maple and hemlock, and has led to the development of the vegetation pattern observed by the pioneers when they entered the region.

Beech and sugar maple were the dominant species of a large part of the region, but local variation in topography and surface drainage and in soil texture and internal drainage established a wide range of habitat variation, and a number of mesophytic species were available in the region; hence the climax beech-maple forest was locally enriched by such species as basswood and tulip poplar. The oak types of the drier uplands were likewise enriched by the addition of such species as slippery elm, butternut, tulip poplar, and wild black cherry, thereby locally approaching the composition of the mixed mesophytic type recognized by Gordon in southwestern New York (1940).

This discussion of vegetational history has thus far taken into account only one phase of the plant succession which has occurred in the area—the long-time changes in plant population and vegetation types which have followed major climatic shifts. But, as pointed out at the outset, vegetation is constantly undergoing short-time changes. The pioneer plants which first occupy a freshly exposed site are usually succeeded by other species in comparatively short order. The sequence of successional stages finally ends in a climax type, whose species are able to reproduce more successfully than others, and which therefore occupies the site indefinitely as long as habitat conditions remain stable. The plants themselves are responsible for this sort of succession. Their contribution of organic matter to the soil not only increases its fertility, but also improves its moisture relations, and their shade not only conserves moisture, but also eliminates the seedlings of certain species which are intolerant of shade, and thus influence the direction of succession.

Along with climatic succession and the biotic sucession brought about by the plants themselves, we may distinguish plant sucession depending on yet another set of external factors—the habitat changes brought about by physiographic development. The period since glaciation has been too short in time for widespread change in the constructional regional topography, but the local effects of erosion and deposition are readily observable. Due to deposition of materials eroded from the adjacent upland and the cutting of outlets, the drainage has improved in many of the kettles and depressions between drumlins; upland types have thus been able to invade areas formerly occupied by ponds, or at least by bogs or swamps. The soil materials of much of Monroe county are unconsolidated and therefore subject to rapid erosion, and the ponds and landlocked bays silt rapidly. But drainage development must follow silting before upland types can invade such areas. The broad silt plains of extinct Lake Scottsville in southern Monroe county are generally char-

acterized by swamp forest types. It is only where the Genesee River and its tributaries have become entrenched, lowering the adjacent water table and improving the soil aeration, that the mesophytic beech and sugar maple have become established.

When we look at vegetation from this detached, long-time point of view, we tend to emphasize its dynamic aspects. But when viewed at closer range it seems very stable. Under primeval conditions, with only the factors of the natural environment operative, significant changes in the natural vegetation would seldom be observed in a man's lifetime. When dealing with trees whose length of life is frequently measured in hundreds of years, we need not expect a great deal of change in a single century. But the more detached viewpoint and broader perspective are essential to an interpretation of the primeval forest cover of Monroe county. This vegetation presented a complex pattern of types differing widely, but each in equilibrium with its particular environment, and it represented a dynamic equilibrium that had responded to environmental changes as they occurred.

ANALYSIS OF THE NATURAL VEGETATION

The foregoing portion of this report has summarized much of the basic information necessary for an interpretation of the natural vegetation of Monroe county; it has discussed the ways in which such information may be used; and has sketched the development of that vegetation up to the time of settlement. This next portion deals more directly with the natural vegetation as it appeared to white man when he settled the region, and undertakes its description, an analysis of its composition and distribution, and an interpretation of its ecological relations.

The plant names used in this report are derived from common use in the region and in the case of plants not well enough known to have local names the *Annotated List of the Ferns and Flowering Plants of New York State* (House 1924) has been followed. These names are identified when first used by citation of the corresponding scientific names, which likewise generally follow the usage of the *Annotated List.*

In this survey no attempt has been made to build up a complete catalogue of the flora of the area. This job has already been admirably done by the Botanical Section of the Rochester Academy of Science. A great deal of painstaking work over a period of many years, principally by enthusiastic amateurs, has resulted in a knowledge of the local flora and has furnished a local herbarium exceeded in only a few places. The work has also led to publication by the Academy of *Plants of Monroe County, New York, and Adjacent Territory* by Beckwith and Macauley (1896) and two supplementary lists by Beckwith, Macauley and Baxter (1910, 1917). These lists include 1761 species and varieties of vascular

plants, native and naturalized, and have served as a valuable check list during the course of the present study. Additional information on the flora of Monroe county which has come to light during the course of the present study is incorporated in a recent paper published by the Rochester Academy of Science (Shanks and Goodwin 1943), and supporting specimens are on file in the Herbarium.

There has been no attempt to make the plant lists in the following discussions long and exhaustive, but rather to include those things which are most likely to be abundant, which recur again and again in stands of a certain vegetation type, or which are confined almost exclusively to a single type. In other words they are lists of the obvious plants which characterize vegetation types, the common rather than the rare. Observations were made during all seasons, but the bulk of the field work was done from late spring to fall and the early spring flora is perhaps least represented in the lists. As one means of arriving at such lists, the record sheets for 183 woodlots, selected for purity of type and including representative samples of each major forest type distributed as widely as possible throughout the county, were tabulated. Their numerical distribution by types is as follows:

Forest Type	*Number of Sample Areas*
Oak-(Chestnut)-Pine	14
Upland Oak	29
Beech-Maple	50
Hemlock-Hardwood	19
Swamp Forest	51
Bog Forest	20
Total number of areas	183

The "obvious flora" of these natural areas as revealed by this tabulation consists of about 430 species, distributed as follows:

Growth Form	*Number of Species*
Trees	46
Small trees	26
Shrubs	59
Vines	16
Herbaceous plants	283
Total species	430

No detailed ecological studies of the regional vegetation have previously been published, but local areas of special interest have received attention: the Bergen swamp, just outside the county, by Stewart and Merrell

(1937) and the Mendon Ponds area in the county by Goodwin (1943). The catalogue of the flora of Monroe county and adjacent territory (Beckwith and Macauley (1896) and the catalogue of the ferns and flowering plants of New York (House 1924) also yield valuable information on species distribution in the region here considered. But they offer little information on the plant communities which make up the vegetation. However, a number of general studies have included maps and general descriptions of the vegetation of this part of the country.

These reports are presented from different points of view and with varying degrees of generalization and these facts help to explain the apparent contradictions which they contain.

Sargent, in his report on the forests of North America (1884), included most of New York in his "northern pine belt", characterized by white pine (*Pinus Strobus* L.), but the Erie and Ontario plains of western New York were regarded as a northeastern extension of the deciduous forest of the east central states. In this procedure he was followed by Schimper (1898).

The early works of Bray (1915)—*The Development of the Vegetation of New York State,* and his account in the *Naturalist's Guide to the Americas* (1926, page 332)—reflect a viewpoint which combines the floristic approach with the life zone concept of Merriam (1898). His maps include Monroe county in his "Zone B" characterized by chestnut, oaks, hickories, and tulip-poplar, a zone which includes all the Ontario plain, the Hudson valley, the immediate valleys of the Susquehanna drainage and the Allegheny river, and northern Long Island.

It is probable that this early work influenced Zon in the preparation of the map, included in the section of the Atlas of American Agriculture, on natural vegetation (Shantz and Zon, 1924). This map and discussion generalizes the Ontario plain as the chestnut-chestnut oak-yellow poplar phase of the oak-chestnut association, and this relates it most closely to the forests of the Appalachian region, Tennessee, Kentucky, and eastern Ohio, although it is separated from the main body of this type by an intervening area mapped as beech-birch-maple. The map of the primary forest types of some northeastern states prepared by Gordon (Gordon et al, 1937) is the most complete map available for the immediate region and gives the best picture of the general regional relations of the vegetation. His recognition of the occurrence of local "mixed mesophytic" stands in the predominant beech-sugar maple forest of the Ontario plain, indicates recognition of the floristic richness and southern affinities of the forest flora of the region, which must also have influenced Bray's classification, although these two investigators expressed their conclusions differently. The meaning of the term "mixed mesophytic" as applied to forests

in this region will be discussed in a later section of this report in connection with the upland oak types.

Detailed regional studies of the vegetation of New York have recently been initiated and sponsored by the New York State Museum under the supervision of Director Charles C. Adams (see Adams 1937). These include the surveys of Allegany State Park by Taylor (1928) and by Gordon, Emerson, Kenoyer, Hicks, and Saunders (1937), and *The Primeval Forest Types of Southwestern New York* by Gordon (1940). The present study is a part of this program.

The Vegetation Pattern of Monroe County

A very general picture of the original vegetation is presented in Figure 10, which brings out the localization of vegetation types. It will be observed, for instance, that the large areas of the hemlock-northern hardwood type occurred in the northeastern and northwestern corners of the county and that the greater part of the oak-chestnut-pine type occurred in the area between them, near Irondequoit bay and the mouth of the Genesee river, north of the present city of Rochester. Swamp forests occurred locally along stream margins and on other poorly drained sites throughout the beech-sugar maple area, but the largest continuous swamp forest area occupied the flats of the Genesee river in the central and southern parts of the county. The upland oak and oak-hickory types were rather widely distributed in the southern half of the county, occupying extensive areas in the southernmost towns and extending farther north along the valleys of Irondequoit creek and the Genesee river. Bogs occupied a rather insignificant total area but were widely distributed in a broad belt extending east and west across the county. The beech-sugar maple type was the most extensive, occupying large areas exclusively and some area in every town in the county.

Some idea of the actual area covered by each of the major vegetation types may be gained from the following tabulation, which is based on planimeter measurement of the areas on the generalized map from which Figure 10 was prepared. Copies of this map are on file with the Monroe County Division of Regional Planning and the New York State Museum; the scale is 8000 feet to the inch.

Original Vegetation, Coverage in Per Cent

Town \ Type	Oak-Chestnut-Pine	Upland Oaks and Oak-Hickory	Oak-Chestnut and Beech-Maple	Beech-Sugar Maple	Hemlock-Hardwood	Swamp Forest	Bog Forest	Marsh
Brighton		*		80		20		
Chili	6	10		57		24	3	
Clarkson	1			90	7		1	
Gates	4			84		12	*	
Greece	5		24	52	5		*	14
Hamlin				29	70			1
Henrietta		1		81		15	3	
Irondequoit	79			15	4			1
Mendon		32		61		3	4	
Ogden	*			98	*	*	*	
Parma	*			69	28		*	2
Penfield		17		74	3		5	1
Perinton		43		47	4	3	4	
Pittsford		34		64			2	
Riga		*		82		11	7	
Rush		23		62		13	2	
Sweden				97			3	
Webster	11	1	7	10	69			*
Wheatland	*	59		17		17	7	
County	4	11	2	61	12	6	2	1

* Less than 1 per cent

Even if a liberal allowance is made for the local stands of swamp forest included in the area mapped as beech-sugar maple, this type is still seen to occupy more than half the total area, and more than twice as much as the combined area of the hemlock-northern hardwood and upland oak types, which rank second and third, respectively, in area covered.

From the foregoing map and tabulation it is obvious that deciduous forests were decidedly predominant in the original vegetation of the region. The most widespread deciduous type was dominated by beech and sugar maple. The beech-sugar maple type occupied the greater part of those soils of the region which were most favorable for crop production from the standpoint of fertility and moisture relations, and the evidence indicates that it was increasing in area at the expense of other types. These facts might be interpreted to indicate that the beech-sugar maple association should be regarded as the climatic climax for the region.

However another point of view deserves consideration. While beech and sugar maple are important species in the deciduous forest complex, they are equally important, if not more important, in the "eastern hemlock region" (Nichols 1935). In describing the composition of the

climatic climax forest of the eastern hemlock region, he lists the characteristic species and states:

"In the position of relative importance which they occupy in the community, these trees differ greatly among themselves, both in different parts of the region and locally within the same general section. Sugar maple is the most universally distributed, being seldom absent and commonly the most abundant tree; but hemlock and beech rival and even outrank the maple in abundance over large parts of their range. Taken together, in varying proportions, these three trees ordinarily make up the bulk of the forest." (Nichols 1935, page 407).

Might it not be assumed that the beech-sugar maple forests of Monroe county and the rest of the Ontario plain are segregates of the hemlock-northern hardwood type rather than of the central deciduous forest, especially since they are more closely associated with the eastern hemlock region than with the body of the deciduous forest? This fact is brought out by Zon's map (Shantz and Zon 1924), which shows a lack of continuity of type from this region to the region to the west and southwest, where the deciduous forest is typically developed. This viewpoint is reflected in the map of the primeval vegetation of Cattaraugus county, New York, prepared by Gordon (1940), in which the beech-sugar maple association recognized and described in his report is mapped as part of the hemlock-white pine-northern hardwood forest. It is also generally believed that the type as developed in this region bears an intimate historical relation to the mixed forest types which characterize the eastern hemlock region, as brought out in the discussion of vegetational history in the proceding section of this report.

In the light of these arguments a comparison of stands representing the beech-sugar maple and hemlock-northern hardwood types as they occur in Monroe county is of interest. A graphic comparison of the species composition of a series of Monroe county woodlots is shown in Figure 11. This graph presents the results of an analysis of the composition of existing remnants of the major forest types of the area. Using field data already collected in this survey of present vegetation described in a previous section of this report, as many typical areas as possible were chosen for each type. The criterion for selection was that the field sheet should respresent a single type insofar as possible, rather than a composite of two or more types. The number in parentheses at the head of each column indicates the number of stands of that type included in the analysis. These 183 sample areas throughout the county are widely distributed. In order to compare only characteristic species, solely those were included which were present in 50 per cent or more of at least one of the type stands and which attained an abundance of 5 per cent or more in at least one type. Thus only the 18 most important of the 46 tree species which occurred in the sample woodlots are included in the graph.

In general the graph indicates that differences between the types recognized in field mapping are differences in dominance rather than differences in species present in the woodlots selected as typical. It will be observed that five species—sugar maple, basswood, white ash, American elm and red maple—occurred in woodlots of each type listed. But elm and red maple are dominant only in swamp and bog forests, and sugar maple occurs as a dominant only in the hemlock-hardwood and beech-maple types.

In addition to the presence of hemlock, the indicator species, as a dominant in the one type and its absence from typical stands of the other type, a comparison of the two middle columns of the graph indicates only two differences between existing remnants of the hemlock-northern hardwood and beech-sugar maple types:

1. the more pronounced dominance of sugar maple and the greater importance of basswood, which became a local dominant, in stands of the latter type;
2. the presence of certain minor species—yellow birch, white pine, sassafras and white oak—in woodlots where hemlock was a dominant.

Of the nine species of small trees and shrubs listed as characteristic for the climax forests of the eastern hemlock region by Nichols (1935), four—mountain maple (*Acer spicatum*), ironwood (*Ostrya virginiana*), alternate-leaf dogwood (*Cornus alternifolia*), and beaked hazel (*Corylus cornuta*)—are more frequent in other types in Monroe county. A fifth—red-berried elder (*Sambucus pubens* Michx.)—is at least equally frequent in other types. Of the thirteen species and three additional genera of herbaceous plants which he cites as characteristic, three—stiff club-moss (*Lycopodium annotinum*), yellow clintonia (*Clintonia borealis*), and white wood sorrel (*Oxalis montana* Raf.)— are not known to occur in Monroe county, and four—false Solomon's seal (*Smilacina racemosa* Desf.), trilliums (*Trilliums* spp.), violets (*Viola* spp.), and wild sarsaparilla (*Aralia nudicaulis*)—are more abundant in other types.

This evidence serves to point out the close relationship which exists between adjacent stands representing two regional climaxes, and the indefiniteness of the boundary between them, and brings to mind the "individualistic concept of the plant association" advanced by Gleason (1926) and further discussed by him at the Cold Spring Harbor conference on plant and animal communities (Gleason 1939). His thesis is thus briefly summarized in the latter paper (page 103): " . . . environment varies constantly in time and continuously in space; environment selects from all available immigrants those species which constitute the present vegetation, and as a result vegetation varies constantly in time and continuously in space." He concludes

(page 108): "Since every community varies in structure, and since no two communities are exactly alike, or have genetic or dynamic connection, a precisely logical classification is not possible." It should be noted that Gleason has used the term "community" in the sense of a concrete unit, or stand (cf. Cain 1939, page 147), and that, while he emphasizes the phenomenon of continuous variation, he does not deny the desirability of classification of plant communities.

In the light of evidence pointing toward the close relationship of the Monroe county beech-sugar maple type to the eastern hemlock region and the relatively minor differences which exist between the hemlock-northern hardwood type and the deciduous types of this region, it must be recognized that the whole region is an ecotone or tension zone between these two regional plant formations. As repeatedly emphasized by students of plant ecology (Livingston and Shreve 1921, Nichols 1923, Weaver and Clements 1938, Zon 1941), the primary control of the regional vegetation is climatic. The localization of the extensive hemlock-hardwood areas of Monroe county near the lake suggests climatic, rather than edaphic or physiographic control, even in the case of the local stands representing the two plant formations. So, in the light of conditions within this area, and while the close relationship and intergradation between the types must be recognized, two regional climax associations—beech-sugar maple and hemlock-northern hardwood—may be conveniently identified in Monroe county. Of these climax associations, beech-sugar maple clearly characterizes the greater part of the area.

However, as indicated by Figure 10, more than one fourth of the area was not occupied by these climatic climaxes. Periods of deficient moisture were too frequent and too prolonged in certain of the sandy and gravelly areas, and even on some of the steeper drumlins, for the establishment of beech, sugar maple, and hemlock; and in the kettles of the morainal areas, the poorly drained depressions of the drumlin area, and a large part of the alluvial area of the county, soil aeration was insufficient for their establishment. The vegetation types which occupied such sites were relatively stable and just as truly in equilibrium with their local environments as the widespread climatic climax types. It is true that these varied habitats were undergoing continuous change in the direction of more mesic conditions due to physiographic development and the effects of the vegetation itself, but the rate of change was so slow as to be almost imperceptible. This extremely slow rate of succession gives rise to the concept "climax for the site" employed by the Committee on Forest Types, Society of American Foresters (Hawley et el. 1932), and wide-spread types largely controlled by substratum factors are commonly referred to as

physiographic or edaphic climaxes: these are well described by Nichols, 1923, 1935 and Gordon, 1940.

Although a relatively small part of the area was occupied by most of those edaphic and physiographic types, they are extremely important from the standpoint of interpretation. Such areas form the basis for inferences concerning the successional relationships of the vegetation types and provide a valuable key to the region's vegetational history.

Primary Vegetation Types

The wide diversity of habitat conditions in this youthful region and the diversity of the flora which has migrated in to the region during the changing climatic conditions of post-glacial time have made possible the segregation of a remarkably wide range of vegetation types for a region of such limited geographical extent. These types generally correspond with types already described in published reports on similar regions or in the more general accounts and will accordingly be identified with published descriptions insofar as possible. Probably the most widely used reference list is the *Report of the Committee on Forest Types, Society of American Foresters* (Hawley et al. 1932).

This list is based on present cover types, but these frequently correspond with types present in the original vegetation. The types are given reference numbers in this list and subsequent citation of S. A. F. type numbers will refer to this list. Naming of forest types follows the customary practice in that names of the dominant species making up over 50 percent of the stand are used in the order of their abundance. Thus over half the trees in the black-white oak type belong to one of the two named species, and black oak characteristically exceeds white oak in abundance in stands of this type.

It has of course been necessary to generalize the types for the purpose of mapping by grouping those most closely related. The types which occupy the drier habitats are discussed first and the arrangement of the series is in order of increasing moisture, and of decreasing drought and soil areation.

Oak Openings

Relatively few treeless areas broke the continuity of the forested landscape when white man entered this region as a permanent settler. Those that did occur were for the most part quite local and of three general kinds:

1. areas too dry for trees to become established because of local edaphic conditions;
2. areas too wet for the establishment of trees, such as the bog meadows occupying kettles, beaver meadows, "intervales" along the smaller streams, and marshes associated with the bays along the lake;

3. areas cleared by the Indians for village sites and for their primitive agriculture.

There is reason to believe, from what is known of the location of the larger Indian towns, that their "clearings" were usually associated with sites of the type first cited, where less actual clearing away of trees was necessary and where insects were less troublesome and conditions generally more healthful.

Since these overdrained sites without trees occurred within areas generally characterized by oak forests, it became customary at an early date to refer to them as "oak openings". The description of the Genesee county published at Fredericktown, Maryland, (Munro 1804) contains the following statement: "On both sides of Genesee river, particularly on the west, are large openings which are thinly timbered, are in some parts very fertile, and could easily be put under cultivation". One of these openings crossed by Augustus Porter in his survey of the west line of town 1, range 1 west of the Genesee in 1791, was described as "Clear land" and the timber associated with it was black and white oak. This area is located in the present town of Wheatland, about a mile west from the village of Mumford. In the notes on the division of this town into lots by John Smith in 1804, lot number 40, located just northeast of the intersection of the Belcoda road with the Scottsville-Mumford road, is described as "all excellent openings" and white oak is the only witness tree cited. The two lot corners to the north were marked by posts indicating that no trees were near enough to be used as witnesses. Two other references to "open oak land" were also made in the notes on the southwest corner of Wheatland. Use of the name "Oak Openings" for a farm in the northern part of Rush, and for a subdivision east of Dewey Avenue and south of Stone road, just northwest of the city of Rochester in the town of Greece, is a record of the occurrence of vegetation of this type in these two widely separated areas, and evidence that the term was in general use in the region.

A large part of the vegetation of these open areas was made up of prairie species. They were dominated by the same tall grasses which characterized the drier portions of the tall grass prairie region of the middle west (Weaver and Fitzpatrick 1934). These species and the characteristic appearance of remnants of the vegetation of the openings are shown in Figures 5, 6, 7, and 8. Indian grass (*Sorghastrum nutans* (L.) Nash) and tall bluestem (*Andropogon furcatus* Muhl.) commonly grew as high as a man's head in these areas, but little bluestem (*Andropogon scoparius* Michx.), growing up to waisthigh, was apparently more abundant in most of them. Tall bluestem seems to have been less general in its distribution than Indian grass, which was locally known as "openings grass". Fortunately these species have persisted in most areas in Monroe county where

they are known to have occurred, and spot maps of their observed distribution, Figures 12 and 13, give a reliable picture of the distribution of oak openings.

Additional evidence as to the occurrence and character of these openings is contained in a copy of the Walker papers in the archives of the University of Rochester library. The map of the town of Mendon included in the original papers was not copied, but it was described as follows: "Minutes of No. 11, 5th Range. This is a map sketch of township land out into lots, each lot noted as good, very good, oak land, *plains and grass*, &c., &c., with lakes and streams delineated". (page 103).

It is apparent that the oak openings of Monroe county were essentially edaphic prairies, the remnants of more extensive grasslands which occurred in this region when the "prairie peninsula" extended further east during a period of drier climate in late post-glacial time (Transeau, 1935). They may be regarded as practically identical with the type which characterized the deep sand deposits along the shoreline of glacial Lake Warren in northwestern Ohio (Moseley 1928; Shanks, 1939).

However in our area the oak openings were not restricted to the shorelines of a single glacial lake stage, nor were they restricted to sand deposits. They occurred on several types of sites in Monroe county:

1. thin soils overlying the limestone of the Onondaga escarpment in the towns of Wheatland, Rush, and Mendon (see Figure 6);
2. gravelly deltas and terraces formed by the temporary streams flowing into and out of glacial lake Avon, in these same towns;
3. sandy and gravelly soils of the kames and eskers, particularly the deep sands which filled the old Genesee valley now occupied by Irondequoit creek (see Figure 5).

Probably the closely associated and relatively continuous habitats of the first two types constituted the most important migration route by which the typically western species of the oak openings entered this area. The sands of Lake Ontario and glacial Lake Iroquois form a much less continuous highway. These sand deposits are concentrated in Monroe county because of the supply of material from the Genesee drainage.

A relatively small part of the total area of the county, certainly less than one per cent, was occupied by oak openings, and most of the openings were small and their boundaries poorly known. Openings occurred in areas generalized as oak-chestnut-pine as well as upland oak and oak-hickory. Previous reference has been made to the oak openings on the Belcoda road, Wheatland. They are believed to have occupied at least 70 acres, the largest area of this kind recorded for Monroe county. Unfortunately this entire area has been subject to cultivation and close

pasturing, and none of the characteristic native plants were found nearer than the Garbutt cemetery about two miles east, where the tall grasses and a few of their characteristic associates occur. The best remnants of the characteristic vegetation of the openings may be seen on the deep sands west of East Rochester in the northern part of the town of Pittsford (Figures 5 and 7) and on thin soils of the Onondaga escarpment west of Five Points, in the town of Rush (Figure 6). A stand about 6 acres in extent at the latter location is regarded as the least disturbed remnant of the original grassland community of Monroe county, since a number of western species recently introduced along the railroads have become established in the East Rochester area.

Certain other species were characteristically associated with the prairie grasses which dominated the openings. Prominent among these were the following species:

Butterfly weed ..... *Asclepias tuberosa* L.
Panicled tick trefoil ..... *Desmodium paniculatum* (L.) DC.
Dillen's tick trefoil ..... *Desmodium dillenii* Darl.
Showy tick trefoil ..... *Desmodium canadense* (L.) DC.
Hairy beard-tongue ..... *Pentstemon hirsutus* (L.) Willd.
Culver's root ..... *Veronicastrum virginicum* (L.) Farw.
Spreading dogbane ..... *Apocynum androsaemifolium* L.
Long-fruited anemone ..... *Anemone cyclindrica* Gray
Tall anemone ..... *Anemone virginiana* L.
Hairy bush clover ..... *Lespedeza hirta* (L.) Hornem.
Wand-like bush clover ..... *Lespedeza intermedia* (Wats.) Britt.
Wild bergamot ..... *Monarda fistulosa* var. *mollis* (L.) Benth.
Dewberry ..... *Rubus flagellaris* Willd.
Pearly everlasting ..... *Anaphalis margaritacea* (L.) Gray
Plantain-leaved everlasting .... *Antennaria plantaginifolia* (L.) Richards
Black-eyed Susan ..... *Rudbeckia hirta* L.
Woodland sunflower ..... *Helianthus divaricatus* L.
Indian tobacco ..... *Lobelia inflata* L.
Canada bluegrass ..... *Poa compressa* L.
Wild oat grass ..... *Danthonia spicata* (L.) Beauv.
Southern sedge ..... *Carex cephalophora* Muhl.
Early goldenrod ..... *Solidago juncea* Ait.
Gray goldenrod ..... *Solidago nemoralis* Ait.
Flat-topped goldenrod ..... *Solidago graminifolia* (L.) Salisb.
Smooth aster ..... *Aster Laevis* L.
Arrow-leaved aster ..... *Aster sagittifolius* Wedemeyer
Flat-topped aster ..... *Sericocarpus asteroides* (L.) BSP.

Hairy ground cherry ..... *Physalis heterophylla* Nees.
Palmate-leaved violet ..... *Viola palmata* L.
Arrow-leaved violet ..... *Viola sagittata* Ait.
Mountain mint ..... *Pycnanthemum flexuosum* (Walt.) BSP.
Whorled milkwort ..... *Polygala verticillata* L.
Thyme-leaved sandwort ..... *Arenaria serpyllifolia* L.
Wood lily ..... *Lilium philadephicum* L.
Prairie willow ..... *Salix humilis* Marsh.
Panicled dogwood ..... *Cornus racemosa* Lam.

In his account of the Phelps and Gorham purchase, which included most of present Monroe county, Turner (1851) speaks of the "oak openings" and "pine plains" of the towns east of the river. Lot 63 in the gore east of Irondequoit bay (east of bay road in the present town of Webster) was described in the survey notes as a "pine plaine" (Ezra Phelps, 1811). Adjacent lots were characterized by "yellow" (i. e., pitch) pine. These pine plains were quite local and, except for the presence of scattered scrubby specimens of pitch pine, were not essentially different from the sandier oak openings. In addition to the species listed above, the following species also characterized the sandier openings.

Bracken ..... *Pteridium latiusculum* (Desv.) Hieronymus
New Jersey tea ..... *Ceanothus americanus* L.
Panic grasses ..... *Panicum* spp.
Muhlenberg's sedge ..... *Carex muhlenbergii* Schkuhr
Dry-spike sedge ..... *Carex siccata* Dewey
Round-headed bush clover ..... *Lespedeza capitata* Michx.
Michaux's tick trefoil ..... *Desmodium rotundifolium* (Michx.) DC.
Lupine ..... *Lupinus perennis* L.
Fernleaf false foxglove ..... *Aureolaria pedicularia* (L.) Raf.
Downy false foxglove ..... *Aureolaria virginica* (L.) Farw.
Smooth false foxglove ..... *Aureolaria flava* (L.) Farw.
Slender agalinis ..... *Gerardia tenuifolia* Vahl.
Hairy pinweed ..... *Lechea mucronata* Raf.
Large-podded pinweed ..... *Lechea intermedia* Leggett
Sporobolus ..... *Sporobolus cryptandrus* (Torr.) Gray
Frostweed ..... *Helianthemum canadense* (L.) Michx.
Sleepy catchfly ..... *Silene antirrhina* L.
Schweinitz's cyperus ..... *Cyperus schweinitzii* Torr.
Slender cyperus ..... *Cyperus filiculmis* var. *macilentus* Fern.

Dewberry, panicled dogwood, New Jersey tea, and prairie willow entered prominently into the plant community of the openings in certain places but other woody species were present only as occasional invaders, which usually did not survive many seasons. The most frequent of these woody plants were:

Black oak ..... *Quercus velutina* Lam.
White oak ..... *Quercus alba* L.
Yellow oak (limestone areas) .. *Quercus muhlenbergii* Engelm.
Shagbark hickory ..... *Carya ovata* (Mill.) K. Koch
Slippery elm ..... *Ulmus fulva* Michx.
Cork elm (limestone areas) ... *Ulmus racemosa* Thomas
Pitch pine (Irondequoit bay area) ..... *Pinus rigida* Mill.
Wild black cherry ..... *Prunus serotina* Ehrh.
Quaking aspen ..... *Populus tremuloides* Michx.
Hawthorn ..... *Crataegus* spp.
Summer grape ..... *Vitis aestivalis* Michx.
Staghorn sumac ..... *Rhus typhina* L.
Beaked hazel ..... *Corylus cornuta* Marsh.
Choke cherry ..... *Prunus virginiana* L.

Panicled dogwood, the three shrubs last named and, in some places, aspen, formed marginal thickets.

Although the persistence of these relict grassland areas in Monroe county may be largely explained on a edaphic basis, since the substratum in every case had a very low water-holding capacity, it should be kept in mind that summer humidity is lower in this area than at any other point of record in New York state (Mordoff 1925), and that dryness of both air and substratum would be favorable to fire, whether from natural causes or set accidentally or purposely by the Indians (cf. Bromley 1935). Regardless of cause, relatively frequent fire must have been a feature of the environment on these dry sites during the aboriginal period, and fire must have contributed to the maintenance of oak openings in this region.

Oak-Chestnut-Pine Forests

The driest forested sites in Monroe county were occupied by forests which have been generalized as oak-chestnut-pine, since chestnut, white pine, and pitch pine occurred as dominants along with the oaks. Such forests were typically developed in the towns of Irondequoit and Webster, and in this county were practically restricted to sandy deltaic deposits laid down in the glacial lakes. Their concentration in the area to the north and northeast of Rochester is due to the large quantity of material from the Genesee drainage deposited in this region. In some places this broad delta was dissected by stream action, as in Durand-Eastman

Park and along Irondequoit Bay, where the streams occupying the ravines were frequently more than 100 feet below the surface of the delta. Nevertheless, its general aspect was that of flat upland, sloping gently upward to the north from an elevation of about 400 feet at the base of the Lake Iroquois beach ridge. Fortunately the land survey notes for town 14, range 7, surveyed by Ezra Phelps in 1811, include descriptions of the timber for every lot. This town, as originally surveyed, included the present town or Irondequoit, extended as far south as Clifford Avenue, Rochester, and included a triangular "gore" in the present towns of Webster and Penfield on the east side of Irondequoit bay. This takes in the greater part of the area occupied by oak-chestnut-pine forests, and the records provide valuable information on the species composition of this type and clearly show its boundaries to the east and south. The southern boundary is especially sharp, since it occurs at the ridge road, the shore line of glacial Lake Iroquois. This ridge crosses lots 36, 37, 38, and 39, and the timber differed so greatly on the two sides that two descriptions were given for each lot. The following descriptions were given for 37 and 38, which lie between Hudson Avenue and Portland Avenue, extending from Norton Street to north across the ridge a short distance: (lot 37) beech, maple, basswood, elm and black ash, northern part some oak, chestnut and white pine; (lot 38) southern part beech, maple and basswood, northern part oak and white pine.

The following species, occurring in various combinations or in some cases in local pure stands, dominated the oak-chestnut-pine type:

Red oak	*Quercus borealis* var. *maxima* (Marsh.) Ashe
White oak	*Quercus alba* L.
Black oak	*Quercus velutina* Lam.
White pine	*Pinus strobus* L.
Pitch pine	*Pinus rigida* Mill.
Chestnut	*Castanea dentata* (Marsh.) Borkh.

Although, as suggested above, white pine, pitch pine and chestnut each formed local pure stands, corresponding with S. A. F. types 9, 37, and 56 respectively, they were exceeded in abundance by the oaks in the type as a whole. The surveyors apparently listed species in approximately their order of abundance, and only in two cases were pine or chestnut placed ahead of oak in the Irondequoit survey. Little is known about the relative abundance of the three oaks in the original forests, but it is believed that all were important. White oak and red oak seem to have been more prominant in the stands that contained chestnut, while black oak was certainly the most important of the three on sites where pitch pine occurred. The graphic comparison of forest types in Figure 11 indicates that red oak is the most abundant species associated with white pine in

the existing remnants of the type, but it must be remembered that this is probably the most altered forest type with which we are dealing in this area.

In discussing the ecological status of white pine in the eastern hemlock region, Nichols (1935) pointed out its dual position as "a normal, although minor, constituent of the climatic climax forest", and at the same time an important constituent of the physiographic climax forests of the region. While reference to the map reproduced in Figure 14 reveals that it is widely distributed in Monroe county, there are very few of these locations at which it might be interpreted as part of the climax forest. At most of the stations indicated in the southwestern two thirds of the county it occurs in bogs along with arbor vitae; on Pine Hill on the Parma-Ogden line, in the Chestnut Ridge section of Chili and Gates, and along Burrell road in Wheatland it occurs on the upland, but in stands that belong to the general oak-chestnut-pine type, and must be regarded as edaphically or physiographically controlled. Only at the stations along Widger road in the southern part of Ogden (Figure 15), along Stottle road in Chili, and on Pine Hill in the northern part of Rush, might this species be interpreted as entering as a chance constituent into the climax forest of beech and sugar maple. The land survey records contain only a single reference to such occurrence of the species, in this case also on the upland near a bog south of Black creek in the town of Chili. White pine was scarcely more important in the upland forests of the hemlock-hardwood type. It occurred in these forests principally in the northwestern part of the town of Webster, where the soil was light and the topography somewhat broken, but was apparently absent from the extensive stands in the northwestern part of the county.

Pitch pine, shown in Figure 9 on a typical site, was restricted in its distribution to the deep sands in the vicinity of Irondequoit bay. Its present distribution, indicated in Figure 14, is practically identical with its distribution in the original forests, but it was a dominant species only in the northern part of its indicated range. The land survey notes mention it only in the region centering about the northern half of Irondequoit bay. It was not mentioned more than a mile and a half away from the bay on either side, nor south of Densmore creek on the west side or the Devil's Cove section on the east side. Within this region chestnut was seldom mentioned as an important species, but the oaks frequently exceeded pitch pine (called "yellow pine" in these records) in abundance.

The occurrence of pitch pine in extensive stands in this region is of special interest, since it apparently flourishes here at the edge of its geographic range. This is the westernmost station from which it has been reported in the Ontario plain, but it is known from scattered eastern stations between this point and Hammond, in St. Lawrence county, and

in the Mohawk lowland east of Oneida Lake, and in the Albany-Schenectady region (House 1924). This distribution strongly suggests that the species migrated into this region from the coastal plain by way of the Hudson valley and the Mohawk-Ontario lowland. Favorable habitats for its establishment are less frequent from this point west.

Although chestnut is known to have formed pure stands locally, this behaviour of the species is exceptional. In most places where it occurred as a dominant it was exceeded in abundance by the oaks but was more abundant than the white pine which sometimes accompanied them. Pitch pine seldom occurred on these sites. The largest continuous area of this type lay just north of the ridge, and extended from the Genesee river east as far as Culver road, and was uniformly characterized in the survey notes as oak-chestnut-white pine. In some places in Irondequoit and Webster, as well as the Clarkson area and the Chestnut Ridge area in Chili and Gates, white pine was either unimportant or entirely absent, and an oak-chestnut type existed.

As indicated by the map showing its distribution, Figure 16, chestnut entered more extensively into the adjacent vegetation types than the pines. The transitional areas north of the ridge in Greece and Webster (shown on the county vegetation map) contained local stands of oak-chestnut, typical beech-sugar maple, and transitions which included the dominants of both these associations in varying proportions, which might be regarded as a mixed mesophytic type. This concept will be discussed in the next section. Chestnut also entered locally into the hemlock-hardwood types near the lake shore in the northwestern part of Webster to a greater extent than white pine, and was locally present on the sandy knolls in the southwestern part of Brighton and the upland oak types of Mendon, Pittsford, and Perinton, but was only very locally dominant in these areas.

Although a few trees still sprout and occasionally bear fruit, chestnut has been effectively eliminated from the forest remnants of the region by the chestnut blight. This explains the omission of this formerly important tree from the analysis of present woodlots, Figure 11. A typical group of dead trees is shown in Figure 17. Apparently the associated oaks are replacing the chestnut on such sites, preceded in some cases by a pioneer stage of aspen.

This is only one of the factors which have contributed to the extreme alteration of the oak-chestnut-pine forests. The commercial value of pine and its accessibility have been of almost equal consequence, and the suburban location of Irondequoit has favored residential development, and both its location and soil have favored truck gardening. The dryness of the habitat has increased the fire hazard, and large areas along the bay still burn over almost every year. Such an area is shown in Figure 18. The ground cover is almost entirely bracken and New Jersey tea, which sprout

from underground parts undamaged by fire, and fire scars may be observed on practically every tree.

The following species of trees were most frequently associated with the dominants in the oak-chestnut-pine forests:

Pignut hickory ..... *Carya glabra* (Mill.) Sweet
White ash ..... *Fraxinus americana* L.
Red maple ..... *Acer rubrum* L.
Wild black cherry ..... *Prunus serotina* Ehrh.
Sassafras ..... *Sassafras albidum* (Nutt.) Nees
Shagbark hickory ..... *Carya ovata* (Mill.) K. Koch
Ironwood ..... *Ostrya virginiana* (Mill.) K. Koch
Quaking aspen ..... *Populus tremuloides* Michx.
Large-toothed aspen ..... *Populus grandidentata* Michx.
Small-fruited hickory ..... *Carya ovalis* (Wang.) Sarg.

In addition to these a number of small trees and shrubs were characteristically present, forming a dense undergrowth in many places. The following list of smaller woody plants is based on a study of existing remnants of the type:

Witch hazel ..... *Hamamelis virginiana* L.
Choke cherry ..... *Prunus virginiana* L.
Flowering dogwood ..... *Cornus florida* L.
Staghorn sumac ..... *Rhus typhina* L.
Shadbush ..... *Amelanchier canadensis* (L.) Medic.
Round-leaved dogwood ..... *Cornus rugosa* Lam.
Blackberry ..... *Rubus allegheniensis* Porter
Maple-leaved viburnum ..... *Viburnum acerifolium* L.
Black raspberry ..... *Rubus occidentalis* L.
Panicled dogwood ..... *Cornus racemosa* Lam.
Red raspberry ..... *Rubus idaeus* var. *strigosus* (Michx.) Maxim.
Low blueberry ..... *Vaccinium vacillans* Kalm
Early blueberry ..... *Vaccinium angustifolium* Ait.
Azalea ..... *Rhododendron nudiflorum* (L.) Torr.
Beaked hazel ..... *Corylus cornuta* Marsh.
Flowering raspberry ..... *Rubus odoratus* L.
Deerberry ..... *Vaccinium stamineum* L.
Fly honeysuckle ..... *Lonicera canadensis* Marsh.
Dewberry ..... *Rubus flagellaris* Willd.
Wintergreen ..... *Gaultheria procumbens* L.
Trailing arbutus ..... *Epigaea repens* L.

It will be noted that these are for the most part the same species which characterize other upland forests in which the oaks are among the dom-

inant species. However the soils are generally lighter and more acid and the heaths tend to be more abundant in the oak-chestnut-pine type. The herbaceous flora of this type was quite varied, including in one phase or another most of those species listed for the oak openings and for the other upland oak types. In addition, the following plants were either restricted to this type or more characteristically associated with it than with any other Monroe county vegetation type:

Goat's rue ..... *Tephrosia virginiana* (L.) Pers.
Indian paintbrush ..... *Castilleja coccinea* (L.) Spreng.
Devil's bit ..... *Chamaelirium luteum* (L.) Gray
Rock sandwort ..... *Arenaria stricta* Michx.
Harebell ..... *Campanula rotundifolia* L.
Downy gentian ..... *Gentiana puberula* Michx.
Pinedrops ..... *Pterospora andromedea* Nutt.
Cream-colored pea ..... *Lathryrus ochroleucus* Hook.
American columbo ..... *Frasera carolinensis* Walt.
Wavy hair-grass ..... *Deschampsia flexuosa* L. Trin.
Slender fescue grass ..... *Festuca octoflora* Walt.
Side-oats grama ..... *Bouteloua curtipendula* (Michx.) Torr.
Autumn bentgrass ..... *Agrostis perennans* (Walt.) Tuckerm.
Lion's foot ..... *Prenanthes serpentaria* Pursh
Wild indigo ..... *Baptisia tinctoria* (L.) R. Br.

The oak-chestnut-pine type must be regarded as an edaphic climax in this region. It was so stable that only a marked change in climate could change it as long as remnants of the upland surface of the delta remained, and a large part of this surface is as yet practically uneroded. The normal course of succession would result first in the elimination of the pine, but even this change has been largely prevented by the extreme dryness of the habitat with its resultant open stands and frequent fires.

Oak Forests

Forests dominated exclusively by various species of oak or by oak and hickory were generally more mesophytic than those described in the previous section and have been grouped together for purposes of mapping and discussion. They were located principally in the southern part of Monroe county and are believed to have occupied more than a tenth of the area of the county. They occurred in several types of habitats, but all of them were characterized by deficient soil moisture during practically every growing season. Both surface drainage and internal drainage of the substratum contributed to this deficiency. Some of the higher and steeper drumlins of Chili and Wheatland were dry principally

because of the rapid run-off of precipitation, and a large part of the filled valley of the "Irondogenesee" in Perinton, Pittsford, and Penfield (see Figure 2) and the flat-lying gravelly soils of the Palmyra series in Wheatland, were dry because of the extreme porosity of the substratum, but in most places these two factors acted in combination. Local relief, thin soil, and subterranean drainage through the limestone all contributed to the dryness of the rocky soils overlying the Onondaga limestone in Wheatland and Rush (see figure 6). Certainly relief and the porosity of the substratum were both important in the Pinnacle kame moraine in the southern part of Rochester and in the kame regions in the southern part of Perinton and surrounding the Mendon ponds.

The oak forests of this region correspond most closely with S.A.F. type number 49—*White oak—Black oak—Red oak*, and lists of characteristic species follow:

Dominants

White oak ..... *Quercus alba* L.
Red oak ..... *Quercus borealis* var. *maxima* (Marsh.) Ashe
Shagbark hickory ..... *Carya ovata* (Mill.) K. Koch
Black oak ..... *Quercus velutina* Lam.
Chestnut oak (local) ..... *Quercus montana* Willd.

Associates

Pignut hickory ..... *Carya glabra* (Mill.) Sweet
Small-fruited hickory ..... *Carya ovalis* (Wang.) Sarg.
White ash ..... *Fraxinus americana* L.
Red maple ..... *Acer rubrum* L.
Wild black cherry ..... *Prunus serotina* Ehrh.
Sassafras ..... *Sassafras albidum* (Nutt.) Nees.
Ironwood ..... *Ostrya virginiana* (Mill.) K. Koch
Butternut ..... *Juglans cinerea* L.
Slippery elm ..... *Ulmus fulva* Michx.
Basswood ..... *Tilia americana* L.
Bitternut hickory ..... *Carya cordiformis* (Wang.) K. Koch
Tulip poplar ..... *Liriodendron tulipifera* L.
Chestnut (local) ..... *Castanea dentata* (Marsh.) Borkh.
Bur oak ..... *Quercus macrocarpa* Michx.
Yellow oak (local) ..... *Quercus muhlenbergii* Engelm.

Small Trees

Witch hazel ..... *Hamamelis virginiana* L.
Staghorn sumac ..... *Rhus typhina* L.
Choke cherry ..... *Prunus virginiana* L.
Flowering dogwood ..... *Cornus florida* L.

Hawthorn ..... *Crataegus* spp.
Shadbush ..... *Amelanchier canadensis* (L.) Medic.
Round-leaved dogwood ..... *Cornus rugosa* Lam.

Shrubs

Maple-leaved viburnum ..... *Viburnum acerifolium* L.
Downy arrowwood ..... *Viburnum affine* var. *hypomalacum* Blake
Bush honeysuckle ..... *Diervilla lonicera* Mill.
Low blueberry ..... *Vaccinium vacillans* Kalm
Early blueberry ..... *Vaccinium angustifolium* Ait.
Huckleberry ..... *Gaylussacia baccata* (Wang.) K. Koch
Red raspberry ..... *Rubus idaeus* var. *strigosus* (Michx.) Maxim.
Black raspberry ..... *Rhus radicans* L.
Blackberry ..... *Rubus allegheniensis* Porter
Deerberry ..... *Vaccinium stamineum* L.
Panicled dogwood ..... *Cornus racemosa* Lam.
Azalea ..... *Rhododendron nudiflorum* (L.) Torr.
Beaked hazel ..... *Corylus cornuta* Marsh.
Flowering raspberry ..... *Rubus odoratus* L.

Vines

Poison ivy ..... *Rhus radicana* L.
Wild grape ..... *Vitis aestivalis* Michx.
Virginia creeper ..... *Parthenocissus quinquefolia* (L.) Planch.
Bittersweet ..... *Celastrus scandens* L.
Dewberry ..... *Rubus flagellaris* Willd.

The length of these lists of characteristic woody species should provide some idea of the richness and variability of the oak forests of this region. They probably occupied a wider habitat range than any other vegetation type represented in the region. This floristic richness is also reflected in the following list of characteristic ground cover plants, which includes some species also present in the openings and some species whose habitat range extends into the beech-sugar maple, swamp and bog forests.

Wild sarsaparilla ..... *Aralia nudicaulis* L.
Black cohosh ..... *Cimicifuga racemosa* (L.) Nutt.
Pointed-leaved tick trefoil ..... *Desmodium acuminatum* (Michx.) Dc.
Panicled tick trefoil ..... *Desmodium paniculatum* (L.) Dc.
Wand-like bush clover ..... *Lespedeza intermedia* (Wats.) Britt.
Hairy bush clover ..... *Lespedeza hirta* (L.) Hornem.
Wild sunflower ..... *Helianthus divaricatus* (L.)

Black-eyed Susan ..... *Rudbeckia hirta* L.
Barren strawberry ..... *Waldsteinia fragarioides* (Michx.) Tratt.
New Jersey tea ..... *Ceanothus americanus* L.
Trailing arbutus ..... *Epigaea repens* L.
Wintergreen ..... *Gaultheria procumbens* L.
Pennsylvania sedge ..... *Carex pennsylvanica* Lam.
Emmons's sedge ..... *Carex artitecta* Mack.
Bracken ..... *Pteridium latiusculum* (Desv.) Hieronymus
Rattlesnake root ..... *Prenanthes alba* L.
Early goldenrod ..... *Solidago juncea* Ait.
Cut-leaved goldenrod ..... *Solidago arguta* Ait.
Stout ragged goldenrod ..... *Solidago squarrosa* Muhl.
White goldenrod ..... *Solidago bicolor* L.
Tall goldenrod ..... *Solidago altissima* L.
Gray goldenrod ..... *Solidago nemoralis* Ait.
Hepatica ..... *Hepatica americana* (Dc.) Ker.
Indian pipe ..... *Monotropa uniflora* L.
Wild bergamot ..... *Monarda fistulosa* var. *mollis* (L.) Benth.
Long-fruited anemone ..... *Anemone cylindrica* Gray
Tall anemone ..... *Anemone virginiana* L.
Large-leaved aster ..... *Aster macrophyllus* L.
Bastard toadflax ..... *Comandra umbellata* (L.) Nutt.
Butterfly weed ..... *Asclepias tuberosa* L.
Squaw root ..... *Conopholis americana* L.f.
Pearly everlasting ..... *Anaphalis margaritacea* (L.) Gray
Plantain-leaved everlasting .... *Antennaria plantaginifolia* (L.) Richards
Round-leaved pyrola ..... *Pyrola rotundifolia* var. *americana* (Sweet) Fern.
False Solomon's seal ..... *Smilacina racemosa* (L.) Desf.
St. John's-wort ..... *Hypericum perforatum* L.
Whorled loosestrife ..... *Lysimachia quadrifolia* L.
Wood lily ..... *Lilium philadelphicum* L.
Hare figwort ..... *Scrophularia lanceolata* Pursh

These forests differed from those of the oak-chestnut-pine type in several respects. As indicated by the species lists, they exhibited a greater range of variation. Their more favorable soil moisture relationships were reflected in their heavier forest canopy, the absence of pine and the subordinate position occupied by chestnut, which, while characteristically present in certain areas, such as the morainal region of Perinton, was only a minor constituent of these more mesophytic oak

forests. White oak was much more abundant in these forests, where it attained its maximum importance. It seldom occurred as the sole dominant, but was usually the most abundant species. Chestnut oak was restricted to the morainal region of Perinton (Figure 19) where it entered into a very local oak-chestnut type on the driest sites. Black oak was correspondingly less important. Fewer prairie species occurred in the oak forests, and in less abundance. The heaths were usually present, but were also generally less abundant.

While the upland oak forests of Monroe county generally constituted a physiographic climax, there is evidence that to a certain extent they must be regarded as relicts from a recent period of drier climate, for on the more favorable sites the species of the beech-sugar maple association have recently increased in abundance. This is indicated by their prominence in the younger age-classes of old oak stands. The woodlot at the rear of the Fairhaven Memorial Park, east of the Marsh road in the western edge of Perinton, pictured in Figure 20, illustrates an early stage of this succession. White, black and red oaks make up the rather open forest canopy. Sugar maple and beech are present in the intermediate size classes, and sugar maple and basswood reproduction is especially abundant. A much later stage of the same succession is illustrated in Figure 21. In this woodlot on the east bank of the Genesee river only a few very old white oaks, overtopping the younger stand of beech and sugar maple, remain as evidence of a period of climate more favorable to the persistence of oak forests. No oak reproduction was observed in the area. The drumlin pictured in Figure 2 is an interesting case in point. When Augustus Porter crossed this drumlin in the survey of the town line of town 1, range 1 west of the Genesee, in 1791, he described the timber as "black and white oak, hickory, ironwood and basswood". Sugar maple was not even mentioned at that time, but a century and a half later it made up over 80% of the wood-lot occupying the site. Removal of timber exposes habitat to sun and wind and results in more xeric conditions, which would be expected to favor the oaks and hickories, but in this case a more mesic type has become established. The history of the treatment of this area is not known, but it is probable that it has never been "clear cut" or heavily pastured, and that sugar maple seedlings already present in the understory of the oak forest have been released by selective cutting of the oaks and hickories.

Several variants and transitional types most closely related to the upland oak forests, including stages in the climatic succession mentioned above, have not been mapped separately. While well marked in certain places, their actual extent is not readily determinable, for they frequently grade insensibly into related types. The following members of this category deserve special comment.

Oak-Hickory

Several species of hickory were commonly present in the oak forests but they almost never exceeded the oaks in abundance and probably only attained dominant rank along with the oaks in local situations. The records indicate that this oak-hickory type was most extensively developed on the Farmington soils in the southwestern part of Wheatland, and in the northwestern part of Penfield between Webster road and Irondequoit bay. Hickory also received prominent mention in the survey records for the lots along the southern edge of Perinton, and must have attained local dominance in that area. In general the pignut and small-fruited hickories grew on the drier sites, bitternut on the moister sites, and shagbark on the whole range of sites except the very driest. Shagbark was probably the most abundant hickory in most of the oak-hickory stands, and white oak was commonly the most abundant oak.

Oak-Maple

An oak-maple type transitional between the beech-sugar maple types of the west central part of the county and the upland oak and oak-hickory forests farther south was particularly well developed in the northwestern part of Wheatland and in the section northwest of Scottsville along the Chili-Wheatland town line. The west line passed through "black oak-white oak" and "clear land" south of Oatka creek and the surveyors encountered "beech, sugar and hickory" in the last mile, south of the intersection of the Riga-Mumford road with the Riga-Wheatland town line. "White oak and sugar" were encountered on the slope north of Oatka creek, and "white and black oak and sugar" in the section near the North road. The north town line shows a similar transition, from "basswood, sugar and beech" at the northwest corner to "black and white oak and hickory" north of Scottsville. On this traverse beech drops out first and basswood remains along with sugar maple, while ironwood and the oaks become increasingly important. The timber in the section along Baker road is described as "ironwood, white oak and sugar", but when the line reaches the Winslow road and the drumlin east of it, shown in Figure 2, sugar maple is not even mentioned in the list of five species—"black and white oak, hickory, ironwood and basswood". However it recurs when lower ground is crossed, and the combination "black and white oak and sugar" is mentioned again for a slope east of the Scottsville-Chili road. It is apparent that with increased relief and exposure, beech is eliminated before sugar maple, and on favorable sites, particularly where a gradual increase in relief is not accompanied by a change in soil texture, a transitional oak-sugar maple type may occur between the beech-sugar maple and upland oak types. The surveyors did not mention red oak in the records cited above, and it is assumed that their references to "black oak" include both red oak and black oak, since red oak is the more abundant species in the present woodlots of this section.

Limestone Outcrop Vegetation

Reference has already been made to the occurrence of oak openings and forests of oak and hickory on the thin soils overlying the Onondaga limestone in the southern towns of the county. Limestone outcrops are frequent in this region, in the towns of Sweden and Ogden south of the Niagara escarpment, and along the Genesee gorge from the city of Rochester north. Calcareous rocks also occur at or near the surface in the towns of Riga and Chili. While there is no uniformity in the vegetation occupying these sites, since their moisture relations vary greatly, a number of species are especially characteristic of them. Yellow oak, cork elm, slippery elm, and black maple are frequently abundant and locally dominant. The species included in the following list do not necessarily make up the bulk of the vegetation associated with these outcrops but are especially characteristic of them.

Yellow oak	*Quercus muhlenbergii* Engelm.
Cork elm	*Ulmus racemosa* Thomas
Slippery elm	*Ulmus fulva* Michx.
Black maple	*Acer nigrum* Michx. f.
Bur oak	*Quercus macrocarpa* Michx.
Butternut	*Juglans cinerea* L.
Arbor vitae	*Thuja occidentalis* L.
Hawthorn	*Crataegus* spp.
Wild crab apple	*Malus coronaria* (L.) Mill.
Bladdernut	*Staphylea trifolia* L.
Downy arrowwood	*Viburnum affine* var. *hypomalacum* Blake
Fragrant sumac	*Rhus aromatica* Ait.
Hairy beard-tongue	*Pentstemon hirsutus* (L.) Willd.
Leaf-cup	*Polymnia canadensis* L.
Columbine	*Aquilegia canadensis* L.
Canada waterleaf	*Hydrophyllum canadense* L.
Smooth rock-cress	*Arabis laevigata* (Muhl.) Poir.
Hairy rock-cress	*Arabis pycnocarpa* Hopkins
Bloodroot	*Sanguinaria canadensis* L.
Bladder fern	*Cystopteris bulbifera* (L.)
Bristle-leaved sedge	*Carex eburnea* Boott

Mixed Mesophytic Forests

In certain areas in Monroe county, most of them quite local, mesophytic forests occurred in which dominance by a few species was less pronounced than in the extensive types recognized in mapping. In such areas several species, including both the dominants of adjacent types and certain species ordinarily of secondary importance, occurred in approximately equal abundance. While sites occupied by such forests varied widely, they charac-

teristically combined good soil aeration with a favorable moisture supply. Protected slopes and ravines commonly provided this combination of factors, but the soil texture in certain upland areas, particularly in parts of Greece and Webster, produced an equivalent habitat.

The descriptive expression "mixed mesophytic" was introduced to the literature as a forest type name by Braun in 1916, and has since been variously applied to both undifferentiated and transitional forests (see Sampson, 1930b; Gordon, 1932, 1940; Braun, 1935, 1938). In the present report the term is used in the general descriptive sense outlined in the preceding paragraph.

Dominants of adjacent associations which were generally less abundant in the mixed mesophytic forests include the following:

White oak	*Quercus alba* L.
Red oak	*Quercus borealis* var. *maxima* (Marsh.) Ashe
Shagbark hickory	*Carya ovata* (Mill.) K. Koch
Sugar maple	*Acer saccharum* Marsh.
Chestnut	*Castanea dentata* (Marsh.) Borkh.
White pine	*Pinus strobus* L.
Hemlock	*Tsuga canadensis* (L.) Carr.
Beech	*Fagus grandifolia* Ehrh.

White pine, hemlock, and beech were absent from the mixed mesophytic forests of the southern part of the county, but entered into them in the ravines of the Irondequoit region. The other species listed above were characteristically present throughout the extent of the type. Species which were characteristically more abundant in these forests than in the adjacent upland types include:

Tulip poplar	*Liriodendron tulipifera* L.
Basswood	*Tilia americana* L.
White ash	*Fraxinus americana* L.
Wild black cherry	*Prunus serotina* Ehrh.
Slippery elm	*Ulmus fulva* Michx.
Red maple	*Acer rubrum* L.
Ironwood	*Ostrya virginiana* (Mill.) K. Koch
Butternut	*Juglans cinerea* L.
Bitternut hickory	*Carya cordiformis* (Wang.) K. Koch

Three rather distinct phases of this type of forest occur in different parts of the county:

1. that associated with the large bodies of upland oak forest, especially in Mendon and Perinton, and mapped as part of the oak forest; most nearly equivalent to the type described by Gordon (1940) for Cattaraugus county, New York;

2. that on the upland along and north of the ridge in Greece and Webster, occurring locally in the area mapped as transitional between oak-chestnut and beech-sugar maple; occupying the same position as the mixed mesophytic community of northeastern Ohio, which Sampson (1930b) characterized as "a special type of transitional community occupying a position between dry sites covered by oak-chestnut and moist sites in which the complex of factors is favorable to the dominance of beech-maple";

3. that occurring in areas transitional between the oak-chestnut-pine and hemlock-northern hardwood types, especially the ravine slopes of Irondequoit and Webster; corresponding with the "beech-hemlock-oak-chestnut mictium" described by Williams (1936) from an area in northeastern Ohio.

There are a few differences between the mixed mesophytic forests of this region and those described by Gordon (1940) for Cattaraugus county. Sweet birch (*Betula lenta*), mentioned as an important constituent in that region, here occurred only in association with hemlock (Figure 22) and cucumber tree, was very local in Monroe county, though restricted to a part of the county where the mixed mesophytic forest was especially well developed. Beech was generally a less important constituent here than in Cattaraugus county. Black oak and chestnut oak were generally absent from the type in both regions. These forests seem to have had the same general aspect. Abundant and varied shrubs and herbaceous plants generally formed a dense ground cover, in which the heaths were relatively unimportant. The moister phases included most of the ferns and flowering plants characteristic of the beech-sugar maple association.

The mixed mesophytic forests of this region were in many places not clearly differentiated from adjacent upland types because of the general floristic richness of these types. Comparison of the species lists for the upland oak, hemlock-hardwood, and beech-maple types and reference to Figure 11, which compares present remnants of these types, show that most of the species important in the mixed mesophytic forest are present in all of them. Figure 23 shows the wide distribution of tulip poplar, which attained its maximum abundance in the mixed mesophytic forest, and is usually regarded as its most characteristic species. Basswood, white ash and black cherry were likewise important in binding these upland forest types into a continuous mesophytic complex.

Beech-Sugar Maple Forests

Forests belonging to this category were more extensive in Monroe county than any other type. Large areas of moderate relief were occupied by them exclusively and they are known to have occurred in every

town in the county, probably occupying at least half of the total county area. These forests fall into the general beech-maple type described by Sampson (1927) and Gordon (1932) and S. A. F. type 57: *Beech-Sugar Maple*. They constitute a climatic climax, as evidenced by their widespread occurrence on a wide variety of soil types, consistent occupation of the better sites of a large part of the region, and their tendency to maintain themselves and to succeed adjacent forest types. Stands of this type which have not been overpastured exhibit abundant regeneration of the dominant species, particularly sugar maple (Figure 24), which frequently forms such a continuous undergrowth that it it difficult to photograph the interior of these stands. A large part of the beech regeneration is by root sprouts. The climax status of these species is largely due to their ability to reproduce in their own shade, which is so dense that it eliminates the seedlings of less shade-tolerant species. A particularly good example of the beech-sugar maple association, occurring on the property of the Oak Hill Country Club, near Pittsford, is shown in Figure 1. In this stand the trees making up the forest canopy vary from 10 to 30 inches in diameter. Occasional trees of basswood, white ash, tulip poplar, wild black cherry, and red oak occur along with the dominant beech and sugar maple in the forest canopy. Basswood is the most important of these associates. It was present in practically every beech-maple stand in the county, usually ranking third in abundance, but locally sharing in dominance. In parts of Riga and Wheatland it exceeded beech in abundance and a sugar maple-basswood type was formed.

The notes for the survey of the Batavia-Rochester road in 1810 (the road through North Chili and Churchville now known as the Buffalo road) indicate both the widespread occurrence of beech-sugar maple forests on the uplands of the western part of the county and the importance of basswood in these forests. For practically every mile of the Monroe county part of this road, which was of course laid out so as to avoid both swampy areas and steep grades insofar as possible, the timber was described as "beech, maple and bass". The original notes of this survey are on file in the office of the Genesee county clerk at Batavia.

The following lists of characteristic species are based largely on the stands in the 50 widely separated distributed woodlots selected as the most typical remnants of the beech-sugar maple association.

Dominants

Sugar maple ..... *Acer saccharum* Marsh.
Beech ..... *Fagus grandifolia* Ehrh.
Basswood ..... *Tilia americana* L.

Most Frequent Associates

American elm ..... *Ulmus americana* L.
White ash ..... *Fraxinus americana* L.

Ironwood ..... *Ostrya virginiana* (Mill.) K. Koch
Red maple ..... *Acer rubrum* L.
Black maple ..... *Acer nigrum* Michx. f.
Red oak ..... *Quercus borealis* var. *maxima* (Marsh.) Ashe
Shagbark hickory ..... *Carya ovata* (Mill.) K. Koch
Wild black cherry ..... *Prunus serotina* Ehrh.
Tulip poplar ..... *Liriodendron tulipifera* L.

Small Trees

Blue beech ..... *Carpinus caroliniana* Walt.
Witch hazel ..... *Hamamelis virginiana* L.
Alternate-leaved dogwood ..... *Cornus alternifolia* L. f.
Hawthorn ..... *Crataegus* spp.
Flowering dogwood ..... *Cornus florida* L.

Ground Cover

Blue cohosh ..... *Caulophyllum thalictroides* (L.) Michx.
False Solomon's seal ..... *Smilacina racemosa* (L.) Desf.
Christmas fern ..... *Polystichum achrostichoides* (Michx.) Schott
White baneberry ..... *Actaea alba* (L.) Mill.
Beechdrops ..... *Epifagus virginiana* (L.) Bart.
Bloodroot ..... *Sanguinaria canadensis* L.
Jack-in-the-pulpit ..... *Arisaema triphyllum* (L.) Schott
Large-flowered trillium ..... *Trillium grandiflorum* (Michx.) Salisb.
Wild ginger ..... *Asarum canadense* L.
Blue-stemmed goldenrod ..... *Solidago caesia* L.
Blue wood aster ..... *Aster cordifolius* L.
Sharp-lobed hepatica ..... *Hepatica acutiloba* DC.
Blunt-lobed hepatica ..... *Hepatica americana* (DC.) Ker.
Plantain-leaved sedge ..... *Carex plantaginea* Lam.
Virginia waterleaf ..... *Hydrophyllum virginianum* L.
Wide-leaved goldenrod ..... *Solidago latifolia* L.
White avens ..... *Geum canadense* Jacq.
Common wood fern ..... *Dryopteris spinulosa* var. *intermedia* (Muhl.) Underw.
May apple ..... *Podophyllum peltatum* L.
Rattlesnake fern ..... *Botrychium virginianum* (L.) Sw.
Enchanter's nightshade ..... *Circaea latifolia* Hill
Herb Robert ..... *Geranium robertianum* L.
Bottle brush grass ..... *Hystrix patula* Moench.
Horse balm ..... *Collinsonia canadensis* L.

Lopseed ..... *Phryma leptostachya* L.
White snakeroot ..... *Eupatorium rugosum* Houtt
Hairy sweet cicely ..... *Osmorhiza claytoni* (Michx.) Clarke
Honewort ..... *Cryptotaenia canadensis* (L.) DC.
False-lily-of-the-valley ..... *Maianthemum canadense* Desf.
Wild leek ..... *Allium tricoccum* Ait.
Dog tooth violet ..... *Erythronium americanum* Ker.
Downy yellow violet ..... *Viola pubescens* Ait.
Wild liquorice ..... *Galium circaezans* Michx.
Black snakeroot ..... *Sanicula marilandica* L.
Pointed-leaved tick trefoil ..... *Desmodium acuminatum* (Michx.) DC.
Bearded short-husk ..... *Brachyelytrum erectum* (Schreb.)
Hog peanut ..... *Amphicarpa bracteata* (L.) Fern.
Ground nut ..... *Apios americana* Medic.
Maidenhair fern ..... *Adiantum pedatum* L.
Upland lady fern ..... *Athyrium angustum* (Willd.) Presl.
Beech fern ..... *Dryopteris hexagonoptera* (Michx.) C. Chr.

Shrubs were generally absent from the more typical beech-maple stands, their place being taken by sugar maple and beech reproduction. Those that did occur were largely restricted to places where the forest canopy had been broken by windfall or cutting, or the moister spots where swamp forest species, such as elm, ash, and red maple, increased in abundance. Elderberry and spice bush commonly occurred in these swampy spots. Abundant and varied spring flowers, which did most of their growing and flowering before the trees had come out in leaf, characterized the beech-sugar maple association, but the mid-summer ground cover was quite sparse under the heavier parts of the forest canopy, where only shade-tolerant plants could survive.

The ecological status of the type in relation to the forests of the eastern hemlock region has already been treated in the discussion of the vegetation pattern of Monroe county. The nature and range of variation within the type and its relationship to adjacent upland types may be illustrated by a hypothetical transect from north to south in the western part of the county, along which there is a gradual decrease in effective moisture. Only upland types and phases known to have occurred in this area are considered, and they are arranged in a gradational series. In each type name the species are listed in order of abundance, and in the trend from north to south:

Hemlock-northern hardwood types ..
- Hemlock-beech-birch
- Beech-birch-hemlock
- Beech-birch-maple-hemlock
- Beech-maple-hemlock

Beech-sugar maple types	Beech-maple Beech-maple-basswood Maple-basswood Maple-basswood-oak
Upland oak types	Oak-maple basswood Oak-hickory-maple Oak-hickory Oak
	Openings

Hemlock-Northern Hardwood Forests

Reference to those forests of Monroe county in which hemlock shared dominance with the "northern hardwoods"—beech, sugar maple, and birch—has already been made in the discussion of the vegetation pattern of the area. Something of the range of variation within the general type and the nature of its relationship to the beech-sugar maple association are illustrated in the idealized transect of upland vegetation in the discussion immediately preceding this. The generalized type recognized in mapping includes all stands in which hemlock was a dominant, although it was frequently exceeded in abundance by beech and sugar maple. This is particularly true of the present remnants of the hemlock-hardwood forest, from which most of the merchantable hemlock has been removed.

The hemlock-northern hardwood forests of this region are interpreted as the local expression of the climax association of the "eastern hemlock region" defined by Nichols (1935). This association has been described from the plateau region of northwestern Pennsylvania and southwestern New York by Lutz (1930), Hough (1936), and Gordon (1940), and the most typical stands in Monroe county correspond closely with these published descriptions. The remnants belong to S.A.F. types 11: *Hemlock* and 12: *Sugar Maple-Beech-Yellow Birch.*

The most extensive areas occupied by the hemlock-northern hardwood type occurred in the northeastern and northwestern corners of the county and were largely restricted to the Lake Iroquois plain north of the ridge road. The strip occupied by them tends to widen out both to the east and west, and suggests a broad belt of climatically controlled hemlock forest along the lake, interrupted by edaphic and physiographic modification in the vicinity of the Genesee river, where the soils were lighter and the streams were entrenched much farther below the upland surface. In this dissected region the hemlock types persisted only in the sheltered ravines which characterize the topography along Irondequoit creek. Enriched transitional stands earlier cited as a local mixed mesophytic com-

munity are included in the generalized hemlock-hardwood type mapped in this region. The present distribution of hemlock in the county is shown in Figure 22. It will be observed that most of the spots are in the towns nearest the lake and in the valley of Irondequoit creek. However a number of outlying stations occur in the three southwestern towns. A few of these are on north-facing slopes along streams, but most of them are in the arbor vitae bogs which characterize this part of the county. On such sites hemlock is interpreted as a relict from a climatic period when hemlock and the northern hardwoods shared dominance in the widespread upland type of the region, and the normal direction of succession with improved drainage was from arbor vitae bog to hemlock-northern hardwood forest. The same local factors which retarded that succession and account for the persistence of arbor vitae also retarded the climatic succession from mixed evergreen-deciduous forest to deciduous forest, and account for the local persistence of hemlock in this part of the area. A particularly good example of the hemlock-hardwood type developed on a site with bog history occurs east of Union street and south of Bowen road in the town of Chili. Views of this area are shown in Figures 20 to 28. This stand represents a late stage in the succession from bog to upland forest. In places it approximates the composition of the upland hemlock-northern hardwood forest, from which it differs in the following respects:

1. persistence of arbor vitae, black ash, and white pine from earlier successional stages;
2. absence of beech and sweet birch;
3. richer undergrowth, including more shrubs and a luxuriant ground cover of ferns and flowering plants;
4. very uneven and hummocky substratum due to many fallen logs and stumps, and settling of the deep muck between them;
5. tree reproduction largely confined to these hummocks and decayed logs and stumps (Figure 25).

The heaviest stands of timber in the region are believed to have belonged to the hemlock-northern hardwood type. The forest canopy was typically very dense and light intensity on the forest floor was extremely low. The undergrowth, aside from reproduction of the dominant species, was usually very sparse in typical stands and was made up of species with very low light requirement. The fact that hemlock is an evergreen resulted in low light intensity throughout the year, not just during the growing season as in the case of the deciduous forests, and limited the spring flora, which was much less abundant and varied in the hemlock forests than in the beech-maple association.

The composition of the hemlock-northern hardwood type of this region as compared with Nichols' analysis for the eastern hemlock region as a

whole has already been discussed, and the relative abundance of the important tree species in existing stands of the type is graphically shown in Figure 11. The following lists of characteristic species constitute a further summary of the composition of the type as developed in this region.

Dominants

Hemlock ..... *Tsuga canadensis* (L.) Carr.
Beech ..... *Fagus grandifolia* Ehrh.
Sugar maple ..... *Acer saccharum* Marsh.

Most Frequent Associates

Yellow birch ..... *Betula lutea* Michx.
Sweet birch ..... *Betula lenta* L.
Basswood ..... *Tilia americana* L.
Red maple ..... *Acer rubrum* L.
White ash ..... *Fraxinus americana* L.
Red oak ..... *Quercus borealis maxima* (Marsh.) Ashe
Ironwood ..... *Ostrya virginiana* (Mill.) K. Koch
Wild black cherry ..... *Prunus serotina* Ehrh.
American elm ..... *Ulmus americana* L.

The birches usually ranked next to the dominants named, and in the moister phrases yellow birch became a local dominant along with hemlock and beech. Sweet birch was practically restricted to the hemlock-hardwood forests (Figure 22), but was in most places only a minor constituent. Paper birch (*Betula papyrifera* Marsh.) and fire cherry (*Prunus pennsylvanica* L.f.), while they did not enter into the climax forest, were similarly largely restricted to that part of the county where hemlock types occurred. The tendency of some of the hemlock-hardwood forests of the Irondequoit-Webster region to vary in the direction of a mixed mesophytic community is indicated by the local importance of the following additional species in them:

Tulip poplar ..... *Liriodendron tulipifera* L.
Chestnut ..... *Castanea dentata* (Marsh.) Borkh.
White pine ..... *Pinus strobus* L.

In such stands basswood, white ash, red oak, and wild black cherry also increased in importance.

Shrubs and small trees were infrequent in the more typical stands. Probably the most typical shrub was hobble bush (*Viburnum alnifolium* Marsh.), shown in Figure 29. A number of species frequently listed as typical of the hemlock-northern hardwood forest were present in some of the stands but were either not universally present or were not restricted to the type. These include:

Striped maple ..... *Acer pennsylvanicum* L.
Alternate-leaved dogwood .... *Cornus alternifolia* L.f.
Blue beech ..... *Carpinus caroliniana* Walt.
Red-berried elder ..... *Sambucus pubens* Michx.
Yew ..... *Taxus canadensis* Marsh.
Fly honeysuckle ..... *Lonicera canadensis* Marsh.
Flowering raspberry ..... *Rubus odoratus* L.

Ferns were especially prominent in the discontinuous ground cover which characterized the type. These include:

Common wood fern ..... *Dryopteris spinulosa* var. *intermedia* (Muhl.) Underw.
Christmas fern ..... *Polystichum achrostichoides* (Michx.) Schott
Lady fern ..... *Athyrium angustum* (Willd.) Presl.
New York fern ..... *Dryopteris noveboracensis* (L.) Gray
Interrupted fern ..... *Osmunda claytoniana* L.
Maidenhair fern ..... *Adiantum pedatum* L.
Rattlesnake fern ..... *Botrychium virginianum* (L.) Sw.
Sensitive fern ..... *Onoclea sensibilis* L.
Ostrich fern ..... *Pteretis nodulosa* (Michx.) Nieuwl.

The common wood fern and Christmas fern were most abundant on the better drained sites, while sensitive fern and ostrich fern characterized only the moister and more open sites.

Other plants which characterized the ground cover are included in the following list. Species regarded as especially characteristic of the type are marked with an asterisk.

*Partridge berry ..... *Mitchella repens* L.
*Shining club moss ..... *Lycopodium lucidulum* Michx.
*Indian cucumber root ..... *Medeola virginiana* L.
Foam flower ..... *Tiarella cordifolia* L.
Blue-stemmed goldenrod ..... *Solidago caesia* L.
Wooly sweet cicely ..... *Osmorhiza claytoni* (Michx.) Clarke
White baneberry ..... *Actaea alba* (L.) Mill.
Virginia waterleaf ..... *Hydrophyllum virginianum* L.
Blue wood aster ..... *Aster cordifolius* L.
*Mountain aster ..... *Aster acuminatus* Michx.
Spikenard ..... *Aralia racemosa* L.
Herb Robert ..... *Geranium robertianum* L.
*False-lily-of-the-valley ..... *Maianthemum canadense* Desf.
Sharp-lobed hepatica ..... *Hepatica acutiloba* Dc.
Canada violet ..... *Viola canadensis* L.
*Round-leaved yellow violet .... *Viola rotundifolia* Michx.

*Plantain-leaved sedge	*Carex plantaginea* Lam.
Woodland sedge	*Carex blanda* Dewey
Wintergreen	*Gaultheria procumbens* L.
Pipsissewa	*Chimaphila umbellata* (L.)
Shinleaf	*Pyrola elliptica* Nutt.
Indian pipe	*Monotropa uniflora* L.
*Starflower	*Trientalis borealis* Raf.

Good examples of the hemlock-hardwood type are preserved in the town of Webster. The stands along Mill creek near Woodhull road and in the Hale woods at the corner of the Sea Breeze-Nine Mile Point road and Pellett road are particularly good. Probably some white pine was taken out of the Hale woods at an early date, but recent cutting has consisted solely of removal of dead and fallen timber. The larger hemlocks in this stand range up to 40 inches in diameter. A view in the interior of this woods is shown in Figure 30. This is an excellent area in which to study the range of variation within the type. The soil is mostly silt loam, but locally approaches a fine sandy loam. The upland surface is relatively flat, but is interrupted by ravines with steep sides and flat bottoms. The broader upland areas were characterized by a hemlock-beech variant similar to that photographed on the upland near Salmon creek, in the town of Parma (Figure 31). Sugar maple was especially important on the slopes, where beech was seldom present. Three species of birch occurred in the area. Sweet birch was more common on the upland. Yellow birch occurred throughout, but was especially important in the ravine bottoms, where it was sometimes associated with hemlock, but more commonly with basswood and white ash. Only occasional trees of paper birch occurred. On the spots of lighter soil, and the narrower strips of upland and slopes associated with them, local variation in the direction of a mixed mesophytic community occurred. Here chestnut, tulip poplar, basswood, white ash, and wild black cherry enriched the stand. It is probable that only occasional trees of white pine were present in the original stand. Most of the hemlock stands of Monroe county are decidedly decadent. Opening up of the canopy by selective cutting and damage to the shallow root systems by the tramping of cattle have made the remaining hemlock especially susceptible to drought damage, which was very severe in the dry years following 1930. Apparently severity of drought damage is directly proportional to the degree of disturbance of the habitat. Beech was similarly affected, and damage to both species was most severe on the heavier soils where the root systems were more superficial.

Deciduous Swamp Forests

The deciduous swamp forests of this region belong to the "northern swamp forest formation" whose variation in northern Ohio was analyzed by Sampson (1930a). They are essentially similar to the swamp forests

of northern Ohio, but are less extensively developed and somewhat poorer in species in this region than in the lake plain of northwestern Ohio (Shanks 1939), or in the filled valleys of the plateau region of northeastern Ohio (Shanks 1942). On the other hand they are richer in species and more varied in composition than the corresponding "bottomland hardwood forests" described by Gordon (1940) from the plateau region of southwestern New York. The occurrence of a "dominantly hardwood swamp forest" farther west in the Ontario plain was recognized by Bray (1915) but no detailed analysis was given. While considerable local variation in composition occurs, the generalized type of this region falls into S. A. F. type 26: *Black Ash-American Elm-Red Maple.*

Sizable swamp forests were widely distributed in Monroe county and probably occupied as much as one tenth of the total area. Small patches occurred principally in the regions generalized as beech-sugar maple, both along the streams and in poorly drained spots on the upland. The largest continuous swamp forest in the area occupied the flats along the Genesee river in the central and southern parts of the county—silt plains laid down in glacial Lake Scottsville (Figure 32). Extensive stands also occurred in Brighton south of the Pinnacle moraine, in the southwestern part of Gates, in the southeastern part of Perinton, and on the flood plains of the major streams.

Habitats occupied by swamp forest were generally subject to flooding and were characterized by a high water table during at least a part of every growing season. Deficient soil aeration resulted and was the most important factor preventing invasion of these swampy habitats by the mesophytes of the climax forest. The soils were largely inorganic, in contrast to the peat or muck which characterized the bog forests, but were generally darker in color than the upland soils due to incorporation of organic matter. They consisted largely of recent alluvium and glacial lake sediments, and were generally heavier in texture than the associated upland soils.

The common characteristic of the species which made up the swamp forest is a low soil aeration requirement. On the other hand they differ among themselves in moisture requirement and tolerance of drought. Some species, such as black ash, are confined to those sites where the moisture is constant, while others, such as red maple, may also occur on dry sites. They generally do not form a very dense forest canopy and their seedlings are unable to survive in the shade of the climax species which succeed them when soil aeration has improved. Differences in moisture requirement, soil aeration requirement and light requirement among the swamp forest species, and variation of the habitat with respect to these factors account for the varying composition of this forest type. Certain species enter the swamp forest in such regular sequence following drainage improvement that they may be regarded as indicators of transitional phases in the suc-

cession toward the mesophytic beech-sugar maple climax. All such phases too wet for the entrance of beech and sugar maple have been mapped as part of the swamp forest. The following species occur as dominants in the various phases of the swamp forest in various combinations. Usually two or three species constitute the bulk of any local stand.

American elm ..... *Ulmus americana* L.
Red maple ..... *Acer rubrum* L.
Silver maple ..... *Acer saccharinum* L.
Basswood ..... *Tilia americana* L.
White ash ..... *Fraxinus americana* L.
Swamp white oak (local) ..... *Quercus bicolor* Willd.
Red ash ..... *Fraxinus pennsylvanica* Marsh.
Black ash ..... *Fraxinus nigra* Marsh.

Characteristic associates which did not attain dominant rank except very locally are included in the following list. As indicated, certain of these were not generally distributed in the area, but when present entered into the swamp forest.

Shagbark hickory ..... *Carya ovata* (Mill.) K. Koch
Big shellbark (local) ..... *Carya laciniosa* (Michx. f.) Loud.
Bur oak ..... *Quercus macrocarpa* Michx.
Slippery elm ..... *Ulmus fulva* Michx.
Red oak ..... *Quercus borealis* var. *maxima* (Marsh) Ashe
Bitternut hickory ..... *Carya cordiformis* (Wang.) K. Koch
Butternut (local) ..... *Juglans cinerea* L.
Black walnut (very local) ..... *Juglans nigra* L.
Black willow ..... *Salix nigra* Marsh.
Peach-leaved willow ..... *Salix amygdaloides* Anders.
Green ash ..... *Fraxinus lanceolata* Borkh.
Cottonwood ..... *Populus deltoides* Marsh.
Sycamore ..... *Platanus occidentalis* L.
Cork elm ..... *Ulmus racemosa* Thomas
Hackberry (local) ..... *Celtis occidentalis* L.

A woody undergrowth of small trees, shrubs and vines was generally well developed in the swamp forest. The more characteristic species are included in the following list.

Blue beech ..... *Carpinus caroliniana* Walt.
Hawthorn ..... *Crataegus* spp.
Nannyberry ..... *Viburnum lentago* L.
Toothed arrowwood ..... *Viburnum dentatum* L.
Common elder ..... *Sambucus canadensis* L.
Prickly ash ..... *Zanthoxylum americanum* Mill.

Spicebush ..... *Benzoin aestivale* (L.) Nees
Red osier ..... *Cornus stolonifera* Michx.
Panicled dogwood ..... *Cornus racemosa* Lam.
Silky dogwood ..... *Cornus amomum* Mill.
Buttonbush ..... *Cephalanthus occidentalis* L.
Pussy willow ..... *Salix discolor* Muhl.
Wild black currant ..... *Ribes americanum* Mill.
Poison ivy ..... *Rhus radicans* L.
Virginia creeper ..... *Parthenocissus quinquefolia* (L.) Planch.
Fox grape ..... *Vitis vulpina* L.
Bittersweet ..... *Celastrus scandens* L.
Moonseed ..... *Menispermum canadense* L.
Hispid greenbriar ..... *Smilax hispida* Muhl.

The ground is more completely covered with herbaceous vegetation than in any other forest type of the region. Moisture, light intensity and soil fertility favor luxuriant growth and the ground cover is especially tall and dense. The following lists include those species which are usually most abundant and which recur with greatest regularity in the swamp forests of the region.

Ferns

Sensitive fern ..... *Onoclea sensibilis* L.
Cinnamon fern ..... *Osmunda cinnamomea* L.
Royal fern ..... *Osmunda regalis* L.
Lady fern ..... *Athyrium angustum* (Willd.) Presl.
Common wood fern ..... *Dryopteris spinulosa* var. *intermedia* (Muhl.) Underw.

Sedges and Grasses

Graceful sedge ..... *Carex gracillima* Schwein.
Gray's sedge ..... *Carex grayii* Carey
Blunt broom sedge ..... *Carex tribuloides* Wahl.
Sickle sedge ..... *Carex crinita* Lam.
Bladder sedge ..... *Carex intumescens* Rudge
Hop sedge ..... *Carex lupulina* Muhl.
Sallow sedge ..... *Carex lurida* Wahl.
Wild rye ..... *Elymus virginicus* L.
Wood reed grass ..... *Cinna arundinacea* L.

Composites

White snakeroot ..... *Eupatorium rugosum* Houtt
Boneset ..... *Eupatorium perfoliatum* L.
Joe Pye weed ..... *Eupatorium maculatum* L.
Tall coneflower ..... *Rudbeckia laciniata* L.

New England aster	*Aster novae-angliae* L.
White wood aster	*Aster divaricatus* L.
Tall white aster	*Aster paniculatus* Lam.
Purple-stemmed aster	*Aster puniceus* L.
Crooked-stemmed aster	*Aster prenanthoides* Muhl.
Tall goldenrod	*Solidago altissima* L.
Wrinkle-leaved goldenrod	*Solidago rugosa* Mill.
Late goldenrod	*Solidago gigantea* var. *leiophylla* Fern.
Canada goldenrod	*Solidago canadensis* L.
Tall wild lettuce	*Lactuca canadensis* L.

Other Herbaceous Plants

Spotted touch-me-not	*Impatiens biflora* Walt.
False Solomon's seal	*Smilacina racemosa* (L.) Desf.
May apple	*Podophyllum peltatum* L.
White avens	*Geum canadense* Jacq.
Foam flower	*Tiarella cordifolia* L.
Early meadow rue	*Thalictrum dioicum* L.
Virginia knotweed	*Polygonum virginianum* L.
Turtlehead	*Chelone glabra* L.
Virginia waterleaf	*Hydrophyllum virginianum* L.
Canada waterleaf	*Hydrophyllum canadense* L.
Wood nettle	*Laportea canadensis* (L.) Gaud.
Canada anemone	*Anemone canadensis* L.
Fringed loosestrife	*Lysimachia ciliata* L.
Clearweed	*Pilea pumila* (L.) Gray
Cardinal flower	*Lobelia cardinalis* L.
Blue lobelia	*Lobelia siphilitica* L.
Spotted water hemlock	*Cicuta maculata* L.
Water parsnip	*Sium suave* Walt.
Carrion vine	*Smilax herbacea* L.
Bittersweet	*Solanum dulcamara* L.

In his analysis of the predominantly elm-ash-soft maple swamp forest which follows the pioneer willow-cottonwood-sycamore community of the stream margins in northern Ohio, Sampson (1930a) recognized the following phases, which denote progressive improvement in drainage and soil aeration. The species used as indicators of these phases were not necessarily dominants.

1. elm-black ash-soft maple
2. bur oak-big shellbark hickory transition
3. red oak-basswood transition
4. tulip poplar-black walnut transition

Similar phases may be recognized in the swamp forests of this region. Black willow, cottonwood, sycamore, and silver maple were the commonest pioneer trees along the streams, but characteristically formed a marginal fringe, not an extensive stand. The most poorly drained phase was characterized by black ash. Upland depressions were frequently described in the land survey notes as "black ash swamps". The notes for Riga, Chili, and Henrietta contain many such references. Most of these swamps were less than a quarter of a mile across, but they were occasionally larger. The most extensive stand of this type known to have occurred in the county occupied about 400 acres in the southwestern corner of Gates along Little Black creek. Usually these swamps were passable, but the survey notes for the Brighton-Henrietta town line (surveyed by Augustus Porter, 1792) describe a part of the mile east from Ballantyne bridge as follows: "Miry wet swamp. Alder and black ash. Went around it." Apparantly elm entered these areas next, for the two species are frequently mentioned together. A slightly better drained area was described near the point where the canal intersects the Brighton-Henrietta town line: "Low and moist. Black and white ash, soft maple and elm."

Black ash is an important link connecting the bog and swamp forests of the region, occurring commonly in both types. Where present in the swamp forest, it generally occurs on a more mucky substratum than the better drained phases. Apparently these mucky spots were formerly shallow bogs, and the bog conifers have been eliminated from them by climatic change. Occasional trees of yellow birch persist along with the black ash on some of these sites.

The phase of the Monroe county swamp forest which corresponds with Sampson's "bur oak-big shellbark transition" was most extensively developed on the river flats of Brighton, Chili, Henrietta, Wheatland, and Rush. The big shellbark hickory was not always present in this phase, but was practically restricted to it and to this part of the county. Bur oak was common throughout, but was frequently exceeded in abundance by swamp white oak, which was codominant with elm in certain areas. White and red ash were important in this "swamp oak" phase, and silver maple usually exceeded red maple, which was more characteristically associated with black ash in the upland swamps. These broad flats are regularly inundated in the spring but in late summer they usually become quite dry. The water table fluctuates more widely here than in any other phase of the swamp forest.

Pin oak (*Quercus palustris* Muench.), which was locally important in an equivalent phase of the swamp forest in northern Ohio (Shanks 1939, 1942), was entirely absent from this region. The absence of buckeye (*Aesculus glabra* Willd.), honey locust (*Gleditsia triacanthos* L.) and Kentucky coffee tree (*Gymnocladus dioica* (L.) Koch), and the infrequent occurrence of hackberry are also notable differences.

The "red oak-basswood transition" was well represented and widely distributed in Monroe county. Michaux (1855) noted the abundance of basswood in his travels through the Genesee region prior to 1800. Bray (1915), page 117, recognized its importance in the swamp forest of the Ontario plain: "On the level plain of the Ontario Basin in Niagara and Orleans counties, American elm and basswood are more prominent in swamps or at least in near-swamp forest than is red maple." His use of expression "near-swamp" suggests that he regarded these stands as transitional. Basswood frequently attained dominant rank in such stands in Monroe county, and a local elm-basswood community was formed. Red oak was rather infrequent in this phase except in those parts of the area where oak types occupied the better drained uplands. White ash probably attained its greatest abundance in this phase and shagbark hickory was locally important.

The "tulip-walnut transition", more characteristic of specialized habitats, has not been recognized in this area. Extensive planting has obscured the native range of black walnut, which was listed as an introduced species in the county flora (Beckwith and Macauley 1896). However it is mentioned several times in the early writings, and occurred locally on moist but well drained sandy bottomlands in the southern part of the county. It became more frequent farther up the Genesee valley, outside the county. Butternut was much more common in Monroe county, attaining its greatest abundance on similar sites—the moist but well drained portions of the flood plains of the smaller streams, where it was frequently associated with elm and sugar maple. While tulip poplar was widely distributed in the county, there is no evidence that it was a regular invader of the swamp forest.

The uplands were most suitable for agriculture and were cleared first, so that the swamp forest is well represented in the present woodlots of Monroe county. Most of these remnants have undergone great modification due to selective cutting, pasturing and artificial drainage, but in some places they approximate the composition of the original forest. A view in one of these secondary stands is shown in Figure 33.

Most of the swamp forests of this area must be regarded as "climax for the site", since further succession in the direction of the mesophytic climax forest must be preceded by drainage development. However the direction of succession is clearly indicated. Drainage development, deposition of soil materials eroded from the uplands, accumulation of organic matter and its incorporation in the soil, the tendency of the better drained transitional phases to form a closed canopy under which their own seedlings cannot survive, all make the site more favorable for beech and sugar maple and less favorable for the typical species of the swamp forest. Basswood is the only important swamp forest species which persists as an important element in the climax beech-sugar maple association.

Editor's Note

Professor Shanks included the pawpaw, *Asimina triloba* (L.) Dunal, in his illustrations, Figure 34. However, there was no reference to it in the manuscript. It seems worthwhile to make the following quotation from Shanks and Goodwin (1943) about its occurrence:

> "Moist woods, principally near streams, in western part of the county. Recorded from twenty-seven stations in the towns of Clarkson, Sweden, Parma, Ogden, Riga, and Greece. Previously listed as rare, from Greece, Parma, Brockport, and Adams Basin."

House (1924) includes this note in his report on the pawpaw:

> "—but specimens measuring up to six inches in diameter have been found in Niagara county, and 4 or 5 inches in diameter near Brockport in Monroe county."

Bog Vegetation

Differentiated from the swamps which essentially belong to the deciduous forest are the bogs, which have distinctly boreal affinities and are regarded as relicts from early post-glacial time, preserved in habitats unfavorable to the invasion of the species which have more recently migrated into the region. Local usage has applied the term "swamp" indiscriminately to all wet areas occupied by land vegetation, but in the sense in which they have been generally used in the literature and in which they will be used in this report, the terms "swamp" and "bog" are mutually exclusive. The outstanding characteristics of bogs which distinguish them from the swamps of the region are:

1. almost universal development in kettles, or depressions between drumlins, which were formerly lakes or ponds;
2. continuous high water table, the result of poor surface drainage or none;
3. resultant conditions unfavorable to oxidation of organic matter, resulting in its accumulation as peat or muck, which may be underlain with marl;
4. dominance of distinctly boreal species.

Because of the nature of the habitats which they occupy, bogs are especially characteristic of the glaciated region and are particularly well represented in the eastern hemlock region and that part of the boreal forest region immediately north of it (Transeau 1903). Although bog vegetation probably occurred in every town in Monroe county, the areas were mostly quite small, and probably did not occupy more than two or three per cent of the total area. No bog areas large enough to be mapped were discovered in the towns of Brighton, Irondequoit, Webster, or Hamlin.

The larger bog areas were mostly forested, but include local sphagnum-cranberry meadows and areas dominated by leatherleaf and associated bog shrubs. While their species overlap considerably, two general types may be conveniently recognized in the area and will be discussed separately: those characterized by tamarack, and those characterized by arbor vitae and white pine.

Bogs Characterized by Tamarack

Tamarack and black spruce, the bog conifers shown in Figure 35, are in this region invaders of open bogs. As shown in Figure 36, black spruce is restricted to the bogs of the Mendon Ponds area, but tamarack is more widely distributed, and is regarded as a bog indicator especially characteristic of late stages in the development of open bogs and the early stages of the bog forest. While it is distinctly a pioneer species in such habitats, the rate of succession is so slow that it forms a temporary type of extremely long duration, leading ultimately to a closed bog forest (S. A. F. type 25: *Tamarack*). A remnant stand of this type is preserved in Powder Mill Park, in the southwestern corner of Perinton, and is shown in Figure 37. The best preserved tamarack bogs in the area are in this park and in Mendon Ponds Park, although the areas near Adams Basin and in the northeastern corner of Ogden are also of considerable interest. Such bogs were most typically developed in glacial kettles without surface drainage, in contrast to the arbor vitae bogs which usually had sluggish streams flowing from them.

The earliest stage in bog development may be observed at Round Pond, Mendon, where a marginal bog mat, preceded in some places by a zone of swamp loosestrife, is encroaching on the open water of the pond. Such a mat has completely covered the surface of the Kennedy bog, west of the Hundred Acre Pond. This is in many ways the most interesting bog in the area and is relatively undisturbed. Views of this bog are shown in Figures 35 and 38. This and other bogs in the Mendon area were drawn on heavily for the following lists of typical plants. For a more detailed description of these bogs as well as the associated upland vegetation, and more complete species lists, see the account by Goodwin (1943). The bog meadow of the more open portion of the Kennedy bog, shown in Figure 37, is characterized by a thick mat of sphagnum moss and the following species, which also persist in parts of the bog dominated by the bog heaths:

Chain fern	*Woodwardia virginica* (L.) Sm.
Swamp loosestrife	*Decodon verticillatus* (L.) Ell.
Pitcher plant	*Sarracenia purpurea* L.
Small cranberry	*Vaccinium oxycoccos* L.
Large cranberry	*Vaccinium macrocarpon* Ait.
Cotton sedge	*Eriophorum virginicum* L.

Dulichium ..... *Dulichium arundinaceum* (L.) Britton
Beak rush ..... *Rhynchospora alba* (L.) Vahl.
Scheuchzeria ..... *Scheuchzeria palustris* var. *americana* Fern.
Three-fruited sedge ..... *Carex trisperma* Dewey
Sundew ..... *Drosera rotundifolia* L.
Tufted loosestrife ..... *Lysimachia thrysiflora* L.
Buckbean ..... *Menyanthes trifoliata* var. *minor* Raf.
Rose pogonia ..... *Pogonia ophioglossoides* (L.) Ker.
Calopogon ..... *Calopogon pulchellus* (Salisb.) R.Br.
Marsh St. John's wort ..... *Hypericum virginicum* L.
Calla ..... *Calla palustris* L.
Mud sedge ..... *Carex limosa* L.

Most of the unforested bogs were characteristically covered with low shrubby heaths about knee-high, of which the following were most important:

Leatherleaf ..... *Chamaedaphne calyculata* (L.) Moench.
Andromeda ..... *Andromeda glaucophylla* Link.
Labrador tea ..... *Ledum groenlandicum* Oeder

Taller shrubs up to ten feet tall usually formed a marginal zone and occupied small "islands" where a firmer substratum had been built up (Figure 38):

High bush blueberry ..... *Vaccinium corymbosum* L.
Mountain holly ..... *Nemopanthus mucronata* (L.) Trel.
Winterberry ..... *Ilex verticillata* (L.) Gray
Poison sumac ..... *Rhus vernix* L.
Bog willow ..... *Salix pedicellaris* var. *hypoglauca* Fern.
Black chokeberry ..... *Aronia melanocarpa* (Michx.) Ell.
Huckleberry ..... *Gaylussacia baccata* (Wang.) K Koch
Wild raisin ..... *Viburnum cassinoides* L.

Trees invading the bog heath occurred in widely spaced clumps or individually. Growth conditions were generally unfavorable and they grew very slowly. The following species are present in the Kennedy bog:

Tamarack ..... *Larix laricina* (Du Roi) Koch
Red maple ..... *Acer rubrum* L.
Black spruce ..... *Picea mariana* (Mill.) B S P
Sweet birch ..... *Betula lenta* L.

The marginal zone surrounding the Mendon bogs included tamarack, black ash, red maple, yellow birch, and occasional trees of sour gum (*Nyssa sylvatica* Marsh.) and balsam poplar (*Populus tacamahacca* Mill.), rare species in the region. Red maple was especially important in the later stages of this bog forest and in the secondary bog forests of the region.

Bogs Characterized by Arbor Vitae and White Pine

Arbor vitae bogs were most typically developed south of Black creek in Riga and Chili, and in the abandoned stream channels of Wheatland and Perinton. The famous "Bergen swamp" along Black creek in Genesee county a few miles west of the Monroe county line includes an extensive area of this type. Detailed descriptions and plant lists from this area have already been published (Baxter and House, 1925; Zenkert, 1934; Stewart and Merrell, 1937). Local remnants of arbor vitae bogs may be observed at various places in the southwestern part of the county (Figure 39). These bogs have a substratum of peat or muck which is underlain with marl, and lie along spring-fed streams. The water from these springs is quite cold, the temperature of the springs near Cedars Avenue, Wheatland remaining constantly at 48°F and the temperature of the Caledonia springs which supply the fish hatchery and discharge into Oatka Creek at Mumford at 49.5°F. The distribution of such bogs is indicated by Figure 40, which shows the present distribution of arbor vitae in the county. The only stations shown which are not in bogs are those which were on outcrops of calcareous rocks immediately adjoining Oatka creek. The larger and better preserved areas of this bog type can be recognized at a distance from the white pine which characteristically overtop the associated tree species (Figure 41). Most of the commercially valuable white pine left in the county occurs on such sites. The stations shown in Riga, Chili, and Wheatland in Figure 14 are principally of this type.

Tamarack, which occurred locally in the more open portions of many of these bogs, is interpreted as a relict from earlier successional stages, and hemlock, as previously pointed out, indicates a later stage in succession only locally attained. These bogs were mostly forested, with few open areas, and belong to S. A. F. type 24: *Northern White Cedar*. Their vegetation includes a wide variety of species, some of which are usually regarded as more typical of upland sites. Patches of yew are often found, Figure 42.

Trees

Arbor vitae ..... *Thuja occidentalis* L.
American elm ..... *Ulmus americana* L.
Black ash ..... *Fraxinus nigra* Marsh.
Red maple ..... *Acer rubrum* L.
Yellow birch ..... *Betula lutea* Michx.

White pine ..... *Pinus strobus* L.
Hemlock ..... *Tsuga canadensis* (L.) Carr.
Basswood ..... *Tilia americana* L.
Red ash ..... *Fraxinus pennsylvanica* Marsh.
Tamarack ..... *Larix laricina* (Du Roi) Koch
Swamp white oak ..... *Quercus bicolor* Willd.
White ash ..... *Fraxinus americana* L.

Small Trees and Shrubs

Smooth shadbush ..... *Amelanchier intermedia* Spach.
Mountain maple ..... *Acer spicatum* Lam.
Round-leaved dogwood ..... *Cornus rugosa* Lam.
Red osier ..... *Cornus stolonifera* Michx.
Panicled dogwood ..... *Cornus racemosa* Lam.
Fly honeysuckle ..... *Lonicera canadensis* Marsh.
Swamp fly honeysuckle ..... *Lonicera oblongifolia* (Goldie) Hook.
Bayberry ..... *Myrica carolinensis* Mill.
Yew ..... *Taxus canadensis* Marsh.
Nannyberry ..... *Viburnum lentago* L.
Toothed arrowwood ..... *Viburnum dentatum* L.
High bush blueberry ..... *Vaccinium corymbosum* L.
Witch hazel ..... *Hamamelis virginiana* L.
Dwarf red blackberry ..... *Rubus pubescens* Raf.
Red raspberry ..... *Rubus idaeus* var. *strigosus* (Michx.) Maxim.
Dewberry ..... *Rubus hispidus* L.
Azalea ..... *Rhododendron nudiflorum* (L.) Torr.
Alder-leaved buckthorn ..... *Rhamnus alnifolia* L'Her.
Bebb's willow ..... *Salix bebbiana* Sarg.
Hoary willow ..... *Salix candida* Flugge
Pussy willow ..... *Salix discolor* Muhl.
Winterberry ..... *Ilex verticillata* (L.) Gray

Ground Cover

Wild sarsaparilla ..... *Aralia nudicaulis* L.
Star flower ..... *Trientalis borealis* Raf.
Wintergreen ..... *Gaultheria procumbens* L.
Partridgeberry ..... *Mitchella repens* L.
Goldthread ..... *Coptis groenlandica* (Oeder) Fern.
Bladder fern ..... *Cystopteris bulbifera* (L.) Bernh.
Cinnamon fern ..... *Osmunda cinnamomea* L.
False-lily-of-the-valley ..... *Maianthemum canadense* Desf.
Star-flowered Solomon's seal ..... *Smilacina stellata* (L.) Desf.
Bunchberry ..... *Cornus canadensis* L.
Flat-topped aster ..... *Aster umbellatus* Mill.

Swamp goldenrod ..... *Solidago patula* Muhl.
Elm-leaved goldenrod ..... *Solidago ulmifolia* Muhl.
Swamp saxifrage ..... *Saxifraga pennsylvanica* L.
Royal fern ..... *Osmunda regalis* L.
Marsh fern ..... *Dryopteris thelypteris* var. *pubescens* (Lawson) A.R. Prince
Boneset ..... *Eupatorium perfoliatum* L.
Joe Pye weed ..... *Eupatorium purpureum* L.
White snakeroot ..... *Eupatorium rugosum* Houtt.
Tall coneflower ..... *Rudbeckia laciniata* L.
Red baneberry ..... *Actaea rubra* (Ait.) Willd.
Skunk cabbage ..... *Symplocarpus foetidus* (L.) Nutt.
Swamp thistle ..... *Cirsium muticum* Michx.
Marsh marigold ..... *Caltha palustris* L.
Wood horsetail ..... *Equisetum sylvaticum* L.
Small bedstraw ..... *Galium trifidum* L.

As indicated by Figure 11, arbor vitae, American elm and red maple are the dominant species in present remnants of this mixed evergreen-deciduous type. White pine, while it is characteristically present and one of the more conspicuous features of the type, is numerically unimportant. Probably it was always a minor species from this standpoint, but its large size and long life gave it a greater degree of dominance than many species which were more numerous. It is probable that arbor vitae was more important in the original forest than in present stands, where few trees are more than ten inches in diameter. One dead tree measured near Union Street, Chili was five feet in diameter, and fallen trees and stumps indicate that the species must have formed stands of considerable commercial value.

A notable feature of the interior of these stands is the accumulation of dead woody material, resulting in a very uneven forest floor. Wood of the bog conifers decays slowly, and fallen trees in various stages of decay lie in every direction. It is frequently difficult to penetrate these bogs, and may best be accomplished by walking on fallen logs and avoiding the deep muck pockets between. Most of the vegetation grows on these decayed logs or on the mounds left by the root systems of wind-thrown trees. Yellow birch is very frequently seen in situations like that shown in Figure 25, and the bases of the larger trees are almost always above the general level of the bog.

Successional Trends

Bog vegetation makes up the oldest vegetation types in the area, which have occupied certain sites continuously since early post-glacial time. They were much more widespread during this early period, and subse-

quent habitat changes resulting from physiographic development and climatic change have eliminated them from most of the area. Bog vegetation has persisted only in those places where local habitat factors have retarded succession most, and the present bogs of the area are therefore essentially stable when not subject to human modification. They have been stabilized at the several successional stages described. On the basis of the evidence at hand, some general inferences may be drawn regarding the bog succession in this area, and the relative positions occupied by the important tree species making up the bog forest.

The bog meadow, characterized by a sphagnum mat in which cranberry and several other characteristic species grow, is invaded by low bog heaths such as leatherleaf, which become dominant although the species of the bog meadow remain. This bog heath is in turn invaded by high bush blueberry and associated tall shrubs and then by tamarack (with which black spruce is locally associated). Tamarack may form a bog forest in favorable situations, in association with black ash, yellow birch, and red maple. There is no evidence that the bog succession proceeded any further than this stage in the kettles without surface drainage in the Mendon and Powder Mill areas. On sites in the southwestern part of the county with subterranean water supply, surface drainage and underlying marl deposits, there is evidence of the earlier stages described above, but further succession also occurred. Arbor vitae invaded the bogs along with the deciduous species, and tamarack, essentially a pioneer species, was shaded out. With it went the vestiges of earlier bog meadow and bog shrub stages. With drainage development and building up of the substratum, the species of the hemlock-northern hardwood forest invaded the better drained portions of this bog forest, as earlier pointed out. The three most important species involved are shown in Figure 27. Yellow birch was already present in the mixed bog forest. White pine was an early invader, and by virtue of its large size and long life was very prominent in the early transitional stages from bog forest to hemlock-hardwood. Hemlock apparently followed white pine as an invader and did not establish dominance immediately. The hemlock-northern hardwood stand shown in Figure 28 apparently had just such a history as outlined.

While the bog forests seem to bear a more direct successional relationship to the upland forests of the eastern hemlock region than to the deciduous forest, post-glacial changes in climate have brought about the replacement of bog forest by deciduous swamp forest in many places. This has been particularly true of the shallower bogs, which could not survive the desiccating effect of the "xeric period" earlier referred to. Once eliminated from such sites, the bog conifers and associated bog plants did not reinvade them and were replaced by their deciduous asso-

ciates and the characteristic herbaceous vegetation of the swamp forest. Such history is in many places reflected in the prominence of black ash and red maple and the ocasional persistence of yellow birch in the wetter phases of the swamp forest, which also have a more mucky substratum than its better drained phases. However the deciduous swamp forest was not universally developed on areas of bog history in this region, but frequently developed from marshes and on alluvial areas which had not previously been occupied by trees.

Marsh and Aquatic Vegetation

The marsh and aquatic vegetation occupying areas too wet for invasion by trees has received less attention in this survey than the other vegetation types of the area. Although it contributes a large number of species to the Monroe county flora, it probably did not occupy more than two per cent of the land area. It was most extensive in the town of Greece where bay-mouth sandbars have created a series of shallow "ponds", but also occurred extensively at the upper end of Irondequait bay and locally throughout the county in habitats of several general types:

1. the marginal areas of kettle lakes in more or less close association with bog vegetation;
2. the "intervales" or flood plains of streams, including "beaver meadows" in some places;
3. upland "swales" which occurred in poorly drained spots in the swamp forest.

Bray (1915) has discussed rather fully the developmental sequence of vegetation upon a substratum having excess of water, recognizing the following phases (*The Development of the Vegetation of New York State,* pages 88–117):

1. floating vegetation of the open water;
2. submerged aquatics;
3. aquatic vegetation with floating or emerged leaves or emerged stems;
4. marsh vegetation;
5. the marsh meadow stage of vegetation;
6. swamp shrub vegetation;
7. the swamp forest stage.

The aquatic vegetation of the first three phases has been studied by Muenscher (1927, 1929) and Clausen (1940) in the general region and an abstract of a report on the flora of Long Pond, Greece has been published by Searing (1895).

The floating vegetation, which at times forms a continuous covering

over parts of the ponds and bays near the lake, consists principally of the following duckweeds:

Ivy-leaved duckweed ..... *Lemna trisulca* L.
Greater duckweed ..... *Spirodela polyrhiza* (L.) Schleid.
Smaller duckweed ..... *Lemna minor* L.
Wolffia ..... *Wolffia columbiana* Karst.

The water fern *Azolla caroliniana* Willd. accompanies them in the waters near the lake.

Submerged vegetation is more abundant in alkaline waters than in the dark-colored, more acid waters of the smaller bog ponds. The submerged macroscopic plants belong almost entirely to the following species and genera:

Stonewort ..... *Chara* spp.
Pondweeds ..... *Potamogeton* spp.
Naiad ..... *Naias flexilis* (Willd.) R. & S.
Water crowfoots ..... *Ranunculus* spp.
Elodea ..... *Anacharis canadensis* (Michx.) Planch.
Hornwort ..... *Ceratophyllum demersum* L.
Water milfoils ..... *Myriophyllum* spp.
Eel grass ..... *Vallisneria americana* Michx.
Bladderworts ..... *Utricularia* spp.

The stoneworts and species of pondweed are especially important in connection with building up the land area through marl formation and deposition (see Bray 1915, pages 95–96; Davis 1900; Stewart and Merrell 1937).

The emergent vegetation belonging to the third phase listed above is illustrated in Figure 43. It includes the following species in this region, and characterizes shallow waters not subject to violent wave action.

Yellow pond lily ..... *Nymphozanthus variegatus* (Engelm.) Fern.
Tuber-bearing water lily ..... *Nymphaea tuberosa* Paine
Sweet white water lily ..... *Nymphaea odorata* Ait. (Mendon only)
Common floating pondweed ... *Potamogeton natans* L.
Wide-leaved cattail ..... *Typha latifolia* L.
Tall cattail ..... *Typha angustifolia* var. *elongata* (Dudley) Wiegand
Narrow-leaved cattail ..... *Typha angustifolia* L.
Lake bulrush ..... *Scirpus validus* Vahl.
Western bulrush ..... *Scirpus acutus* Muhl.

Arrow arum ..... *Peltandra virginica* (L.) Kunth.
Broad-leaved arrowhead ..... *Sagittaria latifolia* Willd.
Pickerel weed ..... *Pontederia cordata* L.
Water plantain ..... *Alisma subcordatum* Raf.
Lizard's tail ..... *Saururus cernuus* L.
Creeping spike rush ..... *Eleocharis palustris* (L.) R. & S.
Broad-fruited burreed ..... *Sparganium eurycarpum* Engelm.
Northern water sedge ..... *Carex substricta* (Kukenth.) Mack.

With the exception of the water lilies and pondweeds, these species also persist in the marsh stage which follows, in which the vegetation forms a relatively continuous cover and in which, although the substratum is continuously wet, water ordinarily does not stand throughout the season. The plants are important in building up and stabilizing the substratum through their contribution of organic matter and the soil-holding influence of their underground parts. The cattails are especially important in this respect. They spread vegetatively by means of rhizomes and occupy large areas almost exclusively. They form extensive marshes in the Irondequoit bay region (Figure 44), where it is reported that they have reduced the area of open water considerably in historic time. The most abundant form in these extensive Irondequoit marshes is *Typha angustifolia* var. *elongata*. In addition to the species listed above the following plants commonly occur in the Monroe county marshes:

Tall reed grass ..... *Phragmites communis* Trin.
Marsh grass ..... *Spartina pectinata* Link.
Swamp loosestrife ..... *Decodon verticillatus* (L.) Ell.
Dark green bulrush ..... *Scirpus atrovirens* Muhl.
River bulrush ..... *Scirpus fluviatilis* (Torr.) A. Gray
Sickle sedge ..... *Carex crinita* Lam.
Retrorse sedge ..... *Carex retrorsa* Schwein.
Sallow sedge ..... *Carex lurida* Wahl.
Sweet flag ..... *Acorus calamus* L.
Spotted water hemlock ..... *Cicuta maculata* L.
Bulb-bearing water hemlock ... *Cicuta bulbifera* L.
Water parsnip ..... *Sium suave* Walt.
Soft rush ..... *Juncus effusus* var. *solutus* Fern. & Wieg.
Great water dock ..... *Rumex britannica* L.
Larger blue flag ..... *Iris versicolor* L.
Swamp smartweed ..... *Polygonum coccineum* Muhl.
Meadowsweet ..... *Spiraea alba* DuRoi
Marsh pea ..... *Lathyrus palustris* L.
Hedge nettle ..... *Stachys hispida* Pursh
Monkey flower ..... *Mimulus ringens* L.

Nodding bur marigold ..... *Bidens cernua* L.
Smooth bur marigold ..... *Bidens laevis* (L.) BSP.
Purple marshlocks ..... *Potentilla palustris* (L.) Scop.
Marsh fern ..... *Dryopteris thelypteris* (L.) Gray
Marsh bellflower ..... *Campanula sparinoides* Pursh
Marsh St. John's wort ..... *Hypericum virginicum* L.
Water hoarhound ..... *Lycopus uniflorus* Michx.
Arrow-leaved tear-thumb ..... *Polygonum sagittatum* L.

The marsh meadow stage generally corresponds with the "Calamagrostis meadow" described by Gordon (1940), and was in this region dominated by *Calamagrostis* and species of *Carex,* as is generally true throughout the extent of the type. A stand of this type southwest of Mud Pond, Mendon (called Quaker Pond on the U. S. G. S. topographic map) is shown in Figure 45. Extensive stands occur back of the marshes which surround the landlocked bays in the town of Greece and local stands in the Irondequoit bay area. Smaller stands are believed to have occurred rather widely in the county, although most of the evidence has been destroyed. This type seems to have been especially characteristic of streamside sites where a high water table was maintained by beaver dams. The survey notes for the Brighton-Henrietta town line (Augustus Porter, 1792) record such a "beaver marsh" near its intersection with John Street. The marsh meadow differs from the more open marsh which precedes it in several respects. The substratum is firmer and usually not quite so wet. The more pronounced dominance of a few species, all of which are grasses or sedges, results in the formation of a more closed community with a more uniform appearance and composition:

Blue-joint grass ..... *Calamagrostis canadensis* (Michx.) Beauv.
Reed canary grass ..... *Phalaris arundinacea* L.
Tall manna grass ..... *Glyceria grandis* Wats.
Northern water sedge ..... *Carex substricta* (Kukenth.) Mack.
Lake-bank sedge ..... *Carex riparia* var. *lacustris* (Willd.) Kukenth.
Northern tussock sedge ..... *Carex stricta* var. *strictior* (Dewey) Carey

The characteristic bluish-green color and uniform height of these plants make it possible to recognize the marsh meadow at a distance. The dominant plants are generally waist to shoulder high. The pronounced tendency to tussock formation is a notable feature of the internal structure of this plant community, particularly in the wetter portions where the sedges are more prominent.

A local marsh meadow of altogether different character occurs on the

marly muck area north of Mud Pond, Mendon, and has been described in detail by Goodwin (1943). Remnants of a similar type persist in southeastern Mendon and in the town of Sweden. The Mendon stands exhibit wide local variation, but the most widespread and consistent phase is dominated by the Baltic rush (*Juncus balticus* var. *littoralis* Engelm.) and the beaked spike rush (*Eleocharis rostellata* Torr.). Local open spots are characterized by a dense mat of the capillary beak rush (*Rhynchospora capillacea* Torr.). Other interesting and characteristic plants of these marly areas are:

Wild timothy ..... *Muhlenbergia racemosa* (Torr.) BSP.
Bog rush ..... *Cladium mariscoides* Torr.
Few-rayed goldenrod ..... *Solidago uniligulata* (DC.) Porter
Ohio goldenrod ..... *Solidago ohioensis* Riddell
Fringed brome grass ..... *Bromus ciliatus* L.
Kalm's lobelia ..... *Lobelia kalmii* L.
Marsh bellflower ..... *Campanula aparinoides* Pursh.
Virginia mountain mint ..... *Pycnanthemum virginicum* Pers.
Star-flowered Solomon's Seal ..*Smilacina stellata* Desf.
Grass of Parnassus ..... *Parnassia glauca* Raf.
Nut rush ..... *Scleria verticillata* Muhl.
Marsh arrow grass ..... *Triglochin palustris* L.
White beak rush ..... *Rhynchospora alba* (L.) Vahl.
Bog aster ..... *Aster junceus* Ait.
Small-headed rush ..... *Juncus brachycephalus* (Engelm.) Buch.
Humped bladderwort ..... *Utricularia gibba* L.
Hooded ladies' tresses ..... *Spiranthes romanzoffiana* Cham.

Blue-joint grass, reed grass, cattails, and bulrushes are present but infrequent. The following characteristic woody invaders form tussocks or "islands" in the rush moor:

Shrubby cinquefoil ..... *Potentilla fruticosa* L.
Bayberry ..... *Myrica carolinensis* Mill.
Alder-leaved buckthorn ..... *Rhamnus alnifolia* L'Her.
Swamp rose ..... *Rosa carolina* L.
Shrubby willows ..... *Salix spp.*

Shrubby cinquefoil is most abundant and dominates large areas at the edge of the marsh.

The role of the sedges in building up a stable land habitat is extremely important. The northern water sedge (*Carex substricta*) is an invader of open water and persists through the marsh into the marsh meadow stage. Several sedges are important members of the marsh community

and the other tussock-forming sedges of the marsh meadow invade it. Many of the smaller marsh plants previously listed characteristically occur on the sedge tussocks in the marsh and persist, usually in less abundance, in the marsh meadow. Other sedges and related plants which also occur in this vegetational sequence, but less prominently than those already mentioned, are:

Sartwell's sedge ..... *Carex sartwellii* Dewey
Prairie sedge ..... *Carex prairea* Dewey
Wooly sedge ..... *Carex lanuginosa* Michx.
Brown sedge ..... *Carex buxbaumii* Wahl.
Small yellow sedge ..... *Carex cryptolepis* Mach.
Wool grass ..... *Scirpus cyperinus* (L.) Kunth
Blunt spike rush ..... *Eleocharis obtusa* (Willd.)
Cyperus-like sedge ..... *Carex pseudo-cyperus* L.
Bristly sedge ..... *Carex comosa* Boott
Silvery sedge ..... *Carex canescens* var. *disjuncta* Fern.

The commonest woody invaders of the marsh or marsh meadow are tall shrubs belonging to the following species:

Alder ..... *Alnus incana* (L.) Moench.
Buttonbush ..... *Cephalanthus occidentalis* L.
Bebb's willow ..... *Salix bebbiana* Sarg.
Hoary willow ..... *Salix candida* Flugge
Pussy willow ..... *Salix discolor* Muhl.
Autumn willow ..... *Salix serrissima* (Bailey) Fern.
Shining willow ..... *Salix lucida* Muhl.
Red osier ..... *Cornus stolonifera* Michx.
Common elder ..... *Sambucus canadensis* L.
Toothed arrowwood ..... *Viburnum dentatum* L.

The most extensive stands of swamp shrubs consisted largely of alder and buttonbush. Most of the shrubs listed persist in the swamp forests which succeed them, clearly indicating the successional relationship of these two types.

While the marsh sequence of vegetation is thus directly related to the deciduous forest and the bog sequence is directly related to coniferous or mixed forest, the presence of a number of typical bog plants in the marshes of the area indicates that in some places marshes now occupy sites formerly occupied by bogs, presumably due to climatic change. This is especially true of the marshes of the Mendon area, but is also true of local areas in the Greece marshes. The bog relationship is reflected in the name of Cranberry Pond, Greece. Cranberry (*Vaccinium macrocarpon*) and pitcher plant are both present on the sedge tussocks along the western margin of Mud Pond, Mendon. The marsh St. John's wort

(*Hypericum virginicum*), purple marshlocks (*Potentilla palustris*), and the sedges *Carex canescens* var. *disjuncta, C. prairea, C. buxbaumii,* and *C. pseudo-cyperus* are common to both bog and marsh in this region, and reflect their relationship. In the Mendon region the bog shrubs, high bush blueberry, and black chokeberry locally accompany the shrubs previously cited as invaders of the marsh meadow.

The highly calcareous, well aerated waters of the spring-fed streams of the southwestern part of the county bear a characteristic vegetation which is not directly related to the developmental sequence outlined above. The stonewort (*Chara*) is abundant and marl deposition is very rapid, particularly in the artificial ponds created by damming these streams. The following species of higher plants are commonly present:

Water cress ..... *Nasturtium officinale* R.Br.
Brooklime ..... *Veronica americana* (Raf.) Schwein.
Forget-me-not ..... *Myosotis laxa* Lehm.
Rice cut-grass ..... *Leersia oryzoides* (L.) Sw.

Upland "swales", the poorly drained spots on the upland away from major streams, were essentially sedge meadows, usually surrounded by swamp shrubs and the deciduous swamp forest. They occupied shallow depressions on the heavier soils, covered with standing water after every rain, but usually very dry during most of the growing season. The tall grasses and sedges of the marsh meadow stage previously described occupied the wetter portions, but other species of sedges and rushes were more common. Remnants of the type were recognized in field mapping of present plant cover, but the areas are too small to be shown on the map. Most of them occur in former swamp forest areas now used as permanent pasture. The following species are most characteristic:

Fox sedge ..... *Carex vulpinoidea* Michx.
Blunt broom sedge ..... *Carex tribuloides* Wahl.
Pointed broom sedge ..... *Carex scoparia* Schkuhr
Awl-fruited sedge ..... *Carex stipata* Muhl.
Sallow sedge ..... *Carex lurida* Wahl.
Dark green bulrush ..... *Scirpus atrovirens* Muhl.
Porcupine sedge ..... *Carex hystricina* Muhl.
Retrorse sedge ..... *Carex retrorsa* Schwein.
Bladder sedge ..... *Carex intumescens* Rudge
Hop sedge ..... *Carex lupulina* Muhl.
Meadow sedge ..... *Carex granularis* Muhl.
Soft rush ..... *Juncus effusus* var. *solutus* Fern. and Wieg.
Dudley's rush ..... *Juncus dudleyi* Wieg.
Slender rush ..... *Juncus tenuis* Willd.

Straw-colored cyperus ..... *Cyperus strigosus* L.
Blunt spike rush ..... *Eleocharis obtusa* (Willd.) Schultes
Swamp milkweed ..... *Asclepias incarnata* L.
Joe Pye weed ..... *Eupatorium maculatum* L.
Boneset ..... *Eupatorium perfoliatum* L.

MODIFICATION OF THE VEGETATION BY MAN

The foregoing portion of this report has dealt with the natural plant cover of the region as it appeared when the first permanent white settlements were established a century and a half ago. The relatively small Indian population which had occupied the area had built towns, cleared adjacent fields for agriculture, and established trails through the forest; but it is probable that the vegetation of only a small fraction of one per cent of the total area had been perceptibly affected. Although the Iroquois became increasingly dependent on agriculture in their later years, the Indian culture of the region was nevertheless based primarily on hunting. The Indian was well adjusted to his environment and his exploitation of the region did not seriously upset the natural balance. Only in his use of fire in hunting or to provide favorable habitats for game, was he sometimes destructive, as pointed out by Bromley (1935). However there is no conclusive evidence that widespread burning was practiced in this area. With this possible exception, the Indian's attack on the plant resources of this region did not exceed their regenerative capacity. Native plants provided him with foods, fibers, medicines, weapons and other equipment, lodging, and fuel. If the Indian did not like his surroundings or if they failed to provide these requirements, he moved on. Apparently large villages were frequently moved because of depletion of readily available fuel. Doubtless food pressure ranked with war as an important cause of major migrations.

White man entered the region with an entirely different cultural background, and consequently modified the region profoundly in the first 25 years of his occupation. Only the pioneer vanguard moved on, after preparing the way for the mass migration that followed. But the typical white man came to stay, to make a home. And, rather than accepting the environment as it was, he began to modify it and very soon assumed a dominant role.

White man has not always been pleased with the results of his changes. Sometimes his response has been identical with that of the Indian who preceded him, and he has moved on within a generation or two. But his more typical response, increasing in prominence when the frontier became more remote or economically more marginal, has been an attempt to revise his program. The "regional planning" of recent years is simply a manifestation of the increasing socialization of this response.

Two distinct processes characterize white man's modification of the vegetation of this region: clearing and cultivation. During the period of clearing his predominant activities were associated with both the destruction and the utilization of native vegetational resources. During the subsequent agricultural period he was primarily concerned with the substitution of cultivated crops for native vegetation, but a number of incidental modifications of remnants of the natural vegetation continued to occur.

Destruction of Vegetational Resources

Forests were regarded as an obstacle by the early white settlers. They were primarily interested in agriculture, and the trees were in their way, so they girdled them, cut them and burned them. The ashes had almost enough market value to pay the cost of clearing and provided an important source of income for the settlers (Hedrick 1933). At the time of the census of 1845 Monroe county had 17 asheries, devoted to the production of "pot and pearl ash" from hardwood ashes. These clearing and burning operations prepared the land for agriculture and provided a source of money. Also it was felt that "opening up the country" would make it more healthful. Unfortunately census reports prior to 1875 do not list area in woods, but the following figures, showing percentage of the total area listed as improved farm land, suggest that most of the land suitable for agriculture was "improved" prior to 1850.

Census Year	*Improved Land (%)*
1845	65.9
1855	74.9
1865	75.8
1875	77.7
1935	78.8

Area in farm woodlots decreased only 6,759 acres between 1875 and 1935, one fourth of one per cent of the total area.

Utilization of Natural Vegetation

The white pioneers learned their early lessons in native food and medicinal plants from the Indians. These lessons included the recognition of edible fruits, roots, and "greens". The Indian technique of making sugar from the sap of the sugar maple was adopted and modified to suit larger scale production. The importance of this source of food is indicated by the census of 1840, which lists a production of 181,119 pounds of sugar in Monroe county in the preceding season. Nuts were also commonly used. No figures are available to indicate the extent of their use, but chestnuts must have been an especially important food source in those parts of the area where they were available, and hickory nuts

were generally available throughout the area. Walnuts and butternuts were less common.

Herbs with real or supposed medicinal value were gathered not only for home use but also for the market. It is mentioned in the census of 1840 that ginseng to the value of $83 was collected in Monroe county in the preceding year.

While these food and medicinal uses of native plants and the continuing harvest of the wild game for which the vegetation provided a cover followed the Indian pattern, the white man departed from the Indian precedent in his extensive use of wood. He had more and better tools, greater skill in their use, and much more interest in permanent building construction. Sawmills were soon erected. Indian Allen's mill at the falls of the Genesee, completed in 1789, was the first, and 76 were listed by 1825 (McIntosh 1877). Selective use of the timber was practiced. White pine, hemlock and tulip poplar were widely used because they could be worked easily. When the area near the present town of Mumford was surveyed by John Smith in 1804, lot number 23, along the outlet to the "Big Spring", was thus described: "two excellent mill seats and some considerable pine timber". Lots 24 and 25, to the east, were timbered with pine and cedar, and the following note was made: "No. 24 and part of 25 is also well covered with timber for sawing, and might perhaps sell better with the mills than any other way".

Certain woods were used in special ways. Much of the original stand of arbor vitae, which included some very large trees, was used in making cedar shingles. The trees were cut and split in the woods and only the finished product hauled out. This work was done during the winter, while the boggy ground was frozen. More recently the cedar has been used for fencing, first as a source of rails, then as post material. White oak was the principal source of cooperage. According to McIntosh a half-million staves were exported in 1819.

Throughout the entire pioneer period the forests were the only available source of fuel. During this period use of firewood must have increased in proportion to the increase in population, and wood remained the most important source of fuel long after improved transportation had made coal available from the Pennsylvania fields.

Early historical accounts make frequent reference to the use of natural pasture by the early white settlers. It was common practice for the settlers along the river in the southern part of Monroe county to pasture their cattle on the flats of the Genesee, and elsewhere the "intervales" along streams and forest openings provided abundant forage, while the nut trees provided mast for the hogs. While other factors, such as market conditions and relative cost of transportation, are not to be mini-

mized, availability of natural food was certainly of prime importance in stimulating the early development of livestock raising in this area. More hogs were produced in 1845, according to census data, than at any time since, and the peak for cattle came in 1855. The figures for sheep show early emphasis followed by a decided decrease and then a rise to peak production during the Civil War period.

Year	*Total Sheep*
1845	173,952
1855	116,817
1865	206,960
1870	70,346
1875	37,832

Substitution of Cultivated Crops for Native Vegetation

Agricultural development of a region involves substitution of cultivated crops for natural vegetation. The basic factors influencing the nature and degree of this replacement are the natural limitations imposed by the environment and the group experience of the human beings involved, as reflected in their cultural stage.

As previously pointed out, Indian agriculture in this region contributed only partial subsistence. Natural products still supplied a large part of the Indian's needs. Corn, beans, sunflowers (*Helianthus tuberosus*), ground nut (*Apios tuberosa*), squashes, pumpkins, and tobacco seem to have been the most important products of Indian agriculture (Hedrick 1933). Some fruit was produced in the period immediately preceding white settlement. Sullivan's expedition against the Iroquois in this general region in 1779 is reported to have destroyed large orchards (McIntosh 1877). Presumably apples had been introduced by the French Jesuit missionaries (Turner 1851).

Pioneer agriculture was similarly very largely of subsistence type. A number of crop plants previously untried in the area were introduced during this pioneer period of subsistence agriculture. These included a wide range of garden vegetables, the smaller cereals, and fiber plants. Hemp raising was tried in the years between 1800 and 1812 on a commercial scale and some rope was manufactured from it, but the venture did not prove profitable. However hemp continued to be used along with flax as a source of fiber for clothing throughout the pioneer period (McIntosh 1877). As late as the census of 1845 over 100,000 yards of cloth were made annually in the homes of Monroe county, an average of 1.4 yards per person.

Transportation problems had an important influence on the agriculture of this area. No local markets were available and transportation of grain

to existing markets was practically impossible. McIntosh (1877) quotes a pioneer of Riga as follows: "In 1808 I took wheat to Canandaigua; there was no price, sale, nor store trade in it. I removed it to Geneva at a cost of twelve and a half cents per bushel, and paid a debt due for a barrel of whisky with it. The net price of the wheat was twelve and a half cents per bushel, or one gallon of whisky for six bushels of wheat." This situation must have contributed to the early emphasis on livestock production, for livestock could be driven long distances to market. Early development of the distilling industry was also a response to difficult transportation, since whiskey had a much greater market value in proportion to its bulk than the grain from which it was made. According to McIntosh there were 34 distilleries in Monroe county in 1825. By 1845, following the development of cheap transportation by water and the accompanying growth of the flour industry, there were only five. Land transportation was difficult and expensive. The following commentary is quoted from a letter of James Wadsworth to Samuel Corp, New York, in July 1807 (quoted by McIntosh, 1877): "The agricultural products of this district cannot be transported to Albany except in years of scarcity. The St. Lawrence is the natural outlet of produce. Lake Ontario is navigable at all seasons; boats may be sent down the St. Lawrence almost eight months of the year. Montreal must become an immense deposit for produce seeking European market." Events prior to 1820 certainly supported this thesis, but Wadsworth had not foreseen the Erie Canal and the part it was to play in the development of the region. During the season of 1818 there were 25,996 barrels of flour shipped from the mouth of the Genesee for the Montreal market (H. Scranton, quoted by McIntosh 1877). Availability of water power and a ready outlet for the finished product stimulated the growth of the flour milling industry and earned for Rochester the name of the "Flour City". This industry soon outgrew wheat production in the area, as indicated by the fact that 200,000 bushels of wheat were imported in 1836 by Rochester dealers, under heavy duty, from Canada (McIntosh 1877). The stimulus to wheat production is reflected in the production within the county of 1,074,813 bushels of wheat by 1840 and 1,338,585 bushels by 1845 (census data).

Construction of the Erie Canal, which was completed as far west as Rochester in 1823, opened a new outlet for the products of the region by way of the traditional Ontario-Mohawk lowland migration and trade route. The pioneer period was past. Rochester had become the industrial and commercial center of the region and had been recognized as its administrative center when Monroe county was established in 1821.

The subsequent agricultural history of the region reflects changing economic conditions, in part resulting from increased urbanization and

industrialization of this area and also the bringing into production of new agricultural areas further west. It is beyond the scope of this report to analyze in detail the factors responsible for the changes in type of agriculture which occurred, but some of the obvious trends are of interest and significance.

As already pointed out, a period with major emphasis on livestock raising followed the pioneer period of subsistence agriculture. As soon as the flour milling industry and development of transportation provided a profitable market, wheat raising expanded rapidly. By 1845 over 25% of the improved land in the county was devoted to wheat, which by this time shared prominence with livestock. The peak of wheat production was reached before 1855 according to census figures. During the ten years 1845–1855 there was a decrease of 18.5% in wheat acreage and a decrease of 7% in the proportion of improved land devoted to wheat.

Increasing diversification of crops and decreasing emphasis on livestock characterized the period following 1850. Greater acreages of corn, oats, beans, potatoes, barley, and rye were sown. Abnormal conditions brought about by the Civil War are reflected in the census of 1865, which lists a production of over 500,000 pounds of tobacco, and indicates a decided peak in sheep production.

Along with general diversification of larger-scale agriculture has come increasing emphasis on special crops which require intensive use of small areas. Market gardens were reported as early as the 1840 census, with products valued at $6,315. Their annual output had increased to $26,540 by 1855 and $51,886 by 1865. By 1935 five percent of the farm area of the county was used in the production of vegetables.

The white settlers, influenced by the abundance of native fruit and by tales of the Indian orchards destroyed in Sullivan's raid, gave some attention to orcharding at an early date. An orchard was planted on the Sheaffer farm, near the present village of Scottsville, in 1799, the first west of the Genesee (McIntosh 1877). By 1840 commercial orcharding had started—the annual "value of the products of the orchard" was listed as $69,561. The following figures give some idea of the rapid rate of growth of this phase of plant culture.

Census Year	*Bushels of Apples*
1855	491,491
1865	498,606
1875	1,093,774
1910	2,592,378

By 1918 more than 11% of the farm area in the county, 44,669 acres, was devoted to fruit crops, which included apples, peaches, pears, plums,

cherries, quinces, grapes, and small fruits (VanWagner 1920). Hay was the only farm crop which occupied a greater area.

The factors which were responsible for the development of fruit raising in this area also stimulated the growth of the nursery business. Nursery products were valued at $7,975 in the census of 1840. In that year the famous Ellwanger and Barry nurseries were established. By 1871 they had occupied 650 acres, employed 400 men, and made Rochester the center of the nursery business in this country. The flower seed business, pioneered in the 1860's by James Vick, followed the nursery business in development, and both have continued in importance to the present day.

Several changes in the agriculture of Monroe county have taken place since the census of 1900. Alfalfa hay has increased from 39 acres (census of 1900) to 16,627 acres. During the same period, spring grains have decreased by one third and wheat by one half. Corn for grain has decreased by two thirds, but more than half of this decrease has been replaced by corn for dairy silage. Potatoes, which reached peak production around 1900, have declined by two fifths, and dry beans, which were at their peak perhaps 25 years earlier, have decreased by one fourth since 1900, while vegetable crops have doubled in acreage. During the period 1899 to 1929 acreage in fruit decreased by 17%. This was largely due to a decrease in apple orchards which had started much earlier and which has continued during every subsequent census period. A decrease of 23% in apple trees of bearing age occurred between the censuses of 1900 and 1930, and an additional decrease of 11% during the following five-year period, due largely to winter kill during 1933–34. A decrease of 43 per cent in total number of apple trees in the county occurred between 1875 and 1935 (Monroe County Division of Regional Planning 1938). Peaks in the production of peaches, pears, and cherries are indicated in the census of 1920, followed by a general decline and renewal of emphasis on cherries by 1935. A general tendency for fruit growing to become more concentrated in those areas where soil and climate are favorable may be noted (Wilson and Efferson 1937; Monroe County Division of Regional Planning 1938). These areas are located principally north of the Ridge on the Lake Iroquois plain.

Modification of Remnants of the Natural Vegetation

Following the period of clearing and during the period of agricultural development which has been described, the farmer's attention was focused chiefly on his cultivated fields. Although livestock raising was quite important, pastures received very little attention, the only attempt at pasture improvement being an occasional removal of brush. The land remaining in forest received even less attention. The part of the land that was thought to be agriculturally useful had already been cleared. Only under

unusual circumstances did further clearing take place, but agricultural development of the area was producing a number of incidental effects on the remnants of the natural vegetation.

Selective use of the timber continued to be practiced. The swamps and woodlots provided cedar rails and posts, and rough timber for building. When prices warranted, the better timber was marketed. Farm income from the sale of forest products amounting to $33,098 was listed in the 1930 census. These practices resulted in a general deterioration of the forest remnants of the area, which came to have a higher proportion of defective trees and of less desirable species.

The woodlots of the area have been generally pastured, many so heavily that normal regeneration has been prevented, and as a result the younger age-classes and undergrowth are frequently very poorly represented. This removal of the understory by grazing and browsing, combined with trampling by livestock and lowering of the water table due to clearing and artificial drainage, has made the trees particularly susceptible to drought damage, which was severe in the 1930's

Damage by fire has been most pronounced in the sandy areas adjacent to Irondequoit bay, where a large part of the timber is defective because of fire scars, and the ground cover is largely made up of bracken and New Jersey tea, which sprout from underground parts after their tops have been burned off (Figure 18). Apparently this area is burned over almost every year.

Through incidental introduction of plant diseases, insect pests, and species of plants which escaped and became weeds, changes were initiated which are still in process. The chestnut blight has practically eliminated a forest tree which was formerly quite important in some parts of the area (Figure 17). Black locust, tree of heaven, and the cultivated apple and sweet cherry are widely established in the woodlots of the county. Over 250 kinds of introduced plants were listed as established in the flora of this area by 1896 (Beckwith and Macauley 1896). The introduced plants made up twenty per cent of the entire list. Many of the important weeds of cultivated crops and meadows are of European origin and introduced plants are coming to occupy a large proportion of the uncultivated area.

With the development of active interest in conservation since 1900, remnants of the forest vegetation in this area have received slightly more attention and better care. Pasturing of woodlots has decreased. Reforestation in Monroe county was started. Early distributions consisted entirely of conifers from the state nursery, but during the years 1937–1942 they have been supplemented by deciduous trees from the county nurseries established by the Division of Regional Planning.

The following species not native to the area have been introduced in this way:

Red pine ..... *Pinus resinosa* Ait.
Black locust ..... *Robinia pseudo-acacia* L.
Norway spruce ..... *Picea abies* Karst.
White spruce ..... *Picea glauca* Voss
Scotch pine ..... *Pinus sylvestris* L.
Japanese larch ..... *Larix kaempferi* Sarg.
Balsam fir ..... *Abies balsamea* Mill.
Douglas fir ..... *Pseudotsuga taxifolia* Britt.
Norway maple ..... *Acer platanoides* L.

The distribution of certain other species which are native in some parts of the county has been extended by these plantings:

Black walnut ..... *Juglans nigra* L.
Box elder ..... *Acer negundo* L.
Butternut ..... *Juglans cinerea* L.
White pine ..... *Pinus strobus* L.
Arbor vitae ..... *Thuja occidentalis* L.

Urbanization and industrialization of the area has not only brought about an expansion of the local market for agricultural products but has also resulted in withdrawal of land from agricultural use. From 1910 to 1930, land in farms decreased over 72,000 acres, aproximately 19%. Even after a third of this acreage went back into farms during the subsequent years of economic depression, a study in 1936 showed that 17% of the land area of the county was non-agricultural (Wilson and Efferson 1937). This included the city of Rochester and its suburban area, villages and rural residential areas, and parks. The total population of Monroe county listed in the 1940 census was 438,230, an average of 651.2 per square mile. Of these, 94% were listed from the Rochester metropolitan district (census of 1940), which provided a local market for most of the fruits, vegetables, and dairy products of the area and which has strongly influenced agricultural trends in these directions.

THE PRESENT-DAY VEGETATION

Scarcely an acre in Monroe county has not been modified by human activity during the last 150 years, but the degree of modification has varied widely. It has been most extreme in the urban areas and has in general decreased with distance from them. In the agricultural area it has been most pronounced on the better soils and has decreased toward the areas of poorer soils, and in the case of individual farms, the part of the farm farthest from the house has been most frequently left in woods. It has in general also decreased with distance from Lake Ontario. Obviously the

present highly complex vegetation pattern reflects this zonal pattern of man's occupancy of the area as well as the pattern of the natural factors, and its interpretation depends upon an understanding of the human ecology as well as the plant ecology of the region.

A general picture of the relative importance of the various types of land use in Monroe county may be derived from the data on type of agriculture in the 1930 census reports. The average size of the 4,165 farm units was 75.5 acres. Farms were classified according to their principal source of income. Those units in which no single crop or enterprise provided more than half the total income were placed in the general farming class. The five most common uses are included in the following list which indicates both percentage of the units so classified and percentage of the total farm area included in them.

Farm units (%)	Type of Agriculture	Farm Area (%)
31.1	General	34.6
12.9	Fruit	12.3
12.5	Dairy	19.8
11.8	Crop specialty	15.9
10.0	Truck	5.1

Other types of agriculture, in their order of frequency, were poultry, self-sufficing, cash grain, and animal specialty.

Further analysis of data from the census of 1930 (Wilson and Efferson 1937) gives a general picture of the crop pattern of the county and points out the broad difference between the lake plain north of the Ridge road and the higher land south of it. Data for the towns of Hamlin, Clarkson, Parma, Greece, and Webster provide the total north of the Ridge. Irondequoit is excluded because it is classified as primarily residential.

Land Use	North of Ridge (%)	South of Ridge (%)	County (%)
Intertilled crops	16.4	18.6	17.9
Orchard and vineyard	18.4	4.9	9.5
Small grains	15.0	19.3	17.9
Hay	17.3	18.7	18.2
Pasture	11.6	15.5	14.2
Idle land and woods	13.8	13.9	13.8
Miscellaneous	7.5	9.1	8.5
TOTAL	100.	100.	100.

Corn, field beans, and potatoes were more important south of the ridge while truck crops and all fruits were more important to the north. Both wheat and spring grains were more important to the south. Alfalfa

was important in the south while timothy was important on the more acid soils in the north. The area to the south had 50% greater acreage of permanent pasture.

The present pattern of land use and consequent vegetation pattern are the result of a century and a half of modification and adjustment. This adjustment to soils, to climate, to markets, to labor supply, to new crops and new varieties, to increased mechanization and new agricultural techniques, is a continuous process. Until recently this adjustment has been regarded as largely a problem for the individual farmer, but increased consciousness of the basic importance of man's relation to the land has in recent years given rise to land-use planning as a social technique, with maximum production consistent with maintenance of the natural resource base as its primary objective.

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CITATIONS IN THE ROCHESTER ACADEMY OF SCIENCE, 1966

WARREN H. WAGNER JR.

Honorary Member

Space walking, meson chasing, and computer thinking occupy our present-day imaginations; hence it is sometimes overlooked that there are still numerous avenues of exploration open in the natural sciences. One might feel, for example, that most of the facts about ferns were already known. It is almost comforting then, to meet someone able to show us that a very old form of plant life can still offer mysteries to challenge morphological, anatomical, cytological, and biochemical sciences for a solution.

Youthful activities kept alive an interest in minerals; a degree in zoology from the University of Pennsylvania gave a background for research and publication on butterflies; but his doctorate in botany from the University of California and a year at Harvard as a Gray Herbarium Fellow, determined his life work in the evolution and systematics of the vascular plants. He is now Professor of Botany at the University of Michigan and the President of the American Society of Plant Taxonomists.

His field work is enlivened by the search for rare ferns. Much of this has been done in the tropics and the Pacific. Yet Rochester has not been neglected, as you who have read his intriguing paper on log ferns in the current issue of our Proceedings will appreciate.

His specimens are to be found in herbaria throughout the world. One Hawaiian group is quite unusual; not because the fern is rare, but because of the label. It bears a Kapu Water Reserve locality. The young collector did not know at the time that "kapu" means "keep out."

For his intensive application of genetics to the study of ferns, that gives professionals valuable clues to plant origins, and his teaching, that encourages amateurs to enjoy botany, we are proud to confer our Honorary Membership to this distinguished scholar.

JOHN WARNER BROWN

Fellow

Writing, hunting, swamp owner, ski, fishing, conservationist, State official, ornithology, nature counseling, and editor—these words are

all part of a jig-saw picture. Put them together and you have a sketch of an Academy Member against a background of deep woods. And in that woods there will be birds and people. For ornithology is his interest, and finding refuges for birds and those who love them and the outdoors, is his accomplishment.

Still living in the house in Scottsville where he was born, he is on the editorial staff of the Rochester Times Union. While at Hobart College studying journalism, he was associated with the late Elon Howard Eaton, the renowned ornithologist, so that he brings a disciplined mind to his hobby.

With others in the Genesee Ornithological Society, he took title to the Reed Road Swamp; and now as President of Bird Refuges Incorporated, he oversees the locality. He has given editorial assistance to the Bergen Swamp Preservation Society; and, on the Genesee State Park Commission, he aided in setting aside the Northrup Creek-Long Pond sanctuary and in the acquisition of the Pear Orchard area at Manitou.

His long-standing, scholarly, and interesting weekly column "Birds Afield" typifies his approach to bringing Nature to people and people to Nature. It is in warm appreciation that we welcome him as a Fellow.

HARRY EDGAR GORDON

Fellow

Reversing a popular trend, the Member we now wish to honor went East in the last century. He left Colorado to settle in Rochester. And this was an appropriate move in view of his technical leanings and the burgeoning of a basically scientific city on the banks of the Genesee. His history brings back nostalgic names like Mechanics Institute and the Institute of Radio Engineers—both of which have new names that indicate the inevitable progress of a few years. Working as an electrical engineer with the Rochester Telephone Corporation, he has participated in many of the advances we now take for granted.

He applied his talents to such pioneering projects as developing electrical components for fever therapy and the first cyclotron at the University fo Rochester. He is a past president of the Rochester Engineering Society and a member of many scientific groups.

Yet his interests have not all been technical, for he has served with

the Rochester Chamber of Commerce and he is still Honorary Trustee of the Rochester Museum Association. Ornithology has been a long-term hobby—as far back as 1907, he started a bird skin collection, which is now in the Museum. He joined the Ornithologists' Union in 1911. In 1913 he published a paper in the Auk: "Feeding Wild Ducks on Sodus Bay".

For contributing to our technological environment and for helping us to enjoy living in it, he well deserves the Fellowship we now extend him.

DONALD RICHARD YEAGER

Fellow

The old concept of a park brings to mind tailored paths winding among prim trees, where nursemaids tried to keep their charges off the forbidden grass and their eyes on the strolling policemen. How fortunate we are in Rochester to be able to enjoy a broader new concept—that of an oasis of Nature preserved in its living state.

Our candidate is Park Naturalist for the Monroe County Parks Department, coming to this position as a graduate in ornamental horticulture from the State University of New York at Alfred. He is also the Director of Nature Education for the Department. His work involves the complete administration and development of the interpretive nature program for adults and young people. He teaches several courses in botany and geology and has evolved the nature trails in Mendon Ponds and Webster Parks. He lectures on parks, nature, and ornamental horticulture to many local groups and conducts field trips for the biology classes of the five area colleges. Recently he has done research in Kennedy's Bob on pollen stratification to determine post-glacial vegetation.

Among numerous outdoor hobbies he includes pictorial and nature photography. His work not only finds its way into exhibitions, but also is indispensable as illustration in his lectures. Working with the Eastman Kodak Company, he wrote, directed, and photographed a three-screen audio-visual presentation on "The Rochester Parks Story".

For encouraging an interest in Nature and for significantly helping to provide the means for the continuing growth of that interest, we enthusiastically grant him our Fellowship.

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